STAFFORDSHIRE UNIVERSITY

Efficiency and Market Share in the Banking Sector in South East European Countries

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Abstract

The banking sector in South East Europe Countries (SEECs) has changed dramatically from the start of the transition process. The change in market structure has been associated with a change in market shares of banks. This thesis investigates factors that determine a bank's market share. According to the literature, the main determinant of a bank's competitive position is its efficiency. Hence, the first part of the thesis investigates a bank's efficiency and its determinants, while the second part uses these efficiency estimates along with other bank-specific factors and regulatory variables to investigate the determinants of a bank's market share. The analyses are conducted in eight SEECs for the 2000-2012 period.

Stochastic Frontier Analysis, specifically the Random Parameters Models (Greene, 2005) and the Battese and Coelli (1995) models, are employed for estimation of the bank's cost efficiency. The empirical findings suggest that the choice of methods of investigation matters, with the Battese and Coelli models performing poorly, which supports the critique that these models are data dependent. The banking sector in Slovenia is the most efficient in the region while that in Serbia is the least efficient.

The thesis then investigates the market share of banks which is argued to depend on "inside" bank determinants (cost efficiency, investment in quality of service, risk-taking, capital, ownership structure, etc.) and "outside" bank determinants (regulatory and supervisory practices and macroeconomic variables). A direct theory of market share is undeveloped in the literature; hence, several related strands of theory are examined to develop a model for estimation. It is argued that a bank's market share is the result of a dynamic process; hence dynamic panel estimation is applied. The empirical findings suggest that the effect of efficiency on a bank's market share depends on its size. Taking more risk, being a more capitalized bank relative to the industry average and investment in quality (expanding branch network) contribute to higher market share. Stringent capital requirements, private monitoring and official supervisory power are found to be associated with a less concentrated banking industry. However, the effects of regulation on bank-level market share are found to vary with different risk-taking behaviour of banks.

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"Life is what happens" once the thesis is brought to an end. Much has happened and changed during the years of my engagement with the PhD studies -life does not stand still, nor wait for you to have time to manage it. The PhD journey was rough and challenging, with continuous ups and downs, getting writer's block just as many times, needing to work as much as possible, but I knew there would be a light at the end of the tunnel, but I just had to do it in my own time and on my own terms.

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I DEDICATE THIS THESIS

TO MY ROLE MODEL,

MY FATHER

ZIVKO

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The contribution of the financial sector to economic growth is well established in the economic literature of the last two decades (Pagano, 1993; Levine, 1997; and Wachtel, 2003). The financial sector plays an important role in the economy by, for instance, improving the efficiency of resource allocation in the economy, facilitating financial intermediation and screening and monitoring economic agents who seek and borrow funds from financial institutions. The process of monitoring and supervision of the projects is less costly because of the intermediation undertaken by specialist institutions and further facilitated by economies of scale. Furthermore, the financial sector enhances the saving rate by launching new and customer tailored attractive financial instruments, products and services. These new instruments, products and services, along with the intermediary role of these institutions, create possibilities for risk sharing, diversification and liquidity. In a nutshell, the financial sector plays a vital role in the overall performance of all economies.

In emerging market economies of South Eastern Europe, however, as Wachtel (2003) argues, the banking sector predominantly plays the role of an intermediary and the financial system is a bank-dominated system because the capital markets have been underdeveloped in these countries. To this end, one of the most important elements of economic policy during the process of transition, as recognized by international financial institutions such as the IMF and the World Bank, has been the establishment of a competitive banking system, independent of the state but regulated by it (Drakos and Konstantinou, 2005). Today, more than twenty years after the start of the transition process, the banking sector in South East European Countries (SEECs) has changed dramatically both in term of size and structure, regulatory framework and technological progress.

The development and role of the banking sector has been extensively investigated from different perspectives in the context of developed economies, but studies related to transition economies are fairly limited and this is the motivation for this thesis. The aim of this chapter is to present an overview of this thesis, including the research questions and how they are addressed in later chapters. Moreover, this chapter provides the necessary background on the development of the banking sector in SEECs for other chapters. The structure of this chapter is as follows: Section 2 presents the aims, research questions and specific objectives of the thesis. Section 3 elaborates the structure of the thesis, while the evolution of the banking sector in SEECs is discussed in Section 4. Finally, Section 5 concludes the chapter.

1.2 AIMS, OBJECTIVES AND RESEARCH QUESTIONS

This thesis aims to investigate the factors influencing the cost efficiency and market structure in the banking sectors in SEECs (Albania, Bosnia and Herzegovina, Croatia, Macedonia, Montenegro, Serbia and Slovenia) in the first decade of 21st century (the period of analysis is from 2000 to 2012). The first part of the study focuses on analysing cost efficiency and its evolution in the banking sector while the second part concentrates on identifying the potential determinants of market share in banking, considering factors under the control of a bank ("inside" bank determinants) and factors beyond its control ("outside" bank determinants). It will therefore contribute to the knowledge of the development of the banking sector in transition economies. The thesis has several objectives:

1. To critically review the literature on the methods of estimation of bank efficiency and the empirical literature on cost efficiency in banking with special emphasis on transition economies;
2. To develop an empirical model in order to estimate banks' cost efficiency in the SEECs using different econometric methods;
3. To critically review the literature on market structure in order to identify the potential determinants of market share in banking.
4. To develop an econometric model in order to investigate the identified potential determinants of a bank's market share in SEECs, highlighting the "inside" bank and "outside" bank determinants.
5. To discuss some policy implications of the thesis and provide recommendations to the Supervision and Regulation authorities of the National Banks on the effect of regulation on the competitive position of banks.

In order to pursue these objectives, the following interrelated research questions have been formulated and investigated in the different chapters of the thesis. (i) What is the most appropriate method for investigating cost efficiency? (ii) What is the level of cost efficiency of banks in the SEECs and has there been any improvement in their cost efficiency over time? (iii) Has there been any technological progress that reduces the total cost of banks, hence improving their efficiency? (iv) What is the role of ownership, EU accession and the last financial crisis on the cost efficiency of banks in SEECs? (v) does cost efficiency matter for banks' market share in SEECs? (vi) What are other potential determinants of banks' market share? (vii) Is there a systemic variation in determinants of market share across different bank size-classes? (viii) Is there a systemic variation in the effect of regulatory and supervisory practices across different risk-taking behaviour on banks' market share? (ix) Are there lessons for bank managers and policy makers on how to improve their efficiency and also their competitive position?

The motivation and importance of this thesis is in its contribution to enriching the literature on efficiency and market share in banking in the context of the SEECs. The novelty of this research is reflected in: (i) the estimation cost efficiency for banks in SEECs in the most recent years, including the period of the financial crisis, using a relatively new econometric method previously not applied to transition economies which is theoretically preferred to the models applied in the existing studies; (ii) opening the “black box” of what determines the market structure, specifically a bank’s market share, in the banking sector in the SEECs, in particular which factors facilitate a bank’s growth and which factors hinder its growth.

1.3 STRUCTURE OF THE THESIS

In this section a brief outline of the individual chapters of the thesis is presented. Chapters 2, 3 and 4 represent the first part of this thesis which deals with the question of cost efficiency in banking in SEECs, while Chapter 5 and 6 constitute the second part of the thesis examining the determinants of market share of banks in this region.

Chapter 2 discusses the theoretical concepts of efficiency followed by a review of the methods of investigation of efficiency. Initially, this chapter identifies the appropriate definition of efficiency after presenting various definitions and concepts related to firm’s efficiency. The next issue considered in this chapter is the choice of preferred method for the empirical analysis of bank’s cost efficiency, which is the subject of analysis in Chapter 4. The choice of the appropriate method for analysis is based on extensive and detailed discussion of the large variety of methods of estimation. Based on this review, the Stochastic Frontier Analysis (SFA) is selected as the appropriate approach, in particular because it allows for the estimation of time-varying efficiency and controls for unobserved heterogeneity. Other issues that are considered in this chapter are: (i) whether the efficiency “frontier” is estimated for individual countries or for the region as a whole, (ii) the choice of the functional form which explains the shape of the relationship between output and inputs in the banking sector, and (iii) the nature of inputs and outputs of the banking system (are banks producers of financial service or just simple intermediaries?).

Chapter 3 presents a critical review of the empirical studies on cost efficiency in banking with special reference to transition economies. Given the conclusions of Chapter 2, this chapter focuses on empirical studies estimating cost efficiency in banking using the SFA method. First, it presents the methods of estimation applied in the empirical studies of cost efficiency in the banking sector. Second, it reviews the existing literature on efficiency in the banking sector in transition economies, aiming to compare similarities and differences with respect to questions tackled and methods of investigation used in various studies. The review will identify the drawbacks in the current literature and address the gap in knowledge in this field with special reference to SEECs. This chapter is a bridge between the theory in the previous chapter and the empirical analysis in the following chapter.

Chapter 4 is devoted to the estimation of banks' cost efficiency, drawing on the theoretical and empirical evidence discussed in the two previous chapters. This chapter is of importance not only because it attempts to fill a gap in the literature on cost efficiency estimation in the banking sector in transition economies, but also because the predicted efficiency scores resulting from the estimation procedure are used as a determinant of the market share in the banking sector, the focus of the second part of the thesis. The chapter consists of developing an econometric model for cost efficiency estimation, followed by a discussion of the data which is of special importance in this thesis (the limited data on countries under consideration available in the Bankscope database has been extended through the considerable effort of the author). The chapter then analyses the empirical findings on cost efficiency.

The second part of the thesis deals with the development of the theoretical and empirical work on market share in banking. Chapter 5 develops a conceptual framework for the study of determinants of market share in the banking sector in transition economies. Given that the literature on market share in banking is very scarce, the chapter adopts an eclectic approach and draws on various strands of economic literature. These include the literature on measuring the extent of competition based on efficiency (Boone, 2000, 2004, 2008), the Endogenous Sunk Cost theory (Sutton, 1991, 2000), the role of total capital (equity) (Berger and Bouwman, 2013), Prospect Theory (Kahneman and Tversky, 1979), probability of bank failures (Buchinsky and Yosha, 1995), lending standards and screening in banking (Dell'Ariccia and Marquez, 2006; Ruckes, 2004) and the effect of regulation on competitive position in banking. By analysing this range of literature we identify two categories of potential determinants of market share: the "inside"- and "outside"-bank determinants, the former category being under the control of a bank's management and the latter being beyond the control of the bank. Possible "outside" bank determinants (regulation and supervision) are even less investigated in the literature than "inside" bank determinants, because the main concern of the literature on regulation in banking is securing a safe and sound banking sector with special reference to risk-taking, rather than with the regulation of market share.

Chapter 6 aims to empirically investigate the potential determinants of a bank's market share. The specification of the empirical model is based on the discussion and the "derived" theoretical framework in Chapter 5. Given that market share is of a dynamic nature, the specified empirical model is a dynamic panel model, estimated by General Methods of Moments (GMM). In addition to the baseline analysis (the effect of "inside" bank and "outside" bank determinants on market share) and in line with the theoretical framework (Chapter 5), additional testable hypotheses are defined to explore the possibility of systemic variation across different risk-taking behaviour and different size-classes of banks.

Finally, Chapter 7 formulates the conclusions of the thesis. As a part of this chapter, special emphasis will be put on the contributions to knowledge provided in this thesis, the limitations of this research project and possibilities for future research. Some policy recommendations in terms of cost efficiency and market share will also be presented in this chapter even though this thesis is not primarily driven by policy considerations.

1.4 AN OVERVIEW OF THE BANKING SECTOR IN SEECs AFTER 20 YEARS OF TRANSITION

This section sets the scene for the research questions and provides relevant background information on the banking sector in SEECs which is necessary for the analysis of the subsequent chapters of the thesis. Given that the SEECs underwent a turbulent transformation from socialism to free market economy, we briefly describe the banking system in SEECs during the era of socialism (until 1990), followed by a discussion of its transformation during the early stage of transition (until 1999). The period from 2000-2012, which we refer to as the later stage of transition, is of special interest because it is the period covered by this investigation. We analyse the banking developments in SEECs only from those aspects relevant to our research objectives presented in Section 1.2.

1.4.1 Banking system under Socialism until 1990

During the era of the socialism (or central planning) in SEE, two types of banking systems were in existence. The most common, the monobank (or the single-tiered banking) system, was predominant in almost all socialist countries while the former Yugoslav Republics (at that time Bosnia and Herzegovina, Croatia, Macedonia, Montenegro, Serbia and Slovenia and two autonomous provinces Vojvodina, and Kosovo and Metohia) had introduced a kind of “two-tier system” (replacing the monobank with eight separate national banks and a number of commercial banks) since the early 1960s. Although, the “form” of the banking system in Yugoslavia was similar to that in market-oriented economies, in essence its role and its functioning was very similar to the monobank system. In particular, all the national banks and commercial banks belonged to a uniform operational system, responsible for the implementation of the common monetary, credit and foreign exchange policies formulated and negotiated in the Federal Assembly and decided by the Federal Government of Yugoslavia, all under the control of the League of Communists of Yugoslavia (Green and Petrick, 2002).

1.4.2 Building a market economy: Banking system in the early stage of transition (1990-1999)

The transition period from a centrally-planned economy towards a free market economy in the SEECs started in the beginning of the 1990s.[1] Transition was a process of complex transformation of the economy, polity and society. Along with reforms in all aspects of economic and wider social life, the transition in the financial sector had the goal of developing market-oriented financial institutions. This involved establishing a genuine two-tier banking system, liberalization of interest rates, abolition of central credit and cash plans, restructuring and privatisation of state banks and the entry of new private banks.

Following the initial measures for the establishment of a market-oriented banking system, all SEECs established a two-tier banking system, with the Central Bank in charge of the creation and implementation of the monetary policy and regulation and supervision of other banks. Although the commercial banks were separated from the central banks, at the outset these (new) commercial banks along with the speciality banks and the saving banks were state owned with a few banks dominating the new banking system and with usually one bank being *"a monopolist in rudimentary retail banking"* (Bonin, 2001).

However, the introduction of the two-tier banking system had the seeds of failure embedded in it from the beginning, because the newly created commercial banks inherited the loans issued under the previous system, with soft budget constraints with no obligation for repayment. Additionally, the elimination of subsidies to firms and market liberalization significantly weakened the ability of firms to repay their loans even when they wanted to meet their obligations (Tang et

[1] In former Yugoslavia the transition process started later than other CEE and SEE countries because of the outbreak of war in this country in 1991 (starting with the separation of Slovenia) followed by civil wars in Croatia (1991-1992), in Bosnia and Herzegovina (1992-1995) and in Kosovo (1999).

al., 2000). This led to enormous accumulation of non-performing loans which resulted in the need for intervention by respective governments. Moreover, the liberalization of banking was expected to introduce competition in the sector, hence many countries applied lax licensing criteria and lenient regulation designed to attract new banks, resulting in the entry of many undercapitalized and poorly managed private banks (Barisitz, 2009). This further increased the riskiness and instability of the sector. A majority of loans were granted on ad hoc basis to state-owned enterprises without screening their creditworthiness because the banks lacked appropriate monitoring technology and human capital capacities and because such practices were completely new to banks in these countries. There was an inherited habit of granting loans according to the requests and the needs of the government.

All this resulted in bank failures and governments were forced to intervene to “rescue” the unhealthy banks due to the large volume of non-performing loans (Bonin, 2001; Bonin and Wachtel, 2004) in order to maintain financial stability. The SEECs approached the banking sector rescue operations in different ways. For example, Bulgaria and Macedonia adopted the recapitalization of the poorly performing banks, whilst Croatia and Slovenia established state-owned hospital banks or similar asset management companies that took over from the non-performing loans of banks. The success of the intervention process was limited, since it targeted only the current stock of non-performing loans while the flow of new bad loans was beyond the scope of the intervention (Bonin et al., 2008).

The two-tier banking system and the forced introduction of competition in the sector by new banks entering the market under lax licensing criteria were not enough to secure well-functioning, efficient and sustainable banking systems in the SEECs. A number of other factors also played their role. The lack of prudential regulation and supervision, corruption in institutional environment allowing weak internal governance practices, politically motivated lending, and the underdeveloped protection of creditor rights which prevented them from seizing collaterals and recovering loans, all contributed to the worsening of the financial position of banks (Tang et al., 2000; Riess et al., 2002).

As Bonin and Wachtel (2002) emphasize, an important prerequisite for an efficient and sustainable banking sector is the existence of financially healthy banks, independent of the state and independent of the heritage of socialism (those that developed under the soft budget constraint). Privatization could produce benefits such as the gradual disappearance of political influence in credit allocation and the adoption of screening technologies and risk management practices which influence the riskiness of banks' activities (Reininger et al., 2002). In addition, state-owned banks were generally considered to be overstaffed, poorly equipped technically and reluctant to adopt banking innovations (EBRD, 1998). Consequently, the advent of privatization in banking, as in the other sectors of the economy, was inevitable and all SEECs had started this process by the mid-1990s. By 1999 the progress of privatization was classified as gradual in most of the SEE countries (EBRD, 1999). In the early stage of the privatization, banks in SEECs were owned by many small owners or by enterprises and the government (Tang et al., 2000). However, the dispersion of the ownership hindered the improvement in corporate governance of banks as many banks were owned by non-financial firms (usually major clients of the banks) and individuals without any expertise in managing banks (Kraft, 2004). Therefore, as extensively advocated in the literature, competition could be enhanced only by the entry of foreign capital. It improved corporate governance, increased efficiency of the banking sector and produced positive externalities in the sector (Thorne, 1993; Anderson and Kegeles, 1998; Bonin et al., 1998 and Kraft, 2004). However, initially there was scepticism among government officials about the benefits of the foreign capital and the process proceeded very slowly until the late 1990s (Slovenia was the last to allow foreign capital in 1999).

Table 1.1 Descriptive statistics of the banking sector, end-1999

Country	Albania	BIH	Bulgaria	Croatia	Macedonia	Slovenia	FRY[a]
Number of banks	13	61	34	53	23	31	81
Majority foreign owned	8	9	14	13	5	5	0
Banks (per million people)	3.9	16.5	3.3	11.6	11.3	15.6	9.9
Total bank assets (US$ billion)	1.8	3.1	4.2	10.6	1.2	13.65	11
Assets of top five banks (% of total bank assets)	87	/	63	62	71	63	60
Non-performing loans (in % of total loans)	32.7	58.7	17.5	20.6	62.6	9.3	10.2[b]
Asset share of state-owned banks (%)	37	76	50.5	39.6	6.47	42.2	89
Asset share of foreign-owned banks (%)	63	3.8	42.8	40.3	11.5	4.9	0.4
Credit to enterprises (% of GDP)	3.6	3.6	14.6	22	11.3	35.9	19
Required capital adequacy ratio	12	8	12	10	8	8	8
Actual Capital adequacy ratio	8.2	n/a	43.1	19.3	28.7	14	n/a
EBRD Index of banking sector reforms[c]	1.7	2.3	2.7	3	3	3.3	n/a

Source: Pissarides (2001), EBRD and World Bank

Note: a) The Federal Republic of Yugoslavia (FRY) consisted of Serbia and Montenegro during the late 1990s. It was officially renamed Serbia and Montenegro in 2003, and in June 2006, Montenegro became an independent country; b) Data refer to Serbia only as presented in the EBRD Report (2004); c) This indicator provides a ranking of progress in liberalisation and institutional reform in the banking sector, on a scale of 1 to 4+. A score of 1 represents little change from a socialist banking system apart from the separation of the central bank and commercial banks, while a score of 2 means that a country has established internal currency convertibility and have liberalised significantly both interest rates and credit allocation. A score of 3 means that a country has achieved substantial progress in developing the capacity for effective prudential regulation and supervision, including procedures for the resolution of bank insolvencies and establishing hardened budget constraints on banks by eliminating preferential access to concessionary refinancing from the central bank. A score of 4+ represents a level of reform that approximates the institutional standards and norms of an industrialised market economy, as represented, for example, by the Basle Committee's Core Principles on Effective Banking Supervision and Regulation.

Table 1.1 presents some descriptive statistics of the banking sector in SEECs at the end of 1999. In particular, by the end of the 1999 the number of banks substantially increased in all countries, possibly as a result of the loose entry requirements. The level of non-performing loans was high in all SEECs except in Slovenia. In Macedonia and BiH this indicator was extremely high. The presence of foreign capital in SEECs by the end of 1999 was low in general, except for Albania, Bulgaria and Croatia. The generally low percentage of credit to enterprise relative to GDP suggests that the credit activity of the banks was still in stage of development. The actual capital adequacy ratio was far above the minimum required level in all SEECs. According to the reports provided by EBRD the banking reforms were still at an infant stage in Albania and to some extant in BiH, while the other countries considered had undergone heavy restructuring processes.

An important element of the transition process in banking is the establishment of prudential regulations (including the Basel standards for capital adequacy requirements, loan classification and provisioning), revision of the licensing criteria and an effective legal framework, enhancing the banking supervision, and adoption of international accounting standards (Tang et al., 2000). Although most of the legislative and other administrative acts were established in the first decade of transition, there was lack of effective implementation. In 1998 EBRD conducted a survey to assess how effectively countries in the region enforced financial laws and regulations so as to foster confidence in the banking sector. The results are presented in Table 1.2. Albania and BiH (with a low rating of 2 for effectiveness) had still not implemented standards with respect to capital adequacy, related party lending and transactions, and bank insolvency, had not adopted international accounting standards and did not perform regular on-site supervisory examinations. Croatia, Macedonia and Slovenia (with a score of 3 for effectiveness) had reasonably comprehensive financial laws and regulations, but could benefit from further refinements in some areas so as to raise standards in line with core principles. Bulgaria (with a score of 4 for effectiveness) had comprehensive banking regulations, but some refinement was still needed in at least one important area. Detailed explanation of the rating score is presented in Appendix to Chapter 1, Section 1.1, and Table A1.1.

Table 1.2 Extent and effectiveness of financial laws and regulations, 1998

Country	Extensiveness	Effectiveness

Albania	2+	2
BiH	3	2
Bulgaria	4	4-
Croatia	3	3
Macedonia	3	3-
Slovenia	4	3

Source: EBRD Transition Report; Note: The higher the rating scores the better financial laws and regulations.

Following the deep transition recession, economic growth restarted in most countries under consideration around mid-1990s, the macroeconomic situation temporarily stabilized, banking sectors started to consolidate, and one could argue that a market-oriented economy was almost re-established in the region (Barisitz, 2009).

1.4.3 Banking systems of SEECs in the later stage of transition (2000-2012)

The developments in the banking sector in SEECs in the later stage of transition (2000-2012) are of special interest as this thesis is concerned with this particular period. This section focuses on selected aspects of banking development in SEECs which are of relevance to our research questions. Specifically, this section:

(i) Illustrates common trends across, and major differences between, countries under investigation. The graphical presentations aim at mainly showing the similarities in patterns and major variations in individual countries over time.
(ii) Compares specific banking system indicators at two points of time, 1999 and 2012 (the end of our dataset).

Several events marked the late 1990s and the second decade of transition. In particular, the collapse of the Pyramid Ponzi scheme in Albania in 1997, the severe financial crisis in Croatia 1998, the war in Serbia in 1999, the civil conflict in Macedonia in 2001 and the international financial crisis in 2008 and beyond affected the SEECs seriously. At the same time, all countries under consideration experienced sustained output growth from 2002 until 2007, as presented in Figure 1.1, with an overall average real growth per capita of 5.3 per cent at 2005 constant prices.

However, growth was negatively affected by the last financial crisis, with an overall average growth per capita of -4.7 in 2009. The most affected country was Slovenia (with real GDP per capita growth of -8.8 per cent) and the least affected was Albania (with real GDP per capita growth of 3.5 per cent). All SEECs quickly recovered from the recent recession, but as argued by EBRD (Transition Report 2013, p.13) *"the growth rates have remained low, not only compared with the boom period of 2004-08, when output in the transition region as a whole expanded by 6.6 per cent a year, but also compared with the five-year period preceding the boom."*

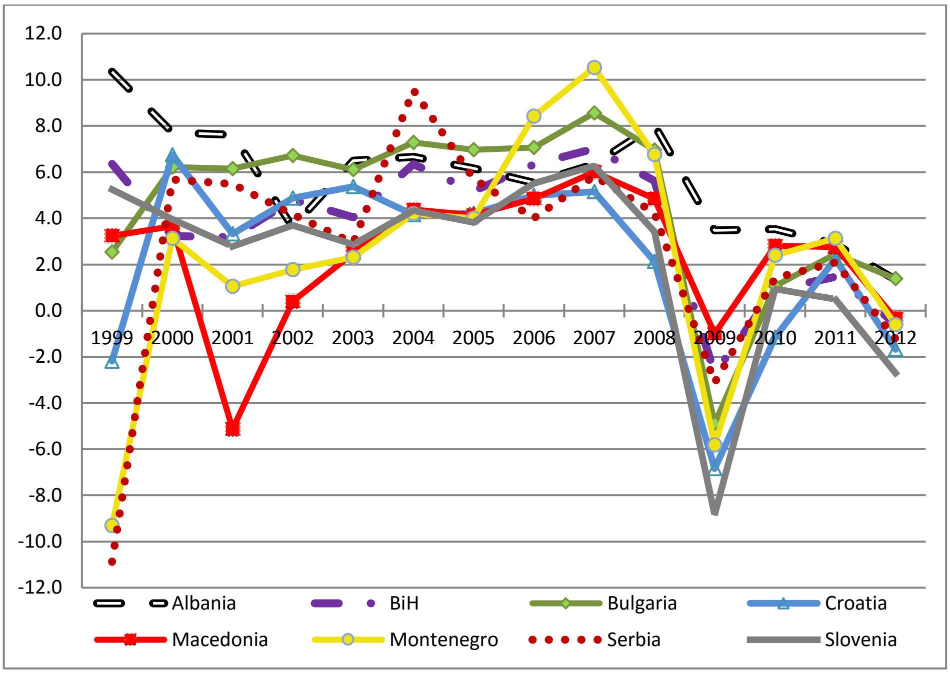

Figure 1.1 Annual GDP per capita growth in 2005 constant prices (in %)
Source: World Bank, World Development Indicators (database)

Although there was overall economic growth in these countries during the later stage of transition, there was still a huge gap between countries in terms of their development. Figure 1.2 presents the GDP per capita (in 2005 constant prices) in the two years, 1999 and 2012, clearly showing that Slovenia and Croatia are the two most developed countries in the region, while Albania is the least developed country (even though it had the highest average real GDP per capita growth, 5.7 per cent, over 1999-2012). It is important to note that Slovenia and Bulgaria have joined the European Union during the analysed period, in 2004 and 2007, respectively. Croatia gained full membership in 2013.

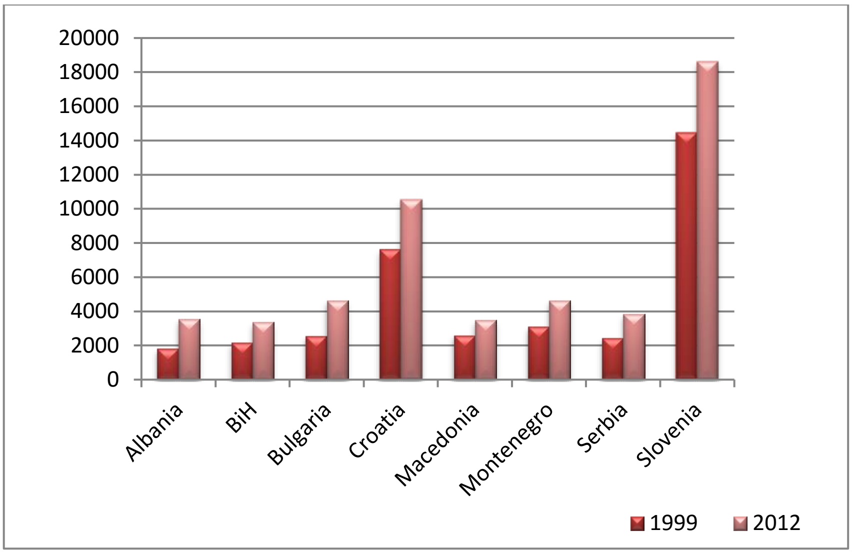

Figure 1.2 Real GDP per capita in thousands US dollars (in 2005 constant prices)

Source: World Bank, World Development Indicators (database)

The SEECs succeeded in stabilizing the inflation, which was a serious macroeconomic problem at the beginning of transition, during the second stage of transition. Over the period 1999-2012 inflation was generally relatively low in the region (the overall average during 1999-2012 in SEECs was 4.5 per cent with Serbia having the highest rate of 10.3 per cent). During the financial crises in 2008 the average inflation in the region reached 8 per cent (see Figure 1.3 for details).

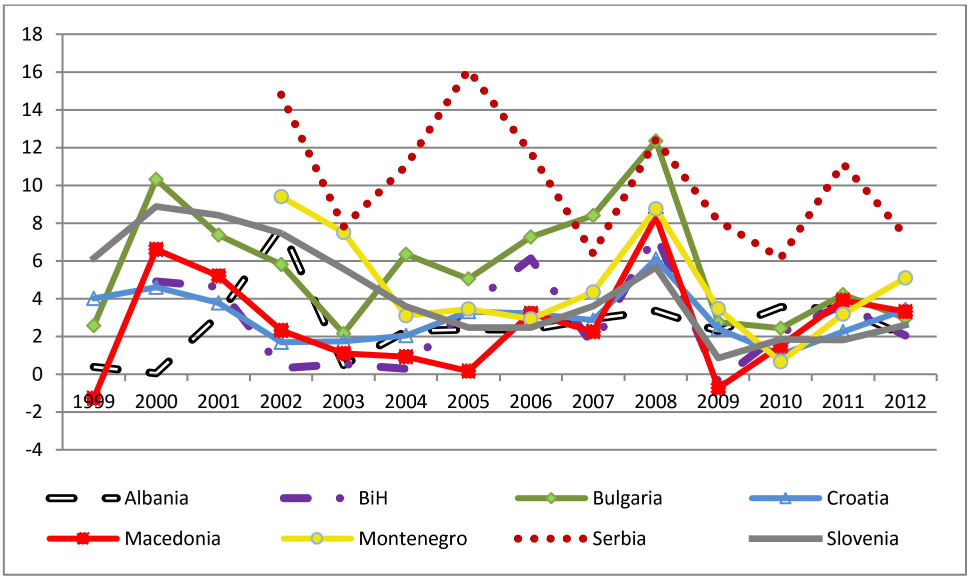

Figure 1.3 Inflation based on Consumer Price Index for the period 1999-2012 (in %)

Source: World Bank, World Development Indicators (database)

Size and Market Structure in Banking in selected SEECs. During the second stage of transition the banking sector in SEECs was significantly strengthened and the principles of a competitive and free banking system were fully adopted by all government. In addition, the banking system stability was considerably improved and the banking sector became capable of resisting shocks, hence reducing the likelihood of disruptions in the financial intermediation process.[2] This resulted mainly from: the process of privatization which enforced competition in banking and transformed banks into profit maximizing firms; the reduction in the role of the state in the banking system; and the introduction of prudential regulation including the adoption of the Basel standards, which contributed to enhancing the quality of banks' portfolios, as well as the rapid increase of the foreign ownership of banks. In what follows, we discuss these developments in the banking system in SEECs as they seem to be important factors affecting banks' efficiency and their competitive position over time.

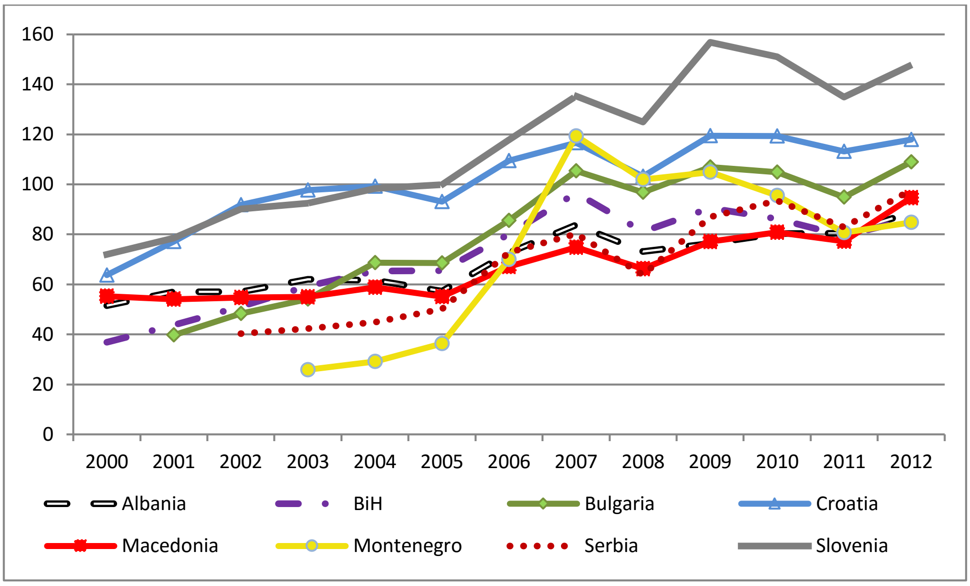

Figure 1.4 Assets-to-GDP ratio in SEECs during 2000-2012
Source: Annual Reports from national banks and authors' own calculations

The banking sector became the major player in the financial markets in SEECs after the process of recovery and transformation, a role which it has retained to the present time, because the capital markets are still underdeveloped. The progress of the financial intermediation in the banking

[2] According to the definition of financial stability by European Central Bank.

systems is presented in Figures 1.4 and 1.5 which respectively illustrate the trend of assets-to-GDP ratio and the domestic credit to private sector as % of GDP. These indicators of financial intermediation clearly suggest a considerable increase in the overall activities of banks. Financial intermediation was the highest in the EU member states of Slovenia, Bulgaria and Croatia (the total assets in these countries were also higher than other countries). Montenegro had the lowest financial intermediation in terms of assets-to-GDP, although in 2008 it reached the level of intermediation of Croatia, it declined sharply with the onset of financial crisis. Albania had the lowest level of domestic credit to private sector issued by banks.

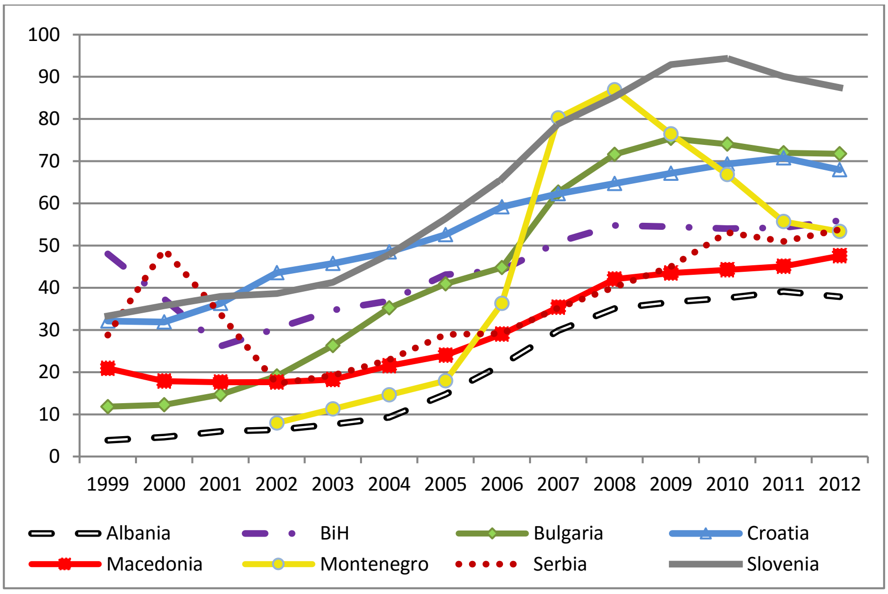

Figure 1.5 Domestic credit to private sector issued by banks (% of GDP)
Source: World Bank, World Development Indicators (database) and EBRD Transition Reports

As discussed in Section 1.4.2, the lenient entry requirements at the beginning of transition led to a significant deterioration of the quality of banks' portfolios instead of intensifying competition in banking. However, in the later stage of transition the banking legislation was revised and with government almost completely marginalized, competition has allowed healthy and well-functioning banks to survive, resulting in the consolidation of the banking sectors and a substantial reduction in the number of banks in most of the countries, except Albania and Montenegro (which started and ended the period with relatively low numbers of banks) (see Figure 1.6 for more details).

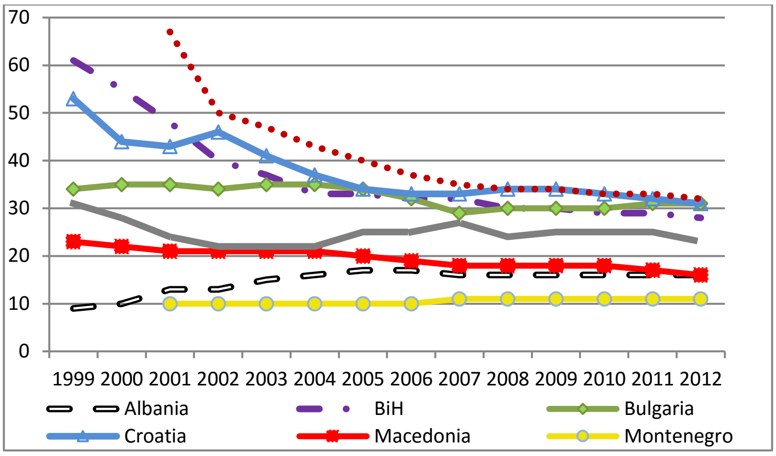

Figure 1.6 Number of banks across countries in the period 1999-2012

Source: EBRD Transition Reports and Annual Reports from national banks

Herfindahl-Hirschman Index (HHI, measured in terms of total assets) and CR3 (the market share of the largest three banks in each country, measured in terms of total assets) are used to present the concentration of the banking sector in SEECs. The former indicator is presented in Figure 1.7, while the latter in Figure 1.8. According to the HHI by the end of the 2012 none of SEECs were characterized by a highly concentrated banking sector (HHI>1800). Montenegro had the highest market concentration with a HHI of 1574, while the Serbia had the least concentrated market, with an HHI of 715. It is noticeable that CR3 did not follow the declining trend of HHI - it increased in BiH, Macedonia, Montenegro and Serbia and decreased in Albania, Bulgaria, Croatia and Slovenia. The variations in the market structure across SEECs may play an important role with respect to banks' efficiency and the competition environment of individual banks.

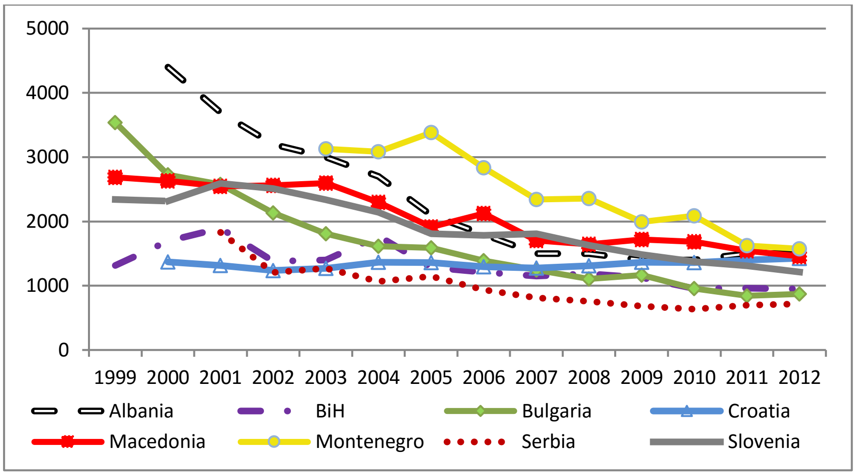

Figure 1.7 Herfindahl-Hirschman Index (based on total assets)

Source: Bankscope and author's own calculations

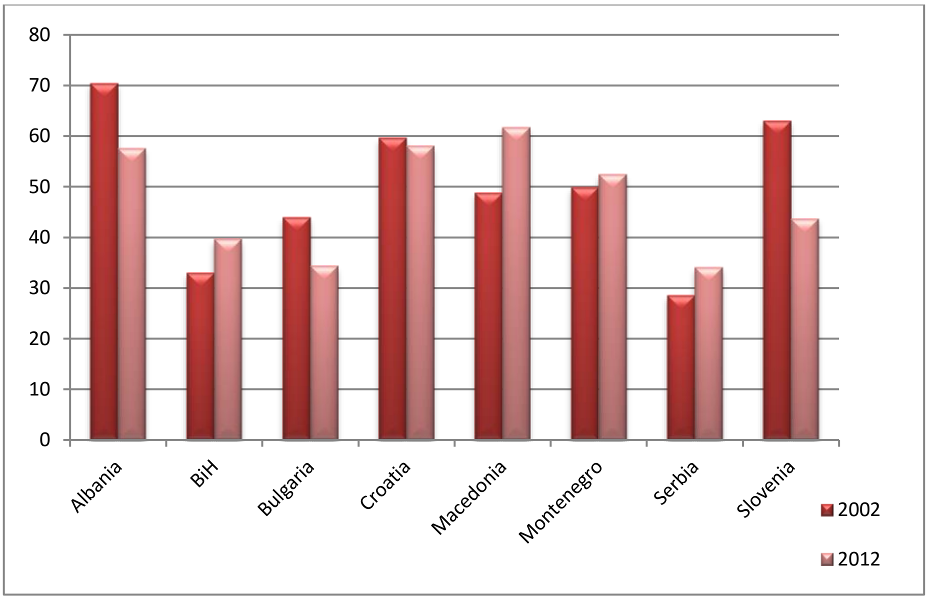

Figure 1.8 Market share of the largest three banks in % (based on total assets)
Source: Bankscope and author's own calculations
Note: The first available data for Montenegro and Serbia is 2003

The different trend of HHI and CR3 although it seems contradictory, it could be explained using the consolidation in the banking sector in SEECs and the recent literature on competition. At first glance, it is expected that consolidation in banking would increase the overall market concentration, this was not the case and market concentration, as measured by the Herfindahl-Hirschman Index (HHI, measured in terms of total assets) reduced considerably over the period. Although in general it is expected that bank consolidation would increase the overall market concentration, this is not necessarily true, and depends on the specificities of the process in each country. Moreover, the recent literature (as discussed in Section 5.1) emphasise that these indicators should be treated with caution as the degree of competition, or concentration, in a market depends not just on the market share of one or a few large firms, but also on the share of remaining firms and other market specificities.

Ownership Structure. Most of the development in the banking sector in SEECs can be attributed to the entry of foreign banks. Such consideration results from their experience in intermediation and provision of banking services, their knowledge of how to compete under free market conditions and the positive spillover effects on domestic banks (in particular with respect to accelerated development in human capital (Litan et al. 2001; Papi and Revoltella, 1999). Foreign banks with their know-how and advanced technology, including sophisticated risk-management practices, have contributed to greater stability of the banking system in SEECs. As Lensink and Hermes (2004) argue, foreign banks have positively affected the creation and implementation of new regulatory and supervisory practices because regulators have come across "new" ways of doing business in banking introduced by foreign banks. Hence banking regulations were changed to incorporate these new practices and activities and were revised in line with regulations in the developed countries. In terms of the effect of foreign banks on efficiency in the banking sector, although theoretically this is expected to be positive (more on this in Chapter 3), the empirical findings are rather mixed. The impact of foreign ownership on efficiency is one of the research questions investigated in Chapter 4 of this thesis.

The significant influx of foreign capital in banking occurred in the period after the privatisation process. Figure 1.9 illustrates the change in the share of foreign capital in the banking system of countries under consideration in the period 1999-2012, while the shares of foreign, private domestic and state ownership in 1999 and 2012 are presented in Figure 1.10.

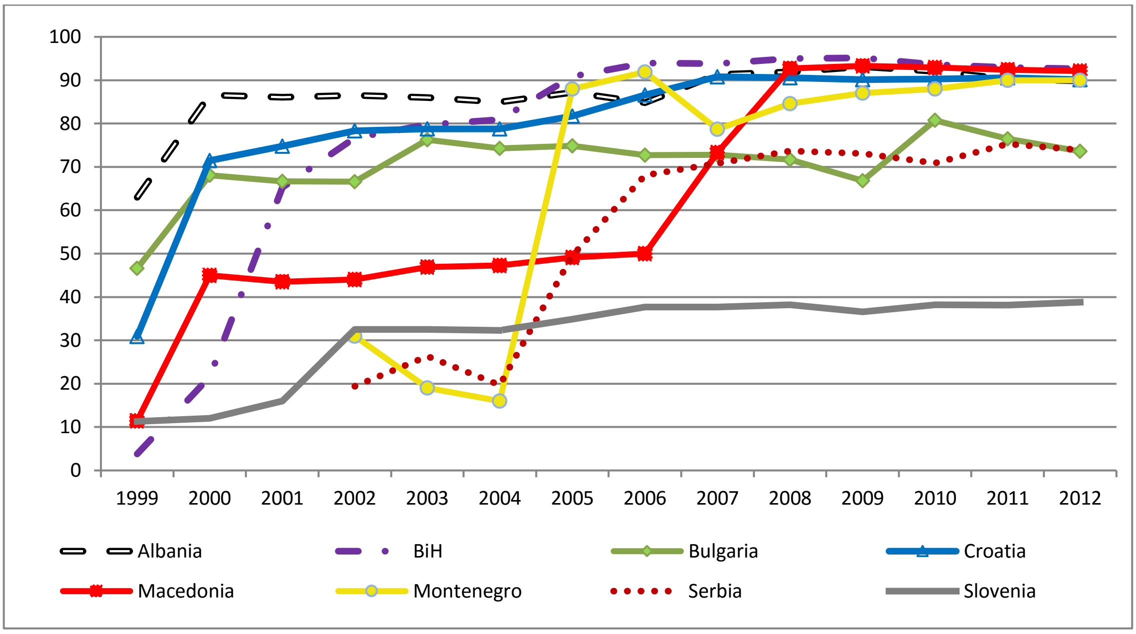

Figure 1.9 Foreign ownership in the banking sector in % (based on total assets)
Source: BSCEE Annual Reports and Annual Reports from national banks

These graphs highlight several points. First, at the beginning of the period under review, countries differed in terms of foreign ownership, with Albania having the highest presence of foreign capital (over 60 per cent) and BiH having very little foreign capital, possibly due to the still vulnerable political situation. The banking sector in other countries is now fully dominated by foreign capital. Slovenia has been resisting the entry of foreign banks but, given the aspiration to join EU, it was impossible to continue to keep out foreign capital. However, even at the end of the period under consideration the Slovenian banking sector is not dominated by foreign capital. Regarding state ownership in the banking sector, Figure 1.10 shows that this type of ownership is now negligible in most countries except in Slovenia and Serbia. By the end of 2012 the private domestic capital is more present in Slovenia and Bulgaria than other countries (Bulgaria is the only banking sector in which the share of private domestic capital has increased over this period, at the expense of state ownership). Such rapid and considerable change in ownership structure is expected to affect the banks' efficiency and changes in efficiency to be experienced in the short-run mainly due to the better know-how of the foreign management and the introduction of advanced technology and the range of new products (this effect is empirically investigated in Chapter 4). Additionally, the enhanced competition introduced by the foreign capital can be expected to affect the competitive position of banks in the market – an issue which is empirically examined in Chapter 6.

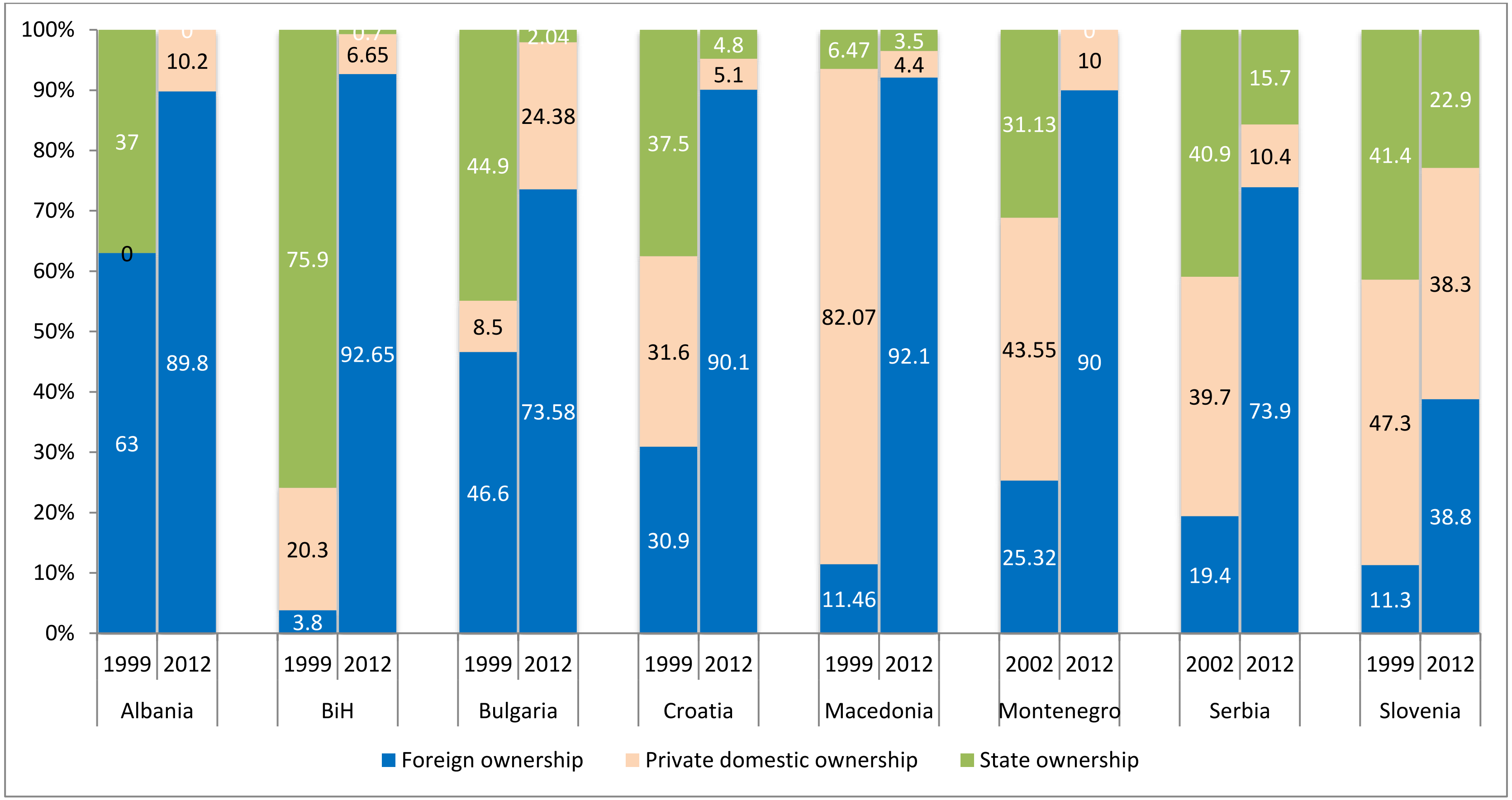

Figure 1.10 Ownership Structure in the banking sector in % (based on total capital: equity)

Source: BSCEE Annual Reports and Annual Reports from national banks

Note: The first available data for Montenegro and Serbia dates from 2002

Efficiency, Quality of Portfolio and Capital Adequacy Ratio. Other important aspects in the evolution of the banking sector which are of interest to this thesis are efficiency, risk-taking behaviour and the level of capital of the banks. Several indicators are presented in order to depict the trends of these important features over time. An indicator that arguably reflects the efficiency of the banking system is the interest rate spread as it presents the cost of intermediation. It may also suggest either enhanced competition or market power of some banks. The interest rate spread in the banking sector in SEECs during 1999-2012 is presented in Figure 1.11. It is noticeable that it has a generally declining trend until the onset of financial crisis in 2008 since when the interest rate spread has broadly stabilized.

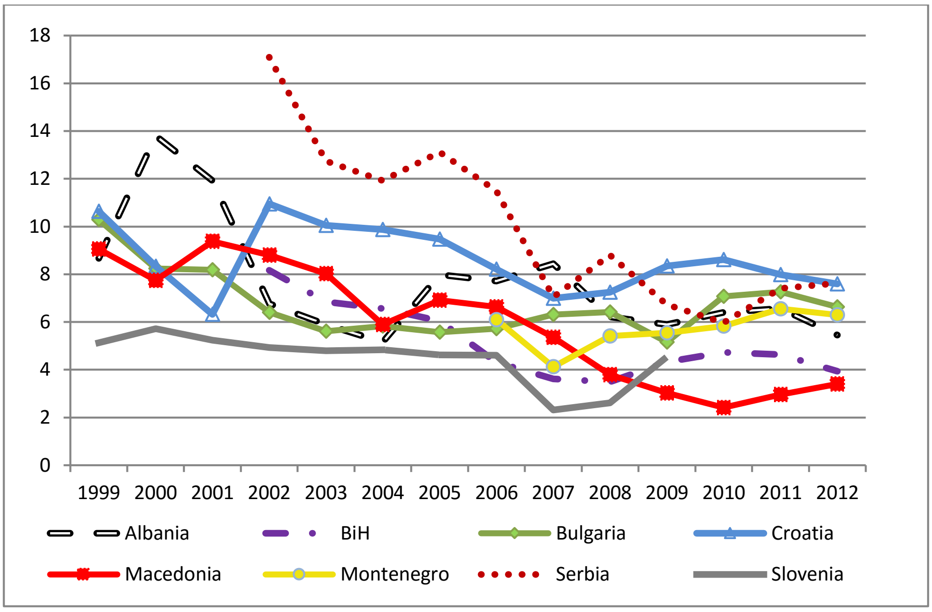

Figure 1.11 Interest rate spread (lending rate % minus deposit rate %)
Source: World Bank, World Development Indicators (database)

At the outset of the financial crisis the bankers in SEECs, as with those in developed countries, became more vigilant regarding the realization of the current and future lending and, hence, in some countries the lending interest rates increased, because of the expected higher risk in that period. However the interest rate spreads have marginally increased, because the deposit interest rate increased as well. By the end of 2012, a considerable difference in the interest rate spread is noticeable, for example in Macedonia and BiH it is about 4 per cent, while in Bulgaria, Croatia and Serbia it is above 6 per cent.

The number of banks per capita in a country may be associated with the exploitation of economies of scale. This indicator is presented in Figure 1.12 for 1999 and 2012. Apart from Albania and Montenegro, the number of banks per 100,000 inhabitants has decreased in these countries, mainly due to the consolidation process discussed earlier. Although this indicator has almost doubled for Albania it is still among the lowest in the region, together with Bulgaria and Serbia. By the end of 2012, Montenegro has by far the highest number of banks per capita. Given that this indicator varies considerably across countries, it may offer banks the possibility of achieving scale economies and hence enhance efficiency.

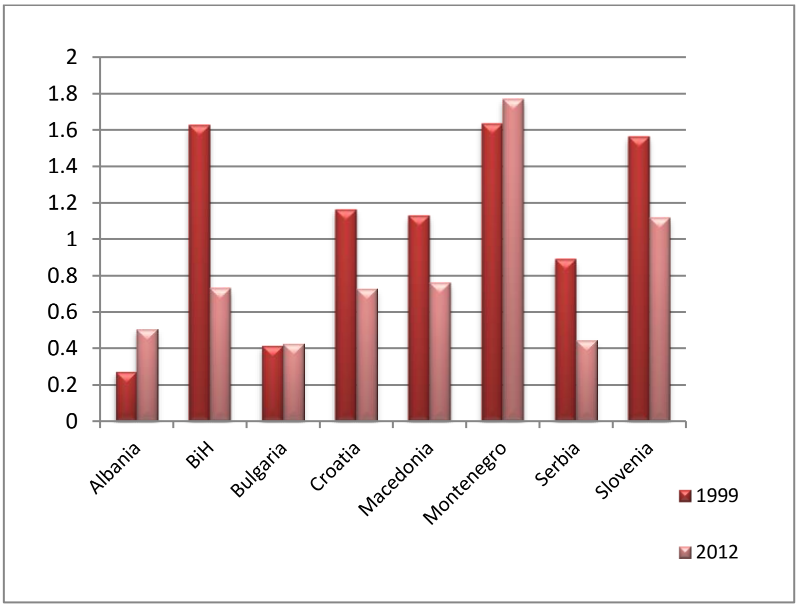

Figure 1.12 Number of banks per 100,000 people

Source: Author's own calculations

The quality of the loan portfolio in SEECs during 1999-2012, represented by the ratio of non-performing loans to total loans, is presented in Figure 1.13. Despite the stabilization of the banking sector in SEECs in the late 1990s, all countries under consideration except Slovenia, had a two-digit non-performing loans ratio (Macedonia's was more than 60 per cent). Given that a loan takes time to be categorised as non-performing, it is reasonable to assume that such loans date from the turbulent period when the free market economy and hard budgeting were not yet fully established. However, after 2000, when state ownership declined significantly and foreign ownership became dominant, the quality of loan portfolio considerably improved in all SEECs until 2007 (apart from Serbia). As expected, the onset of crisis meant that non-performing loan increased in almost all countries under consideration.

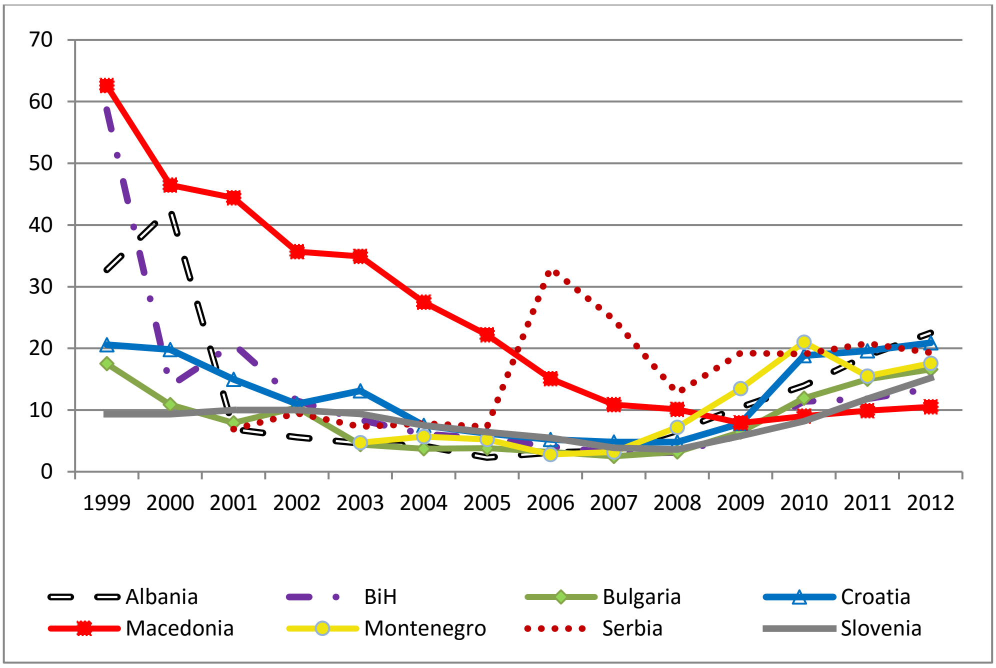

Figure 1.13 Non-performing loans in SEECs during 1999-2012 (in % of total loans)

Source: EBRD Transition Reports and BSCEE Annual Reports

The higher quality of the banks' loan portfolio can be related to several factors (further discussed in Chapter 5). The expansionary macroeconomic environment of the years under consideration brought more prosperous borrowers, with a higher probability of realizing their undertaken projects and increasing capability for repaying their loans. A characteristic of the banking sector in SEECs is the stringent lending process, particularly the high level of collateral required by banks prior to a positive lending decision. The improvement in the quality of loan portfolio may be due to the influx of foreign capital, especially the managerial know-how reflected in the sophisticated risk-assessment practices. The development of comprehensive legislation for regulation and supervision of the banks may also have been a crucial factor for restricting the risk-taking behaviour of the banks. However, as presented in Figure 1.13 the quality of the loan portfolio has deteriorated since 2007-08. Although this period includes the recent global financial crisis, most of the countries in this study have not been substantially affected by the financial crises compared to the developed countries, as the banking sector in these countries still pursue traditional banking. Arguably the increase in the proportion of non-performing loans may be due to the large credit growth in the previous period, as presented in Figure 1.4 and 1.5, particularly as it takes time for a loan to be classified in this way.

The trend of the capital adequacy ratio in the banking sector in SEECs during 1999-2012 is presented in Figure 1.14. In 1999 most SEECs had a very high actual capital adequacy ratio which may be a reason why there was financial stability in these countries despite the very high share of non-performing loans. However, as the financial intermediation has deepened and the credit growth increased, the capital adequacy ratio declined sharply (with the exception of Slovenia which has had constant capital adequacy ratio). Presumably a large portion of this capital was also invested in profitable projects (lending). Nevertheless, during the period under consideration all countries have held a significantly higher per cent of assets than required by the regulators (which varies from 8 to 12 per cent).

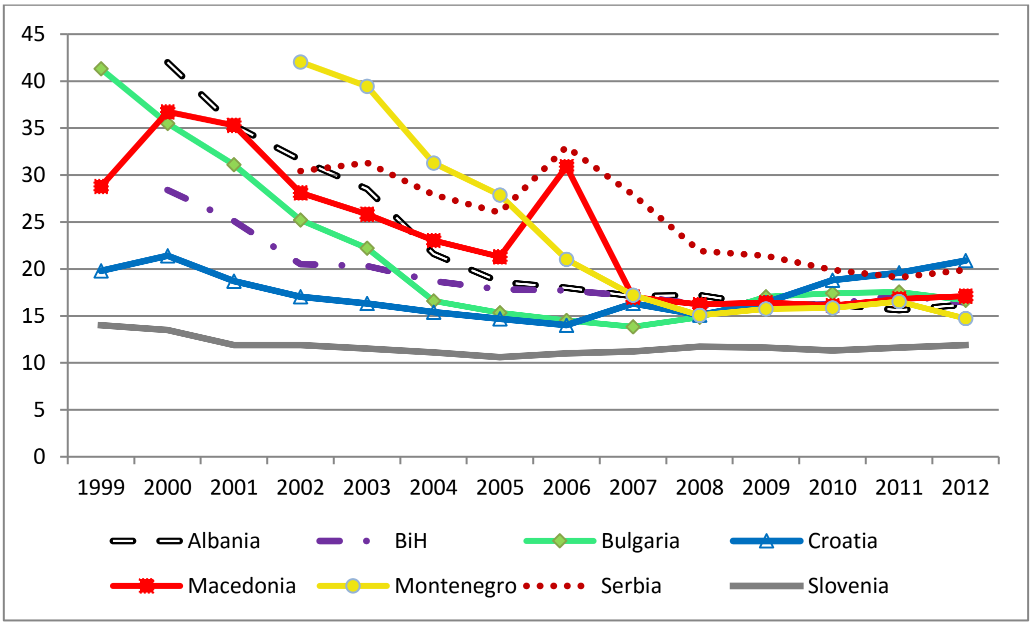

Figure 1.14 Actual capital adequacy ratio in SEECs during 1999-2012 (in %)
Source: BSCEE Annual Reports and Annual Reports from national banks

Regulation. Banking regulation and supervision attracted much attention during the transition period because prudential regulation and supervision are prerequisites for banking sector development and stability. All SEECs banking sectors have undergone a long process of preparation and implementation of financial laws, regulation and supervision processes. As previously presented in Figure 1.2 using the EBRD Survey from 1998, this process was not progressing at the same pace in all countries. According to the EBRD index of banking sector reforms, presented in Figure 1.15, it is noticeable that SEECs countries are still at different stages at the end of 2009, although these differences are quite small. As Figure 1.15 shows, between 2000 and 2009, the greatest progress was achieved by Montenegro and Serbia. Their score of 1 in 2000 indicated little change from a socialist banking system apart from the introduction of a two-tier banking system, whereas the score of 3 in 2009 suggest that these countries have achieved significant progress in developing the capacity for effective prudential regulation and supervision, including procedures for the resolution of bank insolvencies and establishing hard budget constraints for banks by eliminating preferential access to concessionary refinancing from the central bank. By the end of 2009, the progress in the banking sector of Albania, BiH and Macedonia gives the same score of 3. On the other hand, this level of reform was already achieved by Croatia, Bulgaria and Slovenia in 2000, hence their progress over the period was marginal, except for the Croatian banking sector which achieved a score of 4 in 2009, indicating significant progress in banking laws and regulations towards the Bank for International Settlements (BIS) standards, along with well-functioning banking competition and effective prudential supervision. Of course, by 2009, none of the SEECs had achieved the score of 4+ which suggests that the banking sector has incorporated the standards and performance norms of advanced industrial economies, such as full convergence of banking laws and regulations with BIS standards (including Basel II) and the provision of full set of competitive banking services.

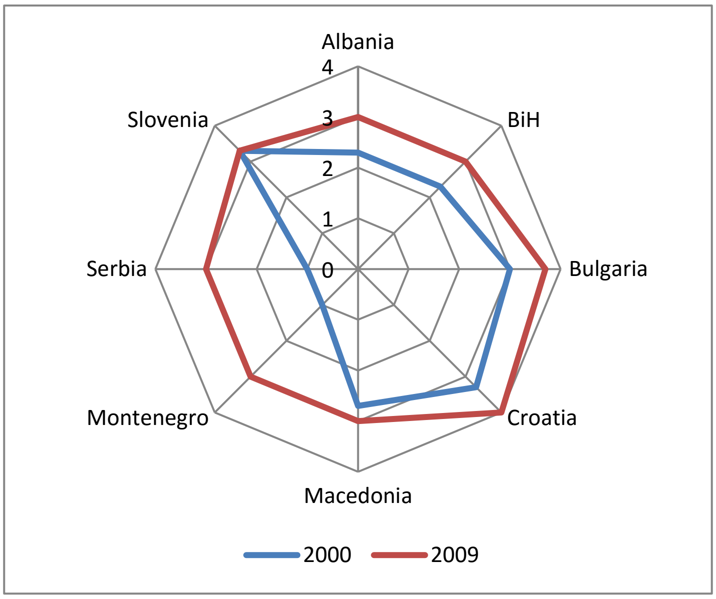

Figure 1.15 EBRD index of banking sector reform

Source: EBRD Transition Reports

Another important aspect in terms of regulation and supervision of the banking sector is the implementation of the Basel principles. The Basel principles date from 1988 when the Basel Committee on Banking Supervision introduced a credit risk framework, named Basel I, which defines the capital standards in order to limit banks´ risk taking and to strengthen the financial system. The Basel I accord was revised and extended in 2004 in order to be in accordance with the new developments in the banking sectors in general, hence Basel I was replaced by the Basel II Accord. Basel II, whose main objective is to secure a safe and sound (international) financial system, consists of three pillars (minimum capital requirements, supervisory review, and market discipline).[3]

The Financial Stability Institute (FSI, established by BIS and Basel Committee on Banking Supervision) has carried out several waves of surveys on Basel II implementation, the latest conducted in 2012 for countries which are neither members of the Basel Committee on Banking Supervision nor members of the European Union. Hence, Table 1.3 presents the process of Basel II implementation in the countries under consideration, except for Bulgaria and Slovenia which were EU members in 2012 and were thus excluded from the survey (details are provided in Appendix to Chapter 1, Section 1.2, Table A1.2). These two countries adopted Basel II in the period 2007-2008.[4] Croatia and Serbia adopted Basel II standards by 2010 (Banks Bulletin, 2011) and 2012, respectively, while Macedonia and Montenegro have been gradually progressing throughout the period. However, during the period of analysis, the implementation of Basel II standards was in an infant stage in Albania and BiH. Thus, according to the FSI survey, SEECs differ considerably with respect to the stage of adoption of the Basel II standards, indicating that banks in SEECs operate under different conditions which may be relevant for their competitive positioning.

[3] Although nowadays the focus and interest is on adoption of Basel III (proposed in 2010-2011 with the period for adoption 2013-2015) our focus is on Basle II because the introduction of Basel III standards is after the period of analysis in this thesis. Appendix to Chapter 1, Section 1.2, Table A1.3 presents the implementation of Basel III in the countries under consideration.
[4] National Bank Annual Reports for 2007 and 2008 for Bulgaria and Slovenia.

Table 1.3 Implementation of Basel II

Elements	Country	Status	Year	Country	Elements	Status	Year
SA	Albania	1	2012	BiH	SA	1	2016
FIRB		1	NA		FIRB	1	2016
AIRB		1	NA		AIRB	1	2016
BIA		1	2012		BIA	4	2009
TSA		1	2012		TSA	1	2016
AMA		1	NA		AMA	1	2016
P2		1	2013		P2	1	2016
P3		4	2013-14		P3	1	2016
SA	Croatia	4	NA	Macedonia	SA	4	2012
FIRB		4	NA		FIRB	1	2014
AIRB		4	NA		AIRB	1	2014
BIA		4	NA		BIA	4	2012
TSA		4	NA		TSA	4	2012
AMA		4	NA		AMA	1	2014
P2		4	NA		P2	4	2009
P3		4	NA		P3	4	2007
SA	Montenegro	4	2008	Serbia	SA	4	2012
FIRB		1	NA		FIRB	4	2012
AIRB		1	NA		AIRB	4	2012
BIA		4	2008		BIA	4	2012
TSA		4	2008		TSA	4	2012
AMA		1	NA		AMA	4	2012
P2		4	2012		P2	4	2012
P3		4	2012		P3	4	2012

Note: The following abbreviations are used in the table: Pillar 1 – Credit risk: SA = Standardised approach, FIRB = Foundation internal ratings-based approach, AIRB = Advanced internal ratings-based approach); Pillar 1 – Operational risk: BIA = Basic indicator approach, TSA = Standardised/alternative standardised approach, AMA = Advanced measurement approaches; P2 = Pillar 2; P3 = Pillar 3. Status indicators are as follows: 1 = Draft regulation not published, 2 = Draft regulation published, 3 = Final rule published, 4 = Final rule in force, NA = Not applicable

Year denotes the year in which the draft or final rule was or is expected to be published or when the final rule was or will be in force. NA means that the jurisdiction is not planning to implement this component or is planning to implement the component but does not know the year in which it will be implemented.

Source: Financial Stability Institute Survey (2012)

1.5 CONCLUSIONS

The first part of this chapter formulated the aims and the specific objectives of the thesis together with the research questions addressed in the thesis which set the scene for this investigation and for the subsequent chapters. The first major concern of the thesis, the cost efficiency of banks in SEECs, is subject of the analysis in Chapters 2, 3 and 4 while the second major concern, determinants of market share in banking is subject of the analysis in Chapters 5 and 6. The second part of this chapter provided a brief review of the development of the banking sector in SEECs as the context for the following chapters. In particular, although all the SEECs have similar general features, especially due to their past socialist system and the pattern of transition process, they differ in terms of the development of their economies in general and their and banking sectors in particular-as well as their status in relation to the European Union. In developing the models of cost efficiency and market share, this description of the banking sector suggests it will be important to incorporate changes over time as well as country specific differences. These issues are further explored in the subsequent chapters.

CHAPTER 2

COST EFFICIENCY AND ITS ESTIMATION: THEORY AND METHODS OF INVESTIGATION

2.1 INTRODUCTION

The analysis and estimation of cost efficiency are at the heart of this thesis. It is the subject of investigation in the present chapter and the following Chapters 3 and 4. It is also used later as an explanatory variable in the analysis of market structure in the banking sector in Chapters 5 and 6. The aims of this chapter are to discuss the theoretical concepts of efficiency followed by a review of the methods of investigation of efficiency levels. In doing this, a number of important issues have to be highlighted and their role in this thesis discussed.

The first important issue is what is meant by efficiency, the different types of efficiency used in the literature and the choice of an appropriate measure of efficiency for the purpose of this thesis. The concept of efficiency has evolved through time and various dimensions have been developed.

It is therefore important to establish the notion of efficiency given the aims and objectives of this thesis and discuss its scope and limitations in the rest of this thesis. The second main issue of interest is the choice of appropriate methods of investigation, which involves several decisions (the approach and method of estimation of efficiency, the choice of functional form, the type of frontier against which efficiency is estimated and the definition of the bank) and each of them is addressed separately. We consider two dimensions for each issue: (i) the theoretical underpinnings, and (ii) the concerns of this thesis as presented in Chapter 1.

On the second issue, the first of these decisions sheds light on the approaches and techniques for estimation of efficiency. In particular, there are parametric and nonparametric approaches, and a range of techniques under each of the two approaches. The choice of approach and technique is based on: (i) the recent theoretical literature; and (ii) the arguments presented in Section 1.4.2 and 1.4.3, specifically that the banking sector in SEECs has undergone substantial reforms and restructuring in the last two decades, hence it can be expected that banks will also experience changes to their cost efficiency. Hence, the review of the preferred technique is mainly focused on the identification of models which allow for estimation of time-varying efficiency. Also, the choice of the appropriate model arguably needs to take into account the latent (unobserved) heterogeneity, which can be easily mixed with inefficiency (Greene, 2008). Besides unobserved heterogeneity, there is also observed heterogeneity in these models and this issue is further discussed in this chapter.

A further matter related to the methods of investigation is the definition and types of "frontier" against which the efficiency is predicted and arguments as to whether it should be common or country specific. This is important for this thesis because our dataset is comprised of a set of countries which, although similar to each other in some respects, are still quite different in other respects, as discussed in Sections 1.4.2 and 1.4.3. Next relevant issue to be considered is the choice of the functional form of the underlying production function, that is, the form of the relationship between output and inputs. Given the nature and complexity of banking services, the definition of the inputs and outputs are not always clear cut and alternative measures need to be discussed before embarking on the process of estimating efficiency. There are two main approaches to nature of banking services, the production and intermediation approaches, and the inputs and outputs in each approach are different.

Thus this chapter is structured around the two main issues: first, discussing the underpinnings of the concepts of efficiency and, second, exploring various methods of estimation of (in)efficiency, including many issues that need to be addressed prior to embarking on the estimation process. Specifically, the structure of this chapter is as follows: Section 2 defines the concept of efficiency, its evolution and various dimensions. Methods of estimation are discussed in Section 3. Section 4 considers the types and the choice of the "frontier" against which efficiency is supposed to be estimated, while the choice of "functional form" is subject of analysis in Section 5. Section 6 discusses the nature of a bank, that is, bank as a producer or an intermediary. The chapter finishes with the concluding remarks in Section 7 which summarises the choices made with respect to the method of estimation (which will be applied in Chapter 4).

2.2 THEORY OF EFFICIENCY

In the 1930s economists developed the argument that the failure of a firm to achieve the theoretical maximum reflects some form of inefficiency in the organisation of production. Hicks (1935) argues that people managing companies in monopoly positions do not strive to minimize the costs of operations (or fully reach the conventional objectives) because the absence of competitive pressure allows them to operate with higher costs than is theoretically possible. Hicks's well-known statement was *"The best of all monopoly profits is a quiet life"* (1935, p.8). Leibenstein (1966, 1975, 1976, 1978, 1987 and elsewhere) developed the concept of X-inefficiency maintaining that production is bound to be inefficient because of the presence of a variety of problems such as: motivation, information, monitoring and agency problems within the firm. Leibestein's X-inefficiency has been criticized by Stigler (1976), and others, on the grounds that it reflects an incompletely specified model rather than a failure to optimize. However, Coelli et al. (2005) emphasize that the difficult problem of model specification (including a complete list of constraints, technological and others such as regulatory, and a proper specification of the objective function) has faced us forever, and will continue to do so.

Optimal production is defined as the maximum obtainable outputs from given inputs for a given level of technology. The production frontier that defines the set of maximum outputs from the available inputs is obtained by the production function. According to Koopmans (1951), a producer is technically inefficient when with less of at least one of the inputs it can produce the same output (input-oriented measure of efficiency) or if it can produce more of at least one output with the same bundle of inputs (output-oriented measure of efficiency). Debreu (1951) introduced a measure of technical efficiency defined as one minus the maximum equi-proportionate reduction in the bundle of inputs that still allows the production process to continue. Economic efficiency could be associated with cost, revenue and profit efficiency, which depends on the optimization process, in other words the objectives which the firm aims to achieve (Kumbhakar and Lovell, 2000; Coelli et al., 2000 and Greene, 2005). As this thesis is concerned with estimation of cost efficiency for transition economies, it is this aspect of efficiency that is explored in detail in what follows.[5]

Farrell (1957) maintains that economic efficiency consists of technical and allocative efficiency. According to Farrell, a producer is inefficient either by producing less than the maximum output available from a given bundle of inputs (technically inefficient) or by not using the best mix of inputs given their prices and marginal productivities (allocatively inefficient). Such a definition considers cost minimisation as a producer's objective and in turn reflects how cost efficient the producer is. The analysis of efficiency defined in Farrell's seminal paper (1957) is graphically presented in Figure 2.1 (as originally used by Farrell) using the input-oriented approach which is used in this thesis and is suitable for measuring cost efficiency.

[5] In the remaining text cost and economic efficiency are used interchangeably.

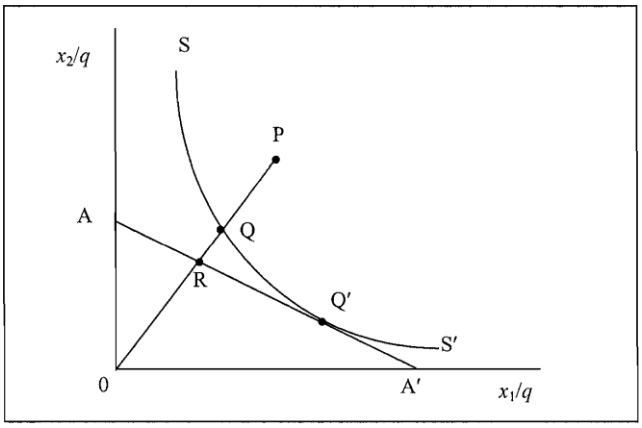

Figure 2.1 Technical and allocative efficiency measures (Farrell, 1957)

To explain this figure and for simplicity consider three firms using x_1 and x_2 as production factors for producing a single product (q) and subject to constant returns to scales. SS’ is the isoquant curve which represents various minimum combinations of x_1 and x_2 per unit of output required. Firms using any combination of the two inputs which corresponds with the isoquant SS’ are technically efficient (TE). Hence, firms operating at Q and Q’ are technically efficient firms, while a firm operating at P is technically inefficient. The distance between the two firms operating at Q and P (QP) presents the technical inefficiency of the firm at P and the ratio QP/OP represents the extent of inefficiency, or the proportion by which x_1 and x_2 need to be reduced for the firm at P to become technically efficient. Hence, technical efficiency (TE) is measured by the ratio:

$$TE = 1 - \frac{QP}{OP} = \frac{OQ}{OP}$$

This ratio is bound between 0 and 1, where 1 stands for fully technically efficient firm, such as at the firm at Q.

If the input prices are known and a particular behavioural objective such as cost minimisation is introduced the cost efficiency of a given firm (which is of special interest to this thesis), can be measured. The slope of the isocost line AA’ is the ratio of the prices of the two inputs. The tangency point of isocost and isoquant is the cost efficient position, because it represents the minimum cost combination of inputs for producing q. The firm operating at Q’ is cost efficient. The cost efficiency of firm P can be presented with the vector of inputs associated with firm at P and the cost-minimizing input vector associated with firm at Q’, hence the cost efficiency of firm at P is defined as the ratio of input costs and the corresponding input vector of that firm and the firm at Q’ or using the distances in the diagram it would be:

$$CE = \frac{OR}{OP}$$

Given this the overall efficiency, which the literature refers to it as either “cost efficiency” or “economic efficiency” (Kumbhakar and Lovell, 2000; Coelli et al., 2005 and Greene, 2005) presents a broader concept than technical efficiency and includes allocative efficiency. This overall measure of efficiency is obtained by the multiplication of both technical and allocative components,

$$CE = TE * AE = \frac{OQ}{OP} * \frac{OR}{OQ} = \frac{OR}{OP}$$

In this section the concept of efficiency, along with its different types, have been briefly presented using the original work of Farrell (1957). The analysis suggests that firm’s efficiency is measured against a “frontier” which represents the optimal combination of minimum inputs for production of a certain output given the budget constraint. Hence, any deviation from the “frontier” indicates that the firm is not fully efficient. Efficiency is measured on a scale from 1 to 0, with 1 being a fully efficiency firm. This thesis investigates cost efficiency, which includes both the technical and allocative types distinguished in above.

2.3 METHODS OF ESTIMATING EFFICIENCY

The estimation of efficiency in the economic literature is a quite complicated issue as it involves not only different broad methods but also a number of technical questions that need to be answered. Here, we shall review the different methods used to estimate efficiency and argue for the approach we will take in our estimation process (Chapter 4).

2.3.1 Parametric vs. Non-parametric approach

The level of bank efficiency can be estimated by either nonparametric or parametric approaches (see Berger and Humphrey, 1997; and Bauer et al., 1998 for a comprehensive discussion of these approaches). The differences between parametric and non-parametric approaches are primarily in the assumptions imposed on the data with regard to how much shape is imposed on the frontier (the functional form, i.e. more restrictive parametric functional form versus a less restrictive nonparametric form), and distinguishing between the random error term and inefficiency. Specifically, in the parametric method, random fluctuation is possible whereas there is no random element in nonparametric approach, thus the former approach aims to distinguish between random error and inefficiency, while in the latter all deviations are considered as inefficiency (Berger and Humphrey, 1997, pp. 4-5).

The most popular non-parametric approach in the literature is the Data Envelopment Analysis (DEA)[6], developed by Charnes, Cooper, and Rhodes (1978). It is a mathematical linear programming-based technique which measures efficiency by enveloping a quasi-convex hull around the data representing the highest output that could be generated given the inputs, or the lowest level of inputs given the outputs. The hull defines the efficient subset; hence all producers inside the hull are classified as inefficient (Greene, 2008 p. 112). A useful feature of DEA is that it performs without parameterizing the technology, meaning that no explicit form of specification of the underlying input-output relationship is required. Because of this feature, DEA is considered as principally atheoretical (Greene, 2008 p. 113).

The literature points out several disadvantages of DEA. Firstly, it can be very vulnerable to the number of variables included in the model. As the number of variables increases relative to the sample size, DEA might overestimate the firm's efficiency since the probability that a firm would

[6] Besides DEA, another nonparametric approach is Free Disposal Hull developed by Deprins et al. (1984), since it is not frequently used in empirical studies of the banking industry, we do not include it in the discussion.

locate and apply a set of weights to its outputs and inputs that would make the firm efficient is increased (Yunos and Hawdon, 1997). In other words, according to Bauer et al. (1998, pp. 9-10) many firms could be presented as 100 per cent efficient, but only because the DEA method itself is not efficient when too many dimensions are included which leaves a firm isolated in terms of comparing with the other firms. This problem is of concern when measuring efficiency for the banking sector because of the importance of including quality and environmental controls, which greatly increase the number of variables included in the model (Bauer et al., 1998 p. 10).

Secondly, the main flaw of DEA is the absence of a random error term, thus any deviation from the frontier is labelled as inefficiency (Berger and Mester, 1997, pp. 11-12). Consequently, DEA does not give any statistical properties, hence no hypotheses testing. In other words, any random error, which may be for instance due to measurement problems associated with using accounting data, may be counted as differences in efficiency. Different accounting practices were used in the early years of transition and the introduction of international accounting standards and their implementation in most SEECs took a number of years to be completed (as discussed in Sections 1.4.2 and 1.4.3). This may result in random measurement errors. Another reason for expecting "randomness" is associated with shocks in the environment, which can affect firms differently. This is important for SEECs given that, as discussed in Chapter 1, their macroeconomic environment underwent considerable changes due to the process of transition. Hence, employing DEA in our case might produce biased efficiency estimates. The aforementioned problems of DEA suggest that this approach would be inappropriate for the estimation of cost efficiency in the banking sector of the countries of interest in this study.

The three parametric approaches to the specification of the efficiency frontier are the Stochastic Frontier Approach (SFA), the Thick Frontier Approach (TFA) and the Distribution-Free Approach (DFA). SFA, which is sometimes referred to as the econometric frontier approach, specifies a functional form for the cost, profit, or production relationship among inputs, outputs and environmental factors and also allows for a random variation element. SFA assumes a composed error model where random errors follow a symmetric distribution, usually the standard normal distribution, while inefficiencies are assumed to follow an asymmetric distribution (the half-normal, exponential, gamma or truncated distributions).

TFA, introduced by Berger and Humphrey (1991 and 1992), does not require restrictive assumptions with respect to the distribution and the independence of the error components and this is an advantage over SFA. Contrary to SFA, it does not assume a one-sided error term, hence does not present a conventional frontier approach for estimating efficiency (Kumbhakar and Lovell, 2000). Specifically, as discussed by Berger and Humphrey (1992, p. 257) the TFA approach estimates two cost functions, first for the lowest average cost quartile of banks which are assumed to be above-average efficient and to form the "thick frontier" and the second for the banks in highest-cost quartile, which are assumed to be less than average efficient. Given this, the error terms within the cost quartiles presumably reflect only random error (measurement error and chance), whilst the predicted differences between the top and bottom cost quartiles are assumed to reflect combination of exogenous influences and cost inefficiencies (Berger and Humphrey, 1992; Bauer et al, 1998 and Kumbhakar and Lovell, 2000). Consequently, the inefficiencies are entrenched in the difference in predicted costs between the lowest and highest cost quartiles (Bauer et al., 1998, p. 13). Having said this, the foundation of this analysis is the division of the firms in quartiles with respect to the average cost distribution (since we are interested in cost efficiency). TFA gives an estimate of the general level of overall efficiency, but does not provide point estimates of efficiency for all individual firms. As Kumbhakar and Lovell (2000) argue, TFA aims to give some indication of the possible magnitude of inefficiency without being econometrically accurate.

As Kumbhakar and Lovell (2000, p. 178-179) point out, TFA has some serious limitations. Firstly, it is common for TFA to employ quartiles based on average cost, but if instead the quartiles are equally distributed and/or banks are divided in less or more groups (for example, tertiles or quintiles), then estimated cost efficiency would decrease or increase, respectively. Secondly, the more quantiles employed the fewer observations available for efficiency estimation. For instance, if we use quartiles or quintiles we use only 50 or 40 per cent of the data respectively. Such loss of degrees of freedom is critical especially in small data sets as is the case in the banking sector of SEECs. Finally, TFA generates only a single cost efficiency estimate, not individual estimates for each firm, and this is indeed the main shortcoming of this approach. Although Bauer et al. (1998) findings suggest a similar magnitude of cost efficiency estimates relative to SFA, this approach is inappropriate for the purpose of this thesis. In particular, we need to estimate the efficiency level for each bank as the efficiency variable will be used as a potential determinant of banks' market share in Chapter 6.

DFA, developed by Berger (1993), is plausible only in the context of panel data and is similar to the Schmidt and Sickles (1984) model in the framework of SFA, which is further discussed in Section 2.3.2). Like TFA, and contrary to SFA, it makes no assumptions regarding the specific distributions of the inefficiency component of the error term, leaving the data to tell the story, which is considered as one of the useful features of this approach. As discussed by Berger (1993, p. 263), distributional assumptions are avoided by assuming stability over time to differentiate inefficiencies from random error. In particular, DFA assumes that cost differences due to (in)efficiencies are persistent, whilst random errors tend to cancel out over time. Berger (1993, p. 263) originally explains *"… good management maximizes long-run profits by keeping costs relatively low over long periods of time, although costs may fluctuate from trend because of luck and measurement error."* The stability of each bank's inefficiency over time, as suggested by Schmidt and Sickles (1984), is based on the notion of a firm-effect of efficiency.

Given that this approach requires panel dataset it can be estimated by the traditional panel models, in particular the WITHIN method (fixed-effects panel model) and Generalized Least Squares (random-effects panel model), adjusted for the analysis of efficiency (discussed in Section 2.3.2). In the context of the fixed effects model, a bank specific intercept is taken to be the bank's measure of inefficiency (efficiency is estimated as difference in the intercepts for each bank, where at least one bank is 100 per cent efficient). Similarly, in the case of the random effects model inefficiency of banks is measured relative to the bank with the smallest average residual (the most efficient bank), with average residuals of each bank over time being obtained from the panel estimates.

The main drawback of DFA is the assumption of time-invariant efficiency (Berger, 1993), which is not sustainable as T increases (Kumhakar and Lovell, 2000 and Greene, 2008). In addition, in the case where banks experience changes in their relative efficiencies over time DFA estimates only their average efficiencies for the period (Berger, 1993, p. 265). Also, the random error may not cancel out if a short panel data (small T) is at disposal (for more details see Berger, 1993). Hence, this assumption requires a long panel, which in turn confronts the assumption of time-invariant efficiency estimates. Most importantly, as discussed in Section 1.4.3, the banking sector in SEECs underwent extensive transformation in many aspects and, therefore, changes in the efficiency of banks are expected in the short run. Consequently, we do not find this approach appropriate for the estimation of cost efficiency for the banking sectors in SEECs.

There is no consensus among researchers on the preferred frontier model. While parametric approaches impose a particular functional form which assumes the shape of the frontier, non-parametric approaches impose less structure on the frontier but do not allow random error. If the functional form is not specified correctly, the measure of efficiency may be confounded by specification errors. Therefore it is very difficult to determine which of the two major approaches dominate the other, since the true level of efficiency is unknown. Adding more flexibility to the parametric approach and allowing for noise into the nonparametric frontier models may contribute to finding a solution to this matter. There are some recent efforts in this direction which are thoroughly examined by Simar and Wilson (2008). These new/adjusted frontier models, which are still in the early stage of development, are neither always easy to implement nor have they become generally accepted approaches as yet. Therefore, they are beyond the scope of this thesis.

Many empirical studies do not find evidence of differences in the inefficiency estimates in using DEA and SFA.[7] However, these studies are not concerned with the banking sector in their analysis. When it comes to the empirical findings for the banking sector, research has found DEA and SFA to produce different inefficiency estimates. For example, Ferrier and Lovell (1990) and Bauer et al. (1998) estimate the efficiency for a large sample of U.S. banks and document major differences in the estimates from parametric and nonparametric approaches. In a nutshell, the discussion provided in this section demonstrates that the parametric approach is preferred over the nonparametric approach for efficiency estimation. Further, from the three parametric methods discussed, SFA, TFA and DFA, the SFA is the most appropriate because it allows for estimates of a time-varying efficiency for each country and each bank included in the dataset separately, which is also in line with the research questions of this thesis.

2.3.2 Estimating cost efficiency using Stochastic Frontier Analysis (SFA)

Early studies that applied Farrell's work are by Aigner and Chu (1968), Seitz (1971), Timmer (1971), Afriat (1972) and Richmond (1974). Their contribution to the literature of production and cost functions is the introduction of deterministic production (cost) frontiers and estimating them either by using linear programming techniques or modified least squares regression techniques. SFA fundamentals originate from the late 1970s. This approach was independently introduced by three teams, Meuseen and Broeck (1977), Aigner, Lovell and Schmidt (1977) and Battese and Cora (1977) in the context of a cross-section data model, while Pitt and Lee (1981) and Schimdt and Sickles (1984) are the first to develop the SFA in the context of panel data models. Since the introduction of SFA, many researchers have contributed to further developments of SFA. Here we present the underpinnings of SFA along with the developments which allow estimation of time-varying cost efficiency.

[7] For example, Bjurek, Hjalmarsson and Forsund (1990) investigate the Swedish social insurance system; Forsund (1992) analyzes the Swedish ferries ; Ray and Mukherjee (1995) study the U.S. electricity generation; Murillo-Zamorano and Vega-Cervera (2001) examine the U.S. electricity generators; Cummins and Zi (1998) question the U.S. insurance industry; Chakraborty, Biswas and Lewis (2001) explore the public education in Utah.

CROSS SECTIONAL MODELS. Figure 2.1 presented in Section 2.2 explains the concept of cost efficiency implying that cost efficiency is measured against a "frontier", expressed as $c(y, w)$, representing the minimum costs given the input prices [$w = (w_1, \dots, w_n)$] to produce particular outputs, [$y = (y_1, \dots, y_m)$]. The cost of banks for producing a given output is $w^T x = \sum_n w_n x_n$, where [$x = (x_1, \dots, x_n)$] denotes the vector of inputs. *Cost efficiency* (CE) is measured as a ratio of minimum costs to observed costs, that is $c(y, w)/w^T x$. The cost frontier against which cost efficiency is measured can be expressed as a single-equation model, which allows for estimation of the technology parameters (factors of production) and bank-specific cost efficiency estimates. The basic requirement for estimating this model is data on the prices of inputs employed, the quantities of outputs produced and total costs for each bank. Moreover, given that this is a stochastic frontier analysis, it assumes that costs may be affected by random shocks beyond the control of banks. Hence the stochastic frontier can be expressed as[8]:

$\mathrm{C_i} \geq \mathrm{c(y_i, w_i;\ \beta) \cdot exp\{v_i\}}$ i=1,...,N, where N is the number of banks … (2.1)

Where $\mathrm{C_i} = w_i^T x_i = \sum_n w_{ni} x_{ni}$ is the total cost incurred by bank *i*, $y_i = (y_{1i}, \dots, y_{Mi})$ is a vector of outputs produced by bank *i*, $w_i = (w_{1i}, \dots, w_{Ni})$ is a vector of input prices faced by bank *i*, $c(y_i w_i; \beta)$ is the cost frontier common to all banks, where β is a vector of parameters to be estimated. $\mathrm{Exp\{v_i\}}$ is a bank-specific random part, which captures the effects of random shocks coming from outside the bank and any events within the bank, all beyond its control and is expected to have a mean of zero. In particular, the Eq. 2.1 represents a stochastic frontier because it comprises two parts: a deterministic part c(y_i, w_i;β), common to all banks and a bank-specific random part, $\mathrm{exp\{v_i\}}$. Given the definition of cost efficiency $CE(y, x, w) = c(y, w)/w^T x$, the cost efficiency measure is:

$\mathrm{CE_i} = \frac{\mathrm{c(y_i w_i; \beta) \cdot exp\{v_i\}}}{\mathrm{C_i}}$ … (2.2)

which defines cost efficiency as the ratio of the most cost-efficient bank (minimum cost attainable in a given environment, accounting for v_i) to observed total cost of any other bank subject to analysis. A bank has CE_i=1, if and only if it manages to produce at the lowest feasible cost level

[8] The work of Kumbhakar and Lovell (2000) is used for the mathematical representation of the model.

(no further reduction in the costs could maintain the same output level), otherwise $CE_i<1$. In other words, the cost efficiency has a range between 0 and 1. It is expected that at least one bank to have a score of 1, presenting the best-practice bank against which the other banks will be compared with respect to cost efficiency. The further a bank is from 1, and closer to zero, the less efficient that bank is.

Now, to convert the cost stochastic frontier into an estimatable model, a particular functional form needs to be imposed defining the relationship between inputs and outputs. For brevity of explanation, a Cobb-Douglas functional form (further discussion in Section 2.4 for other functional forms which are used in SFA and the choice of the preferred functional form used in Chapter 4 for estimation of banks' cost efficiency in SEECs) is used for the deterministic part of the Eq. 2.1, such that the stochastic cost frontier model in Eq. 2.1 can be expressed as

$$\ln C_i = \beta_0 + \beta_y \ln y_i + \sum_n \beta_n \ln w_{ni} + \varepsilon_i \qquad \text{... (2.3)}$$

where ε_i is a two component error term, $\varepsilon_i = v_i + u_i$. This two component error term is an identifying mark of SFA and burdens the estimation procedure. Aigner et al. (1977, p.24) argue: *"The economic logic behind this specification is that the production process is subject to two economically distinguishable random disturbances, with different characteristics*". v_i is the two-sided statistical-noise component, which is assumed to capture the influences beyond control of the bank's management and the measurement errors of the variables included in the model. In general, it follows a normal distribution with a mean of zero. u_i is the one-sided nonnegative part of ε_i, representing the proportion by which the bank fails to achieve the minimum obtainable costs for providing the particular level of services. That is, it measures the bank's inefficiency. The statistical noise is assumed to be symmetric and independent, and identically distributed. Both u_i and v_i are assumed to be not correlated with the regressors and independently distributed from each other. In estimating the cost function it is necessary to impose the homogeneity assumption which ensures that the cost function is homogenous of degree 1 in input prices (the sum of the coefficients of the input prices equals 1).

Eq. 2.3 can be estimated by OLS. The OLS estimators of the slope coefficients are consistent, except for the intercept, since $u_i>0$ and producer-specific efficiency cannot be estimated. Two approaches are proposed as a remedy for this deficiency by amending the OLS procedure, corrected OLS and modified OLS (details on the estimation procedure can be found in Kumbhakar and Lovell, 2000 and Greene, 2008). However, neither corrected OLS nor modified OLS frontiers by construction envelope the data from below, because they are parallel to the OLS (Kumbhakar and Lovell, 2000). Therefore, a different estimation technique is required for obtaining consistent estimates of all the regressors, including the intercept, and consequently obtaining bank-specific efficiency. This method is maximum likelihood (ML) which requires additional distributional assumptions. A two-step procedure is used: in the first step the model is estimated by OLS and the estimates serve as starting values for the ML estimation to obtain the estimates for the technology parameters, the intercept and the variances of the two error components. However, between the two steps the skewness (the third moment) of the OLS residuals are checked. If they have the "wrong" skewness (for cost frontier right-skewness is expected), then ML estimator is simply OLS for the production parameters (the slopes) and for σ_v^2, and zero for σ_u^2 (LIMDEP Manual, 2007, E33-14). Greene (2008) argues that in this case the data do not fit the SF model. However, that this is a potential problem of the SFA method is rarely discussed in the literature. As stated by Simar and Wilson (2008), so far, there are no published papers in which the reported composite residuals are with the "wrong" skewness. According to this, they argue that some authors may possibly manipulate the empirical process (i) either by "modifying" the model specification or (ii) by omitting some observations up to the point where the desired skewness is obtained. Simar and Wilson (2009) emphasize the importance of this issue with respect to the inference. Given their findings, publication bias may exist.

The ML method requires distributional assumptions for the inefficiency component of the composed error term. In the literature, there is no clear cut view regarding the distribution of u_i, just the agreement that it is one-sided and positively skewed, since $u_i>0$. However the most commonly assumed distributions are half-normal, exponential, truncated and gamma distributions, expressed as:

$u_i \sim \text{iid } N^+(0, \sigma_u^2)$ nonnegative half-normal (Aigner et al., 1977);

$u_i \sim \text{iid } G(\lambda, 0)$ exponential with mean λ (Aigner et al., 1997 and Meeusen and van den Broeck, 1977)

$u_i \sim \text{iid } N^+(\mu, \sigma_u^2)$ truncated normal (Stevenson 1980)

$u_i \sim \text{iid } G(\lambda, m)$ gamma with mean λ and degrees of freedom m (Greene, 1980 and Stevenson, 1980).

As can be noted from the above expressions, the half-normal and the exponential are used in the seminal papers of SFA, with the main rationale being to model the assumption that in the real world it is more likely that firms are relatively more efficient rather than relatively less efficient, implying a cluster of banks that score well on the efficiency scale, that is towards 1 (Coelli et al., 2005). This would be appropriate in an industry with high degree of competition. Moreover, half-normal and exponential distributions are quite rigid distributions. Unlike both of them, the truncated normal and the gamma models are flexible and allow for a wider range of distributional shapes which enables the data itself to reveal the efficiency "story", but their limited use is due to the computational complexities. Stevenson (1980) proposed the truncated-normal distribution in order to generalize the half-normal distribution by enabling a nonzero mode. This distribution has an additional parameter to be estimated, the mode, and it collapses to half-normal when the mode is zero. The truncated normal distribution allows the mode of u_i to take either positive or negative values. Greene (1990) generalizes the one-parameter exponential distribution, by including an additional parameter to be estimated, thus providing a more flexible distributional shape for u_i, the gamma distribution. When this additional parameter is zero, the gamma distribution collapses to exponential.[9] Gamma distribution is rarely employed in the empirical analysis due to the complex estimation procedure (Greene, 2008, p. 126).

[9] Kumbhakar and Lovel (2000) and Greene (2008) summarize the properties of these distributions in greater detail.

There is an ongoing debate in the literature about the choice of the distributional assumption that provides the best estimates the efficiency scores. Kumbhakar and Lovell (2000) provide a comparative study of the effects of different distributional assumptions on the estimation of cost frontiers and mean efficiency scores based on Greene (1990), using the Christensen and Greene (1976) electricity production data. Kumbhakar and Lovell obtain rank correlations for estimates of inefficiencies from the four distributions and the score is in the range from 0.75 (exponential and gamma) to 0.98 (half normal and truncated normal). Greene (2008) repeats and extends the same exercise using a full translog model and applying a better algorithm for the simulation based estimator for the gamma model, which more accurately estimates the complex function compared to the Kumbhakar and Lovell's approach. Even though for the cost frontier parameters' estimates he found considerable differences, the estimates of efficiency were almost identical, recording just minimal deviations. Greene (2008) compared the results for the four distributions and with respect to efficiency estimates he found that exponential and half-normal distribution are virtually identical, with correlation coefficients reaching up to 0.99. Coelli et al. (2005, p. 252) also conducted an exercise to compare the ranks of firms on the basis of technical efficiency and their findings suggest that rankings are usually robust to distributional choice.

Despite the high rank correlation, Lee (1984) and Schmidt and Lin (1984) offer several tests for various distributional assumptions of the one-sided error component. The limited applicability of these tests is due to the procedural complexities, because the four distributions are not nested. Vuong (1989) proposes a test for nonnested models but it can only compare two models at a time. Coelli et al., (2005, p. 252) assert that an appropriate choice of a distributional assumption depends on theoretical considerations of the research objective. They explain that sometimes researchers circumvent the half-normal and exponential distributions since by construction, due to the zero mode, the efficiency estimates are around 1. Arguably we can say that it is the researcher's choice to decide whether it is reasonable to expect such outcome. Much evidence suggests that it is better to choose a simple distribution rather than a more flexible and complex one according to the principle of parsimony (Coeilli et al., p. 252).

The discussion so far has been a prelude to the estimation of cost efficiency for each bank, u_i, which is the main objective of SF models. In the first few years of the introduction of the SF modelling, researchers failed to estimate efficiency on an individual level, and instead predicted the average efficiency, for example the mean efficiency of the whole banking sector, because they could not disentangle the two part of the error term at the individual level. The seminal paper of Jondrow, Lovell, Materov and Schmidt (1982) [hereafter JLMS] made an immense contribution to the SF literature, even to the present time, by providing a solution to the problem of predicting the individual efficiency. Their approach solves the problem of separation of the composed error term, $\varepsilon_i = v_i + u_i$, that is, they estimate the contribution of the inefficient one-side error part u_i and the random error v_i to ε_i, given that the model provide estimates of ε_i (Kumbhakar and Lovell, 2000). More precisely, JLMS consider the expected value of u_i to be conditional on the estimated ε_i, which contains the information on u_i.

Kumbhakar and Lovell (2000) adapt the JLMS procedure to the estimation of cost efficiency when u_i follows half-normal distribution $u_i \sim N^+[0, \sigma_*^2]$ the conditional distribution of u given ε is:

$$f(u|\varepsilon) = \frac{f(u,\varepsilon)}{f(\varepsilon)} = \frac{1}{\sqrt{2\pi\sigma_*^2}} . exp\left\{-\frac{(u-\mu_*)^2}{2\sigma_*^2}\right\} \Big/ \left[1 - \Phi\left(\frac{-\mu_*}{\sigma_*}\right)\right], \qquad \text{... (2.4)}$$

Where:

$$\mu_* = {}^{\varepsilon\sigma_u^2}/_{\sigma^2} \qquad \sigma_*^2 = {}^{\sigma_u^2\sigma_v^2}/_{\sigma^2} \qquad \sigma^2 = \sigma_u^2 + \sigma_v^2 \qquad \lambda = {}^{\sigma_u}/_{\sigma_v}$$

Given that $f(u|\varepsilon)$ is distributed as $N^+[\mu_*, \sigma_*^2]$, the mean of this distribution may serve as a point estimator of u_i, hence:

$$E(u_i|\varepsilon_i) = \mu_{*i} + \sigma_* \left[\frac{f^*\left({}^{-\mu_{*i}}/_{\sigma_*}\right)}{1-F^*\left({}^{-\mu_{*i}}/_{\sigma_*}\right)}\right] = \sigma_* \left[\frac{f^*\left({}^{\varepsilon_i\lambda}/_{\sigma}\right)}{1-F^*\left({}^{-\varepsilon_i\lambda}/_{\sigma}\right)} + \frac{\varepsilon_i\lambda}{\sigma}\right] \qquad \text{... (2.5)}$$

where f^* and F^* describe the standard normal density and cdf, respectively.

u_i can be estimated only indirectly, since the obtainable estimates are those of ε_i (Greene, 2008, p. 176). Fried et al. (2008) emphasize that the individual efficiency estimates are unbiased, but inconsistent in a cross-sectional framework given that a bank is observed only at one period in time. The inconsistency can be improved only if $T \to \infty$ (further discussed in Section 2.2.2). An increase in N in the cross-sectional context does not improve the efficiency estimates. On the contrary, Greene (2008, p. 178) emphasizes that by construction JLMS estimator cannot produce unbiased efficiency estimates. In particular, he argues (p. 178) *"The JLMS estimator is unbiased as an estimator of u_i only in the sense that it has the same expectation that u_i does. It does not estimate u_{it} unbiasedly in the sense that in repeated sampling, the mean of a set of observations on $E(u_i|\varepsilon_i)$ would equal u_i. They would not."* In order words, Greene explains that $E(u_i|\varepsilon_i)$ is an estimator of the mean of the distribution that produces the n-observations included in the dataset with particular $\mathrm{C_i}$, $\mathrm{y_i}$, and $\mathrm{w_i}$. The JLMS procedure also applies in the case of normal-exponential distribution; for the normal-truncated and for the normal-gamma distributions details are presented in Kumbhakar and Lovell (2000) and Greene (2008). For brevity they are not presented in the chapter.[10]

Based on the hitherto discussion, the cross-sectional models in SFA context allow for estimation of cost efficiency of each bank individually. Hence, if a stochastic frontier is estimated for each observed year, cost efficiency estimates can be obtained on a yearly basis, which are expected to vary across years for each bank. This seems to be a satisfactory condition in favour of the cross-sectional models in SFA, given that in this thesis we allow bank efficiency to vary over time (based on the discussion in Sections 1.4.2 and 1.4.3). However, the estimation of efficiency in a cross-section context has shortcomings. Schmidt and Sickles (1984) are among the first to discuss the problem of cross-sectional analysis. They emphasize the following three problems:

[10] Another common estimator for u is the Battese and Coelli (1988). However, given that this approach provides similar results compared to JLMS estimator and the latter is incorporated in LIMDEP we do not provide detailed discussion on Battese and Coelli (1988) and more on this estimator can be found in Kim Schmidt (2000), Kumbhakar and Lovell (2000) and Greene (2008).

(i) The JLMS (1982) technique for decomposition of the composed error term into an inefficiency component and random noise is applicable in the cross-sectional analysis, but the efficiency estimates are not consistent, since the variance of the distribution of the efficiency, conditional on the composed error term, does not approach zero as the sample size increases. Moreover, Kumbhakar and Lothgren (1998) found a negative bias in the estimated inefficiencies when the sample size is less than 200;

(ii) the strong distributional assumptions needed for both the maximum likelihood estimation and the composed error term; and

(iii) the strong assumption of the independence of the inefficiency component of the error term and the independent variables (input prices and output quantity). However, it is likely that lower efficiency is a result of the selected input mix, which may call into question the validity of this independence assumption.

(iv) To circumvent these problems researchers have further advanced the SFA by developing and adjusting panel data models for the framework of SFA and this is discussed next.

PANEL MODELS. Panel data sets contain far more information than does a single period cross section data set. This provides the possibility of relaxing some of the restrictive distributional assumptions in the cross-sectional analysis, and also in efficiency estimates with more desirable statistical properties. The introduction of panel models in SFA contributes toward overcoming the problems of the cross-section analysis and opening up numerous challenging possibilities.

Kumbhakar and Lovell (2000, p. 96-97) have summarized the advantage of moving over from a cross section analysis to panel data analysis. First, by having the opportunity to observe the same firm across time, the efficiency levels may be estimated consistently, as T→+∞, where T is the time-series component in panel data. Thus, the inconsistency problem is reduced by observing a firm through time, since by that more information can be collected for the firm. However, according to Greene (2008, p. 179) this is the case only for panel model which assumes time-variant u_{it}, because *“like any common effects model, a method of moments estimator of the ‘effect’ is consistent in T.”*, otherwise JLMS estimator does not converge to u_{it}. He continues that holding efficiency constant with respect to T, requires complex economic justification. Hence, this advantage of panel estimators is somewhat overstated. Second, not all of the panel data estimators require strong distributional assumptions, in that the repetition of observations for each firm inside the sample can be a substitute for strong distributional assumptions. Finally, most panel data estimators provide estimates of the technological parameters and efficiency without the assumption of no correlation between cost efficiency and the independent variables. The time-series component of the panel data set models can be considered as a substitute for the assumption of no correlation.

The work of Schmidt and Sickles (1984) represents an introduction of the traditional panel models in the stochastic frontier literature. From then onwards, numerous panel model estimators have been developed. The estimators that were commonly used in the early stages are the conventional estimators (fixed effects and random effects) as well as the maximum likelihood estimator. Initially, the conventional panel data estimator is suggested by Schmidt and Sickles (1984). Their proposed model for cost frontier is:

$$lnC_{it} = \alpha_o + \beta lnx_{it} + v_{it} + u_i \qquad \text{... (2.6)}$$

Where C_{it} presents total costs, x_{it} represents both input prices and output(s) for simplicity of the presentation, v_{it} is the random noise and u_i≥0 represents ***time-invariant*** cost inefficiency, where the C_{it}, x_{it} and v_{it} can now vary across banks and time. As discussed in the previous section, the assumption of homogeneity of first degree in input prices should be satisfied, hence the sum of the estimated coefficients of input prices should equal 1.

In order to estimate fixed or random effects models there is no need for a particular distributional assumption on u_i (Schmidt and Sickles, 1984). However, the two models differ in two assumptions with respect to the correlation between u_i on one hand and the regressors and v_{it} on the other and regarding the randomness of u_i. In the fixed effects model u_i are allowed to be correlated with the regressors and v_{it}, but are fixed, whereas in the random effects model the correlation of u_i with the regressors and v_{it} is not allowed, but the u_i are random (Greene, 2010). Moreover, the fixed effects model does not allow for the estimation of the effect of time-invariant variables, but the random effect model does allow for such estimation. The fixed effect model is estimated by the within groups (dummy variables) least squares estimator (LSDV), whereas the random effect model is estimated by Generalized Least Squares (GLS) (technical details of the estimation procedure for both models is available in Schmidt and Sickles, 1984; Kumbhakar and Lovell, 2000; and Greene, 2008).

Besides the conventional panel data estimator, SFA in a panel data framework also makes use of maximum likelihood estimation. Pitt and Lee's (1981) random effects model is among the first to introduce this kind of analysis. As in the cross-sectional model, imposing a distributional assumption is necessary even with the panel data model when MLE is used. The MLE procedure in panel data context is structurally similar to the one used for cross-sectional data and technical details of the estimation procedure could be found in the corresponding studies as well as in Kumbhakar and Lovell (2000).

Greene (2005a), however, emphasizes serious flaws in both models (fixed and random effects) and these are presented in what follows. He argues that the individual identity of the estimated inefficiency is obscured in the fixed effects model as a result of the loose parametarization, namely the individual efficiency can only be estimated relative to the "best". On the other hand, the random effects model has a tighter parameterization, thus the inefficiency term in the model can be estimated directly. In the fixed effects model, there is ambiguity in the treatment of the time invariant effects. Greene considers the assumption of no correlation in the random effects model as an unreasonable assumption in stochastic frontier models, specifically when any of the variables of production relate to capital or its cost. Another common and serious shortcoming for these models is the possibility of u_i being biased if any latent (unobserved) heterogeneity (time-invariant effects) exists among the firms which is not related to inefficiency, as this it is forced into the firm specific term u_i or $\beta(t)u_i$, hence u_i no longer reflects only the bank's inefficiency, instead it picks up other time-invariant effects. Greene not only acknowledges this flaw, but also provides evidence of a large distortion of the results caused by the unobserved heterogeneity. In addition to the above problems, the major problem of these models is their treatment of cost efficiency being time invariant. Hence, in what follows models which primarily allow for estimation of time-variant cost efficiency are analysed, followed by models which are able to account for latent heterogeneity.

TIME-VARIANT PANEL MODELS. A perennial question in the panel context is whether efficiency should be treated and modelled as constant over time, or time variant – which is arguably a more favourable and logical assumption. Given that consistency is improved in panel models as T increases, longer panels are preferred, but the longer the time period, the less sustainable the assumption of time-invariance. This issue is of more importance the longer the time period of the observations in a panel, since over time the firm may invest in new technology which will cause a shift in the frontier and/or or the managers benefit from "learning by doing", resulting in improvements in the firm's efficiency and inefficient firms are forced out by market pressures. This argument is particularly relevant to this thesis, given the restructuring in the banking sector in SEECs, including the extensive ownership transformation during the process of transition as discussed in sections 1.4.2 and 1.4.3.

There is no clear cut solution to the problem of how long (how many years) can a firm's efficiency be reasonably treated as time-invariant. Greene (2011) proposes that in 10 years it is to be expected that firms will make changes in the efficiency level, whereas up to 5 years it can be assumed that there are minor, if any, changes in efficiency level. The period between 5 and 10 years is unclear and it mainly depends on the nature of the examined sector. We assume that in our context five years are long enough period to expect changes in cost efficiency to occur as discussed in sections 1.4.2 and 1.4.3. Greene (2004) makes use of the panel models in which efficiency is modelled as time-variant where the particular panel data set has a time-series dimension of 5 years. Greene (2008) emphasizes that after many years of research on stochastic frontier modelling and numerous empirical investigations, efficiency estimates are sensitive to the assumption of time invariant efficiency.[11]

Many researchers have developed models which allow for time-varying efficiency. Among the early models of this kind are Cornwell et al. (1990), Kumbhakar (1990), Lee and Schmidt (1993), and Baltagi and Griffin (1988). This study does not aim to review the complete literature on time-varying panel data models, instead the focus is on a selection of such models, chosen according to the following particular criteria: (i) the models are widely used in the empirical literature, with special reference to transition economies and (ii) the time-varying model which controls for unobserved heterogeneity, given the earlier discussion of Greene (2005b). The empirical literature on efficiency in banking, especially in transition economies, mostly employs the models of Battese and Coelli (1992, 1995), while Greene (2005b) proposes a set of models, such as "true" fixed-effects and "true" random-effects as well as Random Parameters Models which control for latent heterogeneity. Therefore, these two strands of models are presented next, based on Eq. 2.6, but the emphasis is on specification of the inefficiency component of the error term, that is u_{it}.

I. Battese and Coelli (1992): the time "decay" model

$$u_{it} = \eta_{it} u_i = \{exp[-\eta(t-T)]\}u_i, \qquad t \in \Upsilon(i); i = 1,2, \dots N; \qquad \dots (2.7)$$

where, the one-sided error term reflecting inefficiency, u_i is assumed to be independent and identically distributed non-negative truncations of the $N(\mu, \sigma^2)$ distribution; η is the additional scalar parameter $\Upsilon(i)$ to be estimated for the set of T_i time periods. By construction in this model the variation in efficiency is provided systematically, given that the model comprises of two parts, the first being the time invariant u_i as in the case of Pitt and Lee (1981) and the second being the

[11] Greene (2008) finds that efficiency estimates are quite robust with respect to the choice of the panel model (fixed or random) and to the different distributional assumptions. Efficiency estimates are robust regardless of the methods used, in particular Bayesian or classical.

time varying, which is specified as function of time, $exp[-\eta(t-T)]$, where η is parameter to be estimated, t denotes the year and T is the terminal year. Given this, in the last year the latter part is 1, hence u_{it} collapses to u_i. This is a very strong assumption and applies "artificial" variation in the predicted efficiency. Moreover, given that the main component is time-invariant inefficiency, it implies that it incorporates time-invariant unobserved factors, that is the predicted estimates of efficiency reflects any time invariant firm specific heterogeneity in addition to the efficiency itself. This model is estimated by MLE.

II. Battese and Coelli (1995): the observed heterogeneity model (environmental effects)

$$u_{it} = z_{it}\delta + W_{it} \qquad \text{... (2.8)}$$

Where u_{it} is a positive truncation of the $N(z_{it}\delta, \sigma^2)$ distribution and it is assumed to be independently distributed. W_{it}, is a random variable "defined by the truncation of the normal distribution with zero mean and variance σ^2, such that the point of truncation is $-z_{it}\delta$, i.e.,$W_{it} \geq -z_{it}\delta$ (p. 327)" and z_{it} is a (1 x *m)* vector of explanatory variables associated with the cost inefficiency of banks over time; and δ is an *(m x* 1) vector of parameters to be estimated. This extension, BC (1995), allows for inclusion of explanatory variables, which explicitly affect the inefficiency of the bank (bank-specific and other environmental characteristics), in addition to the time function when modelling u_{it}. In other words, u_{it} by construction is a function of explanatory variables, z_{it}, and the parameters to be estimated, δ. In the case where all estimated coefficients of the explanatory variables are insignificant (zero), then the cost inefficiency effects are not associated with these variables, hence the half-normal distribution is obtained. Greene (2008) emphasizes that the BC models produce satisfactory results only when the data is consistent with the model, otherwise extreme results may emerge, for example due to suspicious quality of data and this being an inappropriate model specification, (LIMDEP Manual, 2007, E33-53).

III. True random effects model (Greene, 2005b)

$$y_{it} = (w_i + \alpha) + \boldsymbol{\beta}' x_{it} + v_{it} + u_{it}$$
$$v_{it} \sim N[0, \sigma_v^2]$$
$$u_{it} = |U_{it}|, U_{it} \sim N[0, \sigma_u^2]$$
$$w_i \sim N[0, \sigma_w^2]$$

… (2.9)

This model is a half-normal stochastic frontier and presentation of the whole model is necessary given the differences in its initial construction. The motivation for this model is to model the heterogeneity and allow this to be time-invariant, while inefficiency to be time-variant. Time-invariant heterogeneity is allowed in a common way by variation in the constant term, given this is a random-effects model. It seems very optimistic to have a regression model with three disturbances, $(w_i + \alpha)$, v_{it} and u_{it}, which is inestimable, but in fact it is a model with two disturbance terms in it, that is $(w_i + \alpha)$, where w_i is the random firm specific effect and $\varepsilon_{it} = v_{it} + u_{it}$, which has an asymmetric distribution. Hence, the approach is to fit the SF model and then decompose the ε_{it} using JLMS. This model is estimated by maximum simulated likelihood. It is estimated as a form of random parameters model, where the only random parameter in the model is the constant term which also includes the latent heterogeneity (the random effect) and becomes $\alpha + w_i$. Therefore, it can be expected that estimated inefficiencies from the Pitt and Lee (1981) random-effects model, in which the inefficiency term contains all other time invariant unmeasured sources of heterogeneity, are larger than those from the true random effects model, where bank-specific unobserved heterogeneity appears as a separate parameter from the inefficiency term, that is $\alpha + w_i$. Considering Battese and Coelli models, they represent a middle ground in time-varying panel data models, although it seems that they are closer to the time-invariant models, than to freely time-variant efficiency models, such as the Greene's true random effects model and true fixed effects model. The true fixed effects model is not presented here, given that only (additional) variables which vary over time can also be included in the function (LIMDEP Manual, 2007, p. E33-75). However, in our model as presented in Chapter 4 there some variables which are time-invariant, which makes this model inappropriate for our analysis, hence further discussion is not provided.

IV. The Random Parameters Models (RPM)

In the true random effects model, the only random parameter is the constant term, which makes this model a special case of the broad family of RPMs. In particular RPMs allow for another formulation of the SF model, that is these models allow the function to vary more generally across firms and model the cross firm heterogeneity in the form of continuous parameter variation (Greene, 2005b). Following Greene (2005b) the general form of the random parameters SF model is expressed as:

$$(1)\ Stochastic\ frontier{:}\ y_{it} = \alpha_i + \boldsymbol{\beta}'\mathbf{x}_{it} + v_{it} + u_{it},$$

$$v_{it} \sim N[0, \sigma_v^2], v_{it} \perp u_{it}.$$

$$(2)\ Stochastic\ frontier{:}\ u_{it} = |U_{it}|, U_{it} \sim\ N[\mu_i, \sigma_{ui}^2],$$

$$\mu_i = \boldsymbol{\mu}_i' \boldsymbol{z}_i,$$

$$\sigma_{ui} = \sigma_u \exp(\theta_i' \boldsymbol{h}_i).$$

$$(3)\ Parameter\ heterogeneity{:}\ (\alpha_i, \boldsymbol{\beta}_i) = \left(\bar{\alpha}, \overline{\boldsymbol{\beta}}\right) + \Delta_{\alpha,\boldsymbol{\beta}} \boldsymbol{q}_i + \boldsymbol{\Gamma}_{\alpha,\boldsymbol{\beta}} w_{\alpha,\boldsymbol{\beta}_i}$$

$$\mu_i = \bar{\mu} + \Delta_\mu q_i + \Gamma_\mu w_{\mu_i},$$

$$\theta_i = \bar{\theta} + \Delta_\theta q_i + \Gamma_\theta w_{\theta_i}.$$

... (2.10)

where $(\alpha_i, \boldsymbol{\beta}_i), \boldsymbol{\mu}_i$ and $\boldsymbol{\theta}_i$ are vectors of random parameters to be estimated and each subvector of the full parameter vector, $(\alpha_i, \boldsymbol{\beta}_i), \boldsymbol{\mu}_i$ and $\boldsymbol{\theta}_i$ is allowed to vary randomly with mean vector $\left(\bar{\alpha}, \overline{\boldsymbol{\beta}}\right) + \Delta_{\alpha,\boldsymbol{\beta}} \boldsymbol{q}_i$, $\overline{\boldsymbol{\mu}} + \Delta_{\boldsymbol{\mu}} \boldsymbol{q}_i$ and $\boldsymbol{\theta}_i = \overline{\boldsymbol{\theta}} + \Delta_{\boldsymbol{\theta}} \boldsymbol{q}_i$, respectively. $q_{\boldsymbol{i}}$ is a set of M related variables which do not vary over time and which enter the means (optional) of the random parameters. Δ_j is a coefficient matrix (NxM), which forms the observation specific term in the mean. $w_{j\boldsymbol{i}}$ is an unobservable Nx1 latent random term in the *i*-th observation in j, where $j = \left(\bar{\alpha}, \bar{\beta}\right), \mu, \theta$ and is assumed to have a mean of zero and known variance. Γ_j is a lower triangular matrix which produces the covariance matrix of the random parameters (more technical details in Greene, 2005b and LIMDEP Mannual, 2007; Section E17.8). The parameters of the model are estimated by the technique of maximum simulated likelihood.

2.3.3 Heterogeneity in Stochastic Frontier Analysis

An important issue in stochastic frontier modelling is the between firm heterogeneity, which has been already introduced in the time-varying panel data models. In the conventional representation of the stochastic frontier models we assume that the technology and the inefficiency distributions across individuals and time are homogeneous (Greene, 2008). The only reason for between firms differences is the existence of the random noise, v_{it}, which is a firm and time-specific shift factor. However, heterogeneity may be introduced in stochastic frontier modelling in various ways. Prior to this, it is important to distinguish between observable and unobservable heterogeneity. Observable heterogeneity appears when specific variables that present observable differences across firms that impact their cost function or the efficiency distribution are available but omitted from the model. Unobserved heterogeneity almost always occurs because as well as from the input prices, there are other variables that affect a firm's output that are missing. For example, in service industries quality is an important aspect of firm's performance, but it is very difficult for it to be measured. There are some proxies (for instance, number of branches, well established customer service departments, etc.) that measure the quality, but these are only partly correlated with the underlying variable. Therefore, according to Greene (2008) under unobservable heterogeneity is the awareness of important factors that should enter the model, but are not observable, which is a complicated problem to deal with. Another possibility that may give rise to unobserved heterogeneity, as argued by Greene (2008), is the possibility that the parameters might vary over firms, which implies that different models are appropriate for different groups of firms, if they vary in some manner identifiable by the groups (in line with the Random Parameters Models). Greene (2011) argues that in his study of the World Health Organization, this kind of unobserved heterogeneity might appear because of the existence of specific diseases in different regions in the world. The unobserved heterogeneity has been modelled in the Random Parameters Model (and the special case the true random effects model as discussed above).

Next, we turn our focus on the observable heterogeneity, that is inclusion of additional explanatory variables, which suggest observable differences across firms, hence should be introduced in the model; otherwise there is a problem of “excluded variables” which may lead to biased estimates. In the early stage of the development of the SFA, the usual procedure to explain the variation in efficiency [using other factors, named Zs] was to use a two-stage procedure, where in the first step the efficiency estimates are obtained by for example using SFA and the JLMS technique (as explained above), and in the second step the efficiency estimates are regressed on the Zs in order to explain the effects of the Zs on efficiency. Although, this two-step procedure seems a neat process of not only estimating the efficiency but also explaining its variation, from econometric point of view there are several problems that should be addressed. Wang and Schmidt (2002) investigate the properties of the two-stage procedure and of the advantages of the “scaling property” that u_{it} can be defined as a function of Zs times u_i independent of the Zs. They identify two sources of bias with respect to the two-stage procedure. The regression parameters in the first stage are biased if the Zs and the Xs are correlated and the former are not included in the model. The second source of bias, which is less acknowledged is that, even if Zs and Xs are independent, the estimated inefficiencies are under-dispersed when we ignore the effect of Zs on inefficiency, thus in the second stage the estimates of the effect of Zs on inefficiency is biased downward (toward zero).This is true regardless of whether Xs and Zs are correlated. Consequently, the possibility of estimating something about the determinants of efficiency, regardless of the “quality” of the second-step is questioned. Finally, the inefficiencies are assumed to be identically distributed in the first-step, but in the second-step it is assumed that they are related with the Zs with a certain functional form. Given these problems, Fried et al. (2008) expect that there will be no more studies using the two-stage approach.

A perennial question is whether these additional factors (Zs) are relevant for the cost function itself or somehow they enter in the distribution of the inefficiency term (the observed heterogeneity). The location of the frontier might depend not only on the inputs but also on the Zs. Both the input prices and the Zs are treated as exogenous. The Zs may affect the structure of the technology by which inputs are transformed to outputs, or they may influence the efficiency with which inputs are transformed into outputs. In the case when the Zs are thought of as factors that influence the production process, usually factors that are beyond the control of the managers, they are included directly in the model in the same way as the technology parameters (the inputs). In this case the Zs affect the output directly, by shifting the production function up and down. The structure of the conventional stochastic frontier model remains unchanged, thus the estimation techniques are also the same. In addition, Zs do not influence the efficiency, but define more precisely the relationship between the inputs and the output(s). When using maximum likelihood estimation, it is then required that Xs and Zs are both uncorrelated with v_i and u_i. This formulation contributes to a more accurate determination of the production opportunities and more precise efficiency estimates, but does not contribute to explaining the variations in efficiency.

On the other hand, if there is a prior knowledge that some Zs directly affect the level of efficiency and cause changes in the efficiency distributions, then the Zs should be entered directly in u_i function through a certain functional form. However, the positioning of particular Zs either as a part of the function of the production process or in u_i is still an on-going debate in the literature. Greene (2011) argues that this issue should be left to the researcher herself to decide. We argue this decision primarily depends on the theoretical grounds of the research topic or on empirical evidence if a theory does not exist. The decision on this issue in the context of our empirical analysis is further discussed in Chapter 4.

2.4 THE CHOICE OF FUNCTIONAL FORM

Hildreth (1955) argued that "*the principal disadvantage of continuous models lies in the biases which may accrue if an inappropriate (functional) form is used*" (p. 64). The functional form represents the relationship between output and inputs. The growing number of available functional forms complicates the creation of an empirical model. This might be a reason for many researchers trying to circumvent this issue and resorting to the criteria “widely used in the empirical work”. Griffin et al. (1987) highlight the complexity of choosing the “right” functional form, resulting from the absence of a single criterion for its selection. They present four categories of criteria for selection of an appropriate functional form (homogeneity, homotheticity, elasticity of substitution and concavity) with respect to the proposed hypotheses (assumed to be true, though not tested as part of the analysis).

In order to obtain a better fit of the relationship, less restrictive functional forms are preferable. A function may gain in flexibility by augmenting a restrictive form with additional terms. However, the more flexible the functional form the higher the costs regarding the maintained hypotheses, degrees of freedom, possible multicollinearity and the complexity of parameter estimation. Greene (2008) argues that the choice of functional form in a production (or cost) model involves a range of implications regarding the shape of the implied isoquants and the values of elasticities of factor demand and factor substitution. For example, in the SFA literature, two functional forms dominate, namely Cobb-Douglas and translog. The Cobb-Douglas production function and the implied cost function have universally smooth and convex isoquants. The virtue of the Cobb-Douglas functional form is its simplicity, which unfortunately provokes two major problems. Firstly, it can be used solely in the case of a single-output, otherwise the curvature properties are violated (Hasenkamp, 1976); and secondly, important from econometric point of view, if the true function of a particular production process is more complex than the Cobb-Douglas functional form, then the omission of modelling this complexity will end up in the error term, which may lead to biased efficiency estimates (Kumbhakar and Lovell, 2000). Consequently, the arguments support the choice of a flexible (second order) functional form.[12] In general, these flexible functional forms differ with respect to definitions of flexibility, mathematical expansions, separability and regular regions (Thompson, 1988). Defining flexibility is the primary ground for comparison between functional forms and the notion of flexibility is divided to local and global flexibility. Local flexibility, also named as Diewert flexibility, entails that an approximating functional form gives a perfect approximation for both the arbitrary function along with its derivatives (first and second-order) for any particular point in the domain (Griffin et al., 1987). No restrictions are imposed on the value of the function or its first two derivatives in the locally flexible form. Functions representing second-order Taylor series expansion are locally flexible functional forms. The translog functional form is the second-order Taylor series approximation of

[12] For more details see Griffin et al. (1987), Kumbhakar and Lovell (2000), Greene (2008).

the transcendental function and is arguably the most popular flexible functional form in SFA studies. It has advantages over the strong assumptions of the Cobb-Douglas functional form, since it relaxes the restrictions on demand elasticities and elasticities of substitution, but on the other hand the function is not monotonic or globally convex. Salvanes and Tjotta (1998) discuss the methodological problems of imposing an appropriate curvature on a translog model. Berger and Mester (1997), McAllister and McManus (1993), Mitchell and Onvural (1996) argue that the translog function has problems with fitting data that are far from the mean with respect to output size or mix, leading to differences in the results for scale economies.

A remedy for the above problem might be even a more flexible functional form, which is a global-flexible. Global flexibility can be assessed by the Sobolev norm (a distance measure) which provides a measure of error incorporated both in the derivatives and in the approximating function (Gallant, 1981). The Fourier-flexible (FF) functional form is Sobolev-flexible and has nonparametric properties. Global-flexibility is desirable due to: (i) small average bias predictions (Gallant 1981); (ii) substitution elasticities are estimated consistently (Elbadawi et al., 1983); and (iii) there is no spurious rejection when testing procedures are performed (Gallant 1982). The FF functional form, introduced by Gallant (1981, 1982, 1984), is an extension of the translog which adds Fourier trigonometric terms (sine and cosine), becoming more flexible compared to the translog form and represents a global approximation of the cost function. If the Fourier terms equal zero, the FF form is the translog. Thompson (1988) argues that global-flexibility is preferred over local-flexibility in mathematical and statistical terms. However, he emphasizes two reasons why local-flexible functions are more widely used than the global-flexible ones. The first is the complexity of specifying and estimating a FF functional form, and the second is the complication in calculating the standard errors of Fourier parameters. Moreover, an increase in flexibility is usually achieved by mathematical expansion, but it comes at a cost, that is (i) multicollinearity, as a result of inclusion of various parameters obtained by the transformation of the already existing variables in the model as well as plenty of interaction terms; (ii) difficulties in meeting the regularity conditions; (iii) the intricacy of interpreting parameter estimates; and (iv) a substantial reduction in degrees of freedom. Griffin et al. (1987) argue: "*Because reductions in maintained* *hypotheses come at a cost, added flexibility is not always desirable, and there are likely to be cost-effective opportunities to achieve particular dimensions of flexibility (p. 217)".*

Using the data on U.S. financial institutions, many authors such as McAllister and McAnus (1993), Mitchell and Onvural (1996), Berger et al. (1997a), Berger et al. (1997b), Berger and DeYoung (1997c) and Berger and Mester (1997d) provide evidence that the FF functional form fits the data better than the translog specification. Moreover, Girardone et al. (2009) find that the FF is preferable over the translog form after conducting a set of structural tests and comparisons for the case of banking industry in 15 EU countries. Kraft et al. (2002) also favour the FF functional form by finding that it provides better model specification for the study of the efficiency of Croatian banks compared to the tranlsog form. Berger and DeYoung (1996) find that estimated inefficiency under a translog specification is about twice the size of that specified under Fourier-flexible functional form. Although there are advantages in using FF over the translog form, the aforementioned limitations are rather serious in the context of our analysis, especially the substantial loss of degrees of freedom relative to the sample size used in this thesis.[13] Moreover, given that Random Parameters Models are included in the analysis, where coefficients are estimated for each unit of analysis, causing a substantial loss of degrees of freedom, further loss is not affordable given the size of the data set available. Under these circumstances, we have decided to use the translog functional form for the estimation of cost efficiency in Chapter 4.

2.5 COMMON OR COUNTRY-SPECIFIC FRONTIER

Another important issue is to decide on the "frontier" against which the efficiency is predicted and this could be a common frontier for the whole dataset or a country specific one. In the former case, all banks from different countries are put under the same frontier against which each bank's

[13] The calculation of the degrees of freedom is not straight forward and depends on factors determined within the empirical procedure, mainly by the researcher; however, we could not calculate them at this stage, because it depends on the model specification. However, a small change in these factors can cause a substantial increase in the parameters to be estimated and it can easily reach over 100 parameters.

efficiency is estimated. The latter is a frontier against which only the banks in a particular country are compared and their efficiencies estimated. In the literature this issue is considered by Berger (2007), who discusses fully the advantages and disadvantages of the two types of frontiers, based on an extensive review of the literature. To our knowledge this is the only paper that emphasizes the importance of "modelling" the frontier for cross-country studies, thus this section draws largely on Berger's work and arguments.

The country specific frontier was mainly used in the early studies of efficiency. The comprehensive survey of Berger and Humphrey (1997) regarding the financial depository institutions includes 122 studies. Only six of them deal with more than one country, while 66 out of the 116 single-country studies analyse the efficiency of financial institutions in the USA, with the rest largely considering developed European countries. After this survey the number of single-country studies, particularly studies related to countries of interest to this thesis expanded.[14] The nation specific frontier is appropriate for the analysis of the effects on efficiency resulting from: (i) bank regulation; (ii) domestic banks mergers and acquisition; and (iii) size and organization of banks. This frontier is useful when comparing different methods of efficiency measurement and the efficiency of state-owned banks versus privately-owned banks. It is also suitable when examining the effects of market power on efficiency, the source of productivity change and the efficiency of branches of a particular bank.

Despite the extensive application of the country specific frontier, the main disadvantage is its unsuitability for comparing banks on international level. Specifically, this frontier cannot give any estimates about which countries have more efficient banks. The only possible comparison of efficiency predictions among countries, using country specific frontiers, is to gain insight into which countries the banks operate at an efficiency level closer to the best-practice bank in that

[14] Argentina (Delfino, 2003; Berger et al., 2005), Australia (Otchere and Chan, 2003; Strum and Williams, 2004), China (Berger et al., 2009), Croatia (Kraft et al, 2006), Hungary (Hasan and Marton, 2003), Malaysia (Matthews and Ismail, 2006), Pakistan (Bonaccorsi di Patti and Hardy, 2005), Poland (Havrylchyk, 2006), Portugal (Barros and Borges, 2004), South Korea (Gilbert and Wilson, 1998), Thailand (Leightner and Lovell, 1998; Chantapong, 2005) .

country. Although a common frontier across countries enables comparisons across borders, this approach has difficulties associated with differences in the economic environment between countries, such as: discrepancies in the economic development of the countries; different regulatory and supervisory practices; and differences in the level of development of financial markets. In his review, Berger (2007) asserts that the early studies applying the common frontier do not control for such discrepancies in economic environments, which leads to conflicting results. However, the studies after 2000 introduce better control variables which improve the efficiency estimates. The additional variables in the models include: measures of the banking market conditions, for instance income per capita, population, deposit and branching density; market structure indicators such as concentration ratio; and regulation measures such as the average equity capital ratio, risk and firm specialization.

Berger (2007) argues that although the current literature is huge improvement on the early studies using a common frontier, limitations still exist. In particular, many economic environmental features are difficult to incorporate in the model such as: institutional, cultural, and demographic; settlement cycles and methods, and payments systems; and financial market development. As a result it is possible that measured differences in efficiency are due to unmeasured environmental variations rather than actual efficiency differences. As far as banks in SEECs are concerned, they face some similarities in their environments (as discussed in Chapter 1), that is all of them are former socialist countries that went through the privatization of state-owned banks, with foreign banks often taking large market shares. This is a leading argument used by researchers for applying common frontier studies already conducted for transition economies, for example Fries and Taci, 2005; Bonin, Hasan, and Wachtel, 2005; Rossi, Schwaiger, and Winkler, 2005; Yildirim and Philippatos, 2007.

Bos and Schmiedel (2007) introduce a new strand in the literature on bank efficiency. They apply the meta-frontier methodology from Battese et al. (2004) to envelope the previously estimated country specific frontiers in order to estimate banks' efficiency across a set of countries. The essence of the meta-frontier is first to test for possible technology differences among the countries involved. Once this hypothesis is supported, in the next step a meta-frontier[15] is applied. However, this approach is criticized as it tends to attribute efficiency differences to the "technology gap" which is in itself an unclear concept, specifically when banking sector is concerned.

In this thesis we are interested in the cost efficiency of individual banks in the SEE region, including between banks in different countries. These estimates are used as independent variables in Chapter 6 as a possible determinant of market share in banking. Thus the cost efficiencies will be estimated against a common frontier.

2.6 A BANK: INTERMEDIARY OR PRODUCER?

Another important question to be addressed before estimating efficiency is the definition of inputs and outputs in banking. This issue is quite controversial for financial institutions because of the complex nature of their activities and has an implication for what is regarded as outputs and inputs when estimating efficiency. Berger and Humphrey (1997) discuss the lack of consensus in the choice of inputs and outputs when banking institutions are considered. In particular, two main views describe the nature of the banks' business: the production approach and the intermediation approach. These different perspectives initiated the ongoing debate in the literature regarding the definition of the inputs and outputs in the banking sector. The discussion sheds light particularly on the role of deposits, namely whether deposits are inputs, outputs or they share the characteristics of the both.

The production approach (Berger et al., 1987) defines banks as providers of services for account holders. In other words, this approach assumes that the banks use inputs such as capital and labour to produce outputs as loans and deposits. In particular, the production approach considers

[15] They define the meta-frontier as *"a deterministic parametric function (of specified functional form) such that its values are no smaller than the deterministic components of the stochastic frontier production functions of the different groups involved, for all groups and time periods"* (p. 3, Battese et al., 2002) (originally taken from Bos and Schmiedel, 2007)

deposits as outputs because they contribute in the creation of value added by providing liquidity, safekeeping and payments services to depositors. On the other hand, the intermediation approach (Sealy and Lindley, 1997) regards banks as mediators between savers and investors, using the raised funds deposited by the account holders to offer loans to investors. This approach argues that the deposits and their costs (the interest rate paid to the depositors) should be considered as inputs and the loans and investments as outputs to be used in the estimation of bank efficiency, because the former present a raw material to be converted into the latter.

Neither the production nor the intermediation approaches fully captures the dual roles of financial institutions as (i) providing transactions/document processing services and (ii) being financial intermediaries that transfer funds from savers to investors. Berger and Humphrey (1997) discuss the advantages of each approach. They argue that the production approach fits better for evaluating the efficiencies of branches of banks, because branches primarily process customer documents and branch managers almost have no influence over bank funding and investment decisions. The intermediation approach seems more suitable for evaluating an entire bank because at the bank level interest expenses often accounts for one half to two thirds of total costs, which are not considered in the production approach.

Berger and Humphrey (1991) and Bauer et al. (1993) put forward the modified production approach, suggesting a consideration of both input and output features of the deposits. In particular, the interest paid on the deposits is considered as an input, while the volume of deposits is accounted as an output. Other efficiency studies have first treated deposits as an input and then as an output. These investigations find that efficiency is somewhat higher when deposits are treated as an output. Since the treatment of deposits in efficiency models can affect the efficiency estimates, this aspect of model specification may be of some importance to the outcome. There are empirical studies that compare the efficiency estimates using the two approaches and some of them find differences in the estimates, while others argue they are very similar regardless of the approach employed. In support of the former, Berger and Humphrey (1997, p.32) assert:

"*Overall, it appears that inferences regarding efficiency may be importantly affected by how output is measured, a result which is usually less dependent upon investigator choice than availability of data.*"

Tortosa-Ausina (2002) adds that the choice of appropriate approach depends on the given circumstances, related initially to theoretical basis then data availability. She emphasizes little attention is paid to this issue compared to the choice of technique for efficiency estimation, albeit its importance derived from different output definitions could bias the efficiency estimates.

This thesis employs the intermediation approach (Sealy and Lindley, 1997) because intermediation is still the primary activity of a bank (IMF, 2012). Moreover, the bank's role as an intermediary is even more prominent in SEECs, given that the capital markets have been underdeveloped in these countries (discussed in Section 1.1) and banks are main providers of capital. Finally, Berger and Humphrey (1997) argue that intermediation approach is more suitable for the estimation of the efficiency of each bank.[16]

2.7 CONCLUSIONS

In this chapter various concepts of efficiency were considered initially and "cost efficiency" as defined by Farrell (1957) was selected as the concept investigated in this thesis. That estimation of efficiency is a challenging task is highlighted by Bauer et al. (1997, p. 2) that *"... there is really no consensus on the preferred method for determining the best-practice frontier against which relative efficiencies are measured."* This argument is reflected in the analysis of the methods of investigation for estimation of efficiency which was the main focus of this chapter.

[16] In this chapter and the rest of the thesis we refer to a "bank" in its entirety as the unit of analysis (not individual branches or parts of a bank providing a special service).

The initial issue discussed as a part of the methods of investigation was the choice of estimation approach, namely parametric or nonparametric. The preferred approach was the parametric one because it has statistical properties and distinguishes between random error term and inefficiency, which is not the case for the nonparametric approach. There is also a range of parametric approaches for estimation of cost efficiency as discussed in this chapter, but SFA was selected as the suitable method for estimation of cost efficiency in banking in SEECs, the subject of analysis in Chapter 4. The rationale for this choice is based on the theoretical characteristics of SFA, in that SFA allows for estimation of time-varying efficiency and controls for latent heterogeneity. Specifically, the Random Parameter models are chosen as the most appropriate in the context of SFA because they possess the above mentioned features. However, given the popularity of the Battese and Coelli (1992, 1995) models, we decided to employ these models as well in Chapter 4 for comparative purpose.

Several other issues such as the choice of functional form, the "frontier" type and the definition of bank's inputs and outputs were also discussed in this chapter. In terms of the functional form we argued for the use of translog functional form, although there are advantages in using more flexible functional forms, but there are serious limitations of the latter in the context of our analysis, on the grounds of degrees of freedom given the available data set. Next, it was decided that bank's cost efficiency should be estimated against a common frontier, because our data sets includes the SEECs and besides their similarities, these countries experienced different transitional pace and economic development as discussed in sections 1.4.2 and 1.4.3 and this will be done in Chapter 4. Finally, in terms of the role of the bank, it was decided to treat banks as intermediaries because of the fact that intermediation is the primary role of banks in SEECs and also because we aim to estimate cost efficiency of each bank.

CHAPTER 3

THE ESTIMATION OF COST EFFICIECNY IN BANKING: A REVIEW OF LITERATURE

3.1 INTRODUCTION

In Chapter 2 the concept of efficiency was presented along with a number of relevant issues associated with the methods of estimation of cost efficiency in the banking sector. The empirical approach to the estimation of cost efficiency in this thesis has been determined on the basis of the theoretical framework, including the new developments in theory of stochastic frontier analysis (SFA), and in line with the aims of this thesis, that is estimating cost efficiency which is time-variant (Section 1.2). However, before we proceed with this empirical analysis, this chapter reviews the empirical literature on cost efficiency estimation in banking, with special reference to transition economies, thus, serving as a bridge between the previous chapter and the empirical analysis of the thesis in Chapter 4.

In reviewing this literature the chapter aims to: (i) identify the knowledge gap in the field of cost efficiency in banking with special reference to transition economies; (ii) identify the variables which should be included in the estimation of cost efficiency in banking, including those reflecting observable differences across countries (and the banking industries) and across banks; and (iii) following the discussion in Chapter 2, confirming our decisions regarding the methods of investigation for the empirical analysis in Chapter 4.

Given these aims, the focus of the discussion in this chapter is on the methods of estimation of the SFA applied in the empirical studies of cost efficiency in banking and this is presented systematically in line with the structure of Chapter 2. By doing this we can compare similarities and differences with respect to relevant aspects of the methods of estimation and the empirical questions tackled in the respective analyses. The review is accompanied by a critical assessment of the studies examined, identifying the drawbacks in the current literature and the knowledge gap associated with the estimation of cost efficiency in banking using SFA. This literature review focuses almost exclusively on the studies conducted for the transition economies (an exception being Section 3.2 that briefly discusses the early studies of efficiency estimation in banking). The rationale for this is fourfold: First, the countries under consideration in the empirical work in this thesis are all transition countries. Second, the application of models discussed in Chapter 2 requires decisions related to specificities of the industry and countries under consideration. Given the discussion in Sections 1.4.2 and 1.4.3 the transition economies have undergone massive restructuring in the banking sector and present a separate group of countries with specific similarities and differences very distinct from other countries that have been studied and, therefore, should be studied separately. Third, given that the bank level data for these countries is still limited (even in the Bankscope database), only studies on transition economies are useful in the process of identifying the specific variables used in the estimation process. Studies for developed economies use disaggregated data for the variables of interest, for example the input prices and outputs of each bank, but such data are not available for SEECs. Finally, and possibly most importantly, to our knowledge these empirical studies follow the approaches used in the studies for the developed economies. We follow this approach as long as the literature on transition economies provides good coverage of the methods of investigation. If the coverage is not achieved we will go beyond this literature.

This chapter is organized as follows: Section 3.2 contains a brief discussion of the early studies of estimating banking efficiency. Section 3.3 presents the empirical studies and developments in estimating banking efficiency in transition countries. In particular, Section 3.3.1 provides an overview of the single and cross-country studies. An examination of the methods of investigation applied in the estimation of cost efficiency in banking in transition economies is the subject of analysis in Section 3.3.2. Section 3.3.3 identifies the variables of relevance for the empirical analysis in Chapter 4. Section 3.3.4 provides a comparison of the results in terms of banks' cost efficiency in transition economies obtained from the studies reviewed here. Section 3.3.5 discusses and extends the two important empirical studies which are most relevant and help to establish our contribution to knowledge used as a basis in Chapter 4. Finally, Section 3.4 concludes the chapter.

3.2 EARLY STUDIES ON COST EFFICIENCY IN BANKING

Efficiency estimation for the banking sector began in the late 1980s. In the early stage, a remarkably high number of studies were conducted for the U.S. compared to the developed European countries' banking sectors. Berger and Humphrey (1997) present a comprehensive survey of the early studies of the efficiency of financial institutions. The survey comprises of 130 studies, of which 122 examine financial depository institutions and eight analyse efficiency in insurance companies.[17] Sixty-six out of the 122 studies examine efficiency in the U.S. banking sector and 41 studies are predominantly focused on the developed European countries, but none of these studies considered transition economies (for obvious reasons). Almost all of these studies focus on a single country (accounting for 116 out of 122 studies), but during the 1990s several

[17] In the discussion that follows, the studies of insurance company are excluded, since the interest of this thesis is on the banking sector alone.

authors extended their datasets to include additional countries. For example, three studies evaluate efficiency in the Scandinavian banking sectors, one study considers eight developed countries and one study examines 15 developed countries.

Regarding the technique of estimation applied, the reviewed early studies make use of at least five different frontier approaches, in particular 69 studies use nonparametric techniques (Data Envelopment Analysis, DEA, and Free Disposal Hull, FDH) and 60 make use of parametric techniques (SFA, DFA, TFA). As discussed in Section 2.3.1 the differences between the two broad techniques are in the extent of shape imposed on the frontier and the existence of a random error in addition to inefficiency. Comparing the results of the vast number of early studies, Berger and Humhprey (1997, p.45) find that the efficiency estimates from the nonparametric and parametric frontier models are similar, but the mean efficiency estimates obtained from the nonparametric techniques are somewhat lower and have greater dispersion compared to those obtained from the parametric techniques (more specifically, the mean efficiency for the nonparametric and parametric techniques is 72 and 84 per cent, respectively). However, in terms of the efficiency rankings of the financial institutions when nonparametric and parametric techniques are applied (only presented in few of the reviewed studies), these ranking are inconsistent across the techniques. Additionally, some of the reviewed studies find a strong relationship between the findings of different techniques while some of them find only weak relationships (Berger and Humphrey, 1997).

In their review, Berger and Humphrey summarize several shortcomings of these early studies on efficiency in the banking sector. First, they argue that researchers decide upon the method/model used in the study in line with the idiom “the lesser evil”. Choosing “the lesser evil” results from the complexity of efficiency estimation as discussed in Chapter 2, hence the chosen method/model was usually the one which is easily applicable. Such approach for choosing a method/model is inappropriate, because this kind of decision should be based on theory and evidence. Second, they emphasize the limitations of the nonparametric and parametric methods, namely the absence of random error term in the former method and restriction on the frontier shape in the latter method. Given this, they call for further developments and improvements in both methods so that the data will arguably yield efficiency estimates that are more accurate and more consistent across different approaches. Third, they encourage efficiency estimation analysis to be conducted for banking sectors across the world, given that studies are predominantly focused on the US and some developed European countries. Moreover, they assert the necessity of cross-country investigation of efficiency in banking, since such studies were limited at the time of their review. Finally and vey importantly, they point out that, although the early studies find that financial institutions are not fully efficient, little has been said about the possible factors that may affect efficiency and by that explain why inefficiency exists along with efficiency differences among financial institutions and its persistence over time in market economies. However, even the few studies that examine determinants of efficiency by regressing efficiency estimates on a set of explanatory variables in a second stage, manage to explain only a small portion of the total variation in efficiency. In addition to Berger and Humphrey criticism although the two-stage studies opt for the analysis of determinants of efficiency, they overlook the limitations of the two-stage procedure as discussed in Section 2.3.3, which is a deficiency in the early studies that carried out this process.

3.3 STUDIES ON COST EFFICIENCY IN BANKING IN TRANSITION ECONOMIES

None of the vast number of studies reviewed in the survey by Berger and Humphrey (1997), and discussed in the previous section, covered any of the transition countries. However, researchers began to show interest in estimating banking efficiency for this group of countries in the late 1990s. The empirical studies for transition countries are quite diversified with respect to the methods of investigation and findings, therefore this literature review is organized in such manner that analyse different issues in separate subsections in line with the structure of Chapter 2.

3.3.1 Single versus Cross-country studies

The first paper to examine the banks' efficiency in transition economies dates back to 1998 by Kraft and Tirtiroglu, focusing on the Croatian banking sector for the period 1994-1995 and applies the SFA technique. From then onwards, the archive considering transition economies expands. Similar to the studies surveyed by Berger and Humphrey, in the early stage of these studies, the interest is mostly in analyzing single countries Nikiel and Opiela (2002) for Poland, and Taci and Zampieri (1998) for the Czech Republic (as cited in Fries and Taci, 2005). Kraft et al. (2002) evaluate the relative efficiency of state-owned, private and foreign banks in Croatia using different models and functional forms. Hasan and Merton (2003) analyse the performance and efficiency of Hungarian banks in the post-privatization era with an emphasis on the dynamics of bank efficiency and the effect of foreign banks entering the market. Mertens and Urga (1998) examine the progress of the banking sector by estimating cost and profit efficiency in Ukraine.

The focal point of the more recent studies is cross country comparisons for transition economies, in particular the Central and East Europe countries (CEECs) that are already members of EU and counties in SEE with prominent EU aspiration which are working on their EU accession. This stream of studies comprises of the following empirical contributions. Weill (2003) and Kasman (2005) estimate cost efficiency for the banks in the Czech Republic and Poland, with special reference to the effect of the presence of foreign ownership in the banking sector in both countries. Rossi et al. (2005) aim to investigate cost and profit efficiency of the banking sector in nine transition economies and to examine the impact of managers' behaviour on the efficiency levels. Fries and Taci (2005), Bonin et al. (2005), Kasman and Yildirim (2006) examine the cost efficiency and the effect of the influx of foreign ownership in the banking sectors of 15, 11 and 8 transition economies in the process of restructuring, respectively. Fries and Taci (2005) and Kasman and Yildirim (2006), in addition, attempt to show the country-specific and bank-specific factors that are related with higher/lower cost efficiency, as well as to portray the progress of financial integration before joining EU. Mamatzakis et al. (2008) focus on the banking sectors in ten of the new EU countries and estimate both cost and profit efficiency. Furthermore, they investigate the convergence of the efficiency levels and the efficiency differences. Yildirim and

Phillipatos (2007) aim to estimate cost and profit efficiency of banking sectors and their determinants in 12 transition economies, including both EU members and non-EU members. Likewise, Kosak and Zajc (2006) and Kosak et al. (2009) analyse the eight new EU members. The former evaluate and compare banks' cost efficiency and aim to identify the factors that influence the level and differences of cost efficiency scores, whereas the latter examine the evolution of efficiency and the factors that enhance that development in the banking sectors. Kosak and Zoric (2011) examine the cost efficiency in the eight new EU member countries, by employing different models and methods of estimation with special reference to the importance of properly accounting for unobserved heterogeneity.

The discussion, so far, reveals that the empirical contributions considering transition countries deal almost exclusively with the countries that recently joined EU; the exceptions are several studies that include Croatia in their set of countries (this country, too, has been an EU member since 2013) and Macedonia (in three studies only). To the best of our knowledge, there is only one empirical study evaluating cost efficiency in the banking sector for the SEECs (that is, BiH, Bulgaria, Croatia, Macedonia, Romania, Serbia-Montenegro), conducted by Staikouras et al. (2008). Although, Bulgaria, Croatia and Romania, are subject to analysis in the other studies focusing on the new EU member states, most of the successors of Yugoslavia (Serbia and Montenegro as a separate countries and BiH) are not examined before this study, indicating the small amount of research on this region. Moreover, Albania is not included in any of the reviewed studies.

The time span of investigation in the aforementioned studies is largely in the period from 1993 to 2003, i.e., in the relatively early stages of transition. Only the study of Kosak and Zoric (2011) covers the later period of 1998-2007. It is remarkable that although all of these studies emphasize the aim of evaluating bank efficiency in the new EU member states, only this last study covers the period after the countries acceded to the EU. Most of these countries joined the EU in 2004, with the last two joining in 2007.

Table 3.1 Methods of investigation used in the reviewed studies for cost efficiency in the banking sectors in transition economies using SFA

Author(s)	Period	No. of countries	List of countries	Data source	No. of obs.
Kraft and Tirtiroglu (1998)	1994	1	Croatia	National Bank of Croatia	86
Mertens and Urga (2001)	1998	1	Ukraine	UICE	79
Kraft et al. (2002)	1994-2000	1	Croatia	National Bank of Croatia	363
Nikiel and Opiela (2002)	1997-2001	1	Poland	National Bank of Poland	301
Hasan and Marton (2003)	1993-1998	1	Hungary	HFSEA, NBG, HMF	193
Weill (2003)	1997	2	Czech and Poland	Banskcope	47
Fries and Taci (2005)	1994-2001	15	Bulgaria, Czech, Estonia, Croatia, Latvia, Hungary, Lithuania, Kazakhstan, Macedonia, Poland, Romania, Russia, Slovenia, Slovakia and Ukraine	Bankscope, EBRD Transition Reports, IMF's IFS	1897
Bonin et al. (2005)	1996-2000	11	Bulgaria, Croatia, Czech, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia	Bankscope	856
Rossi et al (2005)	1995-2002	9	Czech, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia	Bankscope	1170
Kasman (2005)	1995-2000	2	Czech and Poland	Bankscope, IMF's IFS, WBI	261
Kasman and Yildirim (2006)	1995-2002	8	Czech, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia	Bankscope	997
Kosak and Zajc (2006)	1996-2003	8	Czech, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia	Bankscope	429
Yildirim and Philippatos (2007)	1993-2000	12	Czech, Estonia, Croatia, Hungary, Latvia, Lithuania, Macedonia, Poland, Romania, Russia, Slovakia and Slovenia	Bankscope	2042
Staikouras et al. (2008)	1998-2003	6	BIH, Bulgaria, Croatia, Romania, Macedonia and Serbia-Montenegro	Bankscope	515
Mamatzakis et al. (2008)	1998-2003	10	Cyprus, Czech, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia	Bankscope	766
Kosak et al. (2009)	1996-2006	8	Czech, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia	Bankscope	1055
Kosak and Zoric (2011)	1998-2007	8	Czech, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia	Bankscope	928

Source: Author's own compilation

Although in the study by Kosak and Zoric (2011) one part of the time period under investigation covers the first years of EU membership for all the countries included in their analysis, they do not control for the period before and after joining the EU. It could be expected that once a transition country becomes an EU member it faces a single market with different environment characterized with respect to the size of the financial market, the diversity of available products and activities, competition, human capital and expertise, albeit the enhanced progress towards financial integration and accepting the legislative of EU during the process of negotiating. Table 3.1 presents a summary of the scope of the analysis of the studies discussed above.

3.3.2 Methods of investigation

As elaborated in Section 2.3, the efficiency estimation requires decisions on a number of issues when setting the empirical model for efficiency estimation. Therefore, this section aims to present the methods of investigation employed in the reviewed studies for the banking sectors in transition economies with respect to these relevant issues. We replicate the structure of Section 2.3 where the theoretical underpinnings are elaborated for the issues of concern, but in this section, we analyse them from a perspective of their application to the empirical studies on transition economies. Table 3.2 (presented at the end of this section, after the individual items of this table are discussed in the following sub-sections) summarizes the issues related to the methods of investigation used in the studies reviewed in this chapter (initially presented in Table 3.1)

Type of model and estimator. Irrespective of whether the aforementioned studies analyse single or multiple countries, at one point in time or over time, they employ different estimation techniques (Table 3.2). These empirical studies use various estimation techniques for cross-section and panel data models. A typical representative of cross-section studies is Mertens and Urga (2001) examining the Ukrainian banking sector for 1998, using the least-squares estimator. But, in the context of SFA, this estimator has serious shortcomings: it does not necessarily envelope the data as closely as possible from above, and not all observations are enveloped by the regression line (Kumbhakar and Lovell, 2000, pp. 70-72). The former indicates a possibility of "superefficient" firms and the latter indicates that no firm is efficient.

The cross-section study of Weill (2003) estimates a system of equations (translog function and its input cost share equations) by the Iterative Seemingly Unrelated Regression (ITSUR) technique using a maximum likelihood estimator for Poland and the Czech Republic for 1997. It is a common approach for the method of Maximum Likelihood to be applied in SFA. However, both cross-section studies provide inconsistent cost efficiency estimates (see Section 2.3.2) which is a problem with cross-section data models.

Besides these two studies, several studies estimate cost efficiency using data for more than one year. However, not all of these studies take full advantage of the panel data models, since they employ pooled estimation. Among these studies are: Kratft and Tirtiroglu (1998), Hasan and Marton (2003), Bonin et al. (2005), Kasman (2005), Yildirim and Philippatos (2007) and Staikouras et al. (2008). It should be noted that some of these studies are placed in this group in this discussion because the type of the model used in the study is unclear in that it is neither discussed in the study nor can be identified from the model presentation or the empirical results that it is a panel model. As in the "pure" cross-section studies, the cost efficiency estimates in the pooled models are inconsistent, since there is no time component which increases the likelihood of consistent efficiency estimates as $T \rightarrow \infty$, as discussed in Section 2.3.2. However, there are also studies dealing with cost efficiency in the banking sector in transition economies which apply panel data models, making use of the time component appropriately, hence increasing the probability that efficiency estimates being consistent. Studies that are included in this category are: Kraft et al. (2002), Fries and Taci (2005), Rossi et al. (2005) and Kasman and Yildirim (2006). A common feature of this group of studies is that the same estimator is used in the analysis, namely all of them exploit the estimators of Battese and Coelli (either 1992 or 1995), which are discussed in Section 2.3.2.

Distribution of u_i. The next issue to be addressed is the choice of distribution of the inefficiency error term. In the reviewed studies a variety of distributional forms are applied (Table 3.2). Some studies employ more than one distributional form, mainly to compare the results obtained from different distributional forms. For example, Kraft et al. (2002) apply two different assumptions for the distributional form of the inefficiency error term, half-normal and truncated. Using the Likelihood Ratio Test (given that the two models are nested as discussed in Section 2.3.2), the results suggest no preferences for either of the two distributional assumptions. Kasman (2005) makes three different assumptions regarding the distribution of the inefficiency error term: half-normal, exponential and truncated. Similarly to Kraft et al. (2002), Kasman (2005) obtains similar results from the three models with the different distributional assumptions. Only the study of Weill (2003) considers the gamma distribution for the inefficiency error term; this may be due to the complicated computation, because as originally argued by Greene (2008, p. 110): *"The restriction that all sample residuals must be kept strictly positive for the estimator to be computable turns out to be a persistent and major complication for iterative search methods."* Like studies for the developed economies, the most common distributional assumptions for the inefficiency component of the composed error term are either half-normal or truncated. The former distribution is applied in Mertens and Urga (2001), Kraft et al. (2002), Bonin et al. (2005), Rossi et al. (2005) and Kasman (2005), whereas the latter distribution is used in Kraft et al. (2002), Hasan and Marton (2003), Fries and Taci (2005), Kasman (2005), Kasman and Yildirim (2006), and Yildirim and Philippatos (2007). In addition, the truncated distribution is an integral part of the models of Battese and Coelli and thus also used in the studies discussed at the end of the previous sub-section.

Time (in)variant efficiency estimates. As argued in Section 2.3.2 the feature of time-variant efficiency is found to be a significant factor for the differences in the efficiency scores obtained from estimation. However, in a number of studies under review in this section a different treatment of the efficiency with respect to time can be noted (Table 3.2). Some of the studies, Weill (2003) and Yilidirim and Philippatos (2007), treat cost efficiency as constant over time. Other studies present efficiency estimates for each year of the period included. Kasman (2005) and Hasan and Marton (2003), in particular, use pooled data models where the average yearly estimates are calculated by simple average of each year's bank efficiency obtained from the estimates of the pooled model. Bonin et al. (2005), by inclusion of time dummies, aim to control for differences in each year's estimates. We refer to these methods of presenting time-varying efficiency as "quasi-time-variant" efficiency levels. Kraft et al. (2002), Fries and Taci (2005), Rossi et al. (2005), Kasman and Yildirim (2006), Kosak and Zajc (2006) and Kosak et al. (2009) obtain efficiency estimates that vary from year to year which results from the attributes of the Battese and Coelli (1992, 1995) estimators (Section 2.3.2). The wide use of these models is not really clear, given that the reviewed studies do not provide a detailed discussion regarding the criteria upon which the particular model is chosen for the empirical analysis. The argument of Greene (2008, 2011) that the majority of the empirical studies employ the Battese and Coelli models (1992, 1995) is further supported by this review of studies. Greene (2011) suspects the wide use of these models is possibly due to the implementation of Battese and Coelli models in the STATA software. No other SFA models have been available in STATA in a user friendly way. The popularity of these models is arguably the main reason for their consideration in the empirical work in Chapter 4. Moreover, it is a good opportunity to compare the performance of these models with the other chosen models, that is the true random effects model of Greene (2005) and the RPMs, as discussed in Section 2.7.

Kosak and Zoric (2011) is the only study, to our best knowledge, which estimates time-varying efficiency and control for unobserved heterogeneity using, among the other models, the true random effects model proposed by Greene (2005). Given that this is one of the theoretically preferred models for estimation of efficiency in the banking sector in SEECs in Chapter 4 (as discussed in Section 2.7), this study is further discussed in Section 3.2.4. It is important to be noted that none of the empirical studies on efficiency in banking in transition economies makes use of RPMs. Therefore, we look wider and search the literature on efficiency in banking beyond those considering transition economies, for example studies examining the US or the EU banking sector. Despite an extensive search on the EconLit and Google Scholar, at the time of writing this chapter, we could not find any study employing RPMs, except the original study of Greene (2005) which considers the banking sector in the US to demonstrate the application of the true random effects and RPMs in the framework of SFA. Based on this discussion we identify a knowledge gap in the empirical literature on efficiency estimation. In particular, the estimation of efficiency in banking using RPMs will further contribute to this literature. In terms of the true random effects model the contribution to knowledge is discussed in Section 3.2.4.

Table 3.2 Methods of investigation used in the reviewed studies for cost efficiency in the banking sectors in transition economies using SFA

AUTHOR(S)	Type of Analysis	Estimator	Variation u_i	Distribution of u_i	Functional form
Kraft and Tirtiroglu (1998)	Panel	ITSUR[a] (MLE[b])	No	Half-normal	Translog
Mertens and Urga 2001	Cross-section	Least-squares	No	Half-normal	Translog
Kraft et al. (2002)	Panel	BC[c] (1995)	Time-variant	Half-normal Truncated	Fourier-flexible
Hasan and Merton (2003)	Panel	Pooled (ASL[d]-MLE)	Quazi time-variant	Truncated	Translog
Weill (2003)	Cross-section	ITSUR (MLE)	Time-invariant	Gamma	Translog
Fries and Taci (2005)	Panel	BC (1993, 1995)	Time-variant	Truncated	Translog
Bonin et al (2005)	Panel	Pooled (ASL-MLE)	Quazi time-variant	Half-normal	Translog
Rossi et al (2005)	Panel	BC (1995)	Time-variant	Truncated; Half-normal	Fourier-flexible
Kasman (2005)	Panel	Pooled (ASL-MLE)	Quazi time-variant	Half-normal Exponential Truncated	Translog
Kasman and Yildirim (2006)	Panel	BC (1995)	Time-variant	Truncated	Fourier-flexible
Kosak and Zajc (2006)	Panel	BC (1992)	Time-variant	Truncated	Translog
Yildirim and Philippatos (2007)	Panel	Pooled (ASL-MLE)	Quazi time-variant	Truncated	Translog
Staikouras et al (2008)	Panel	Pooled (ASL-MLE)	Quazi time-variant	Truncated	Translog
Mamatzakis et al. (2008)	Panel	Pooled (ASL-MLE)	Quazi time-variant	Half-normal	Translog
Kosak et al. (2009)	Panel	BC (1995)	Time-variant	Truncated	Translog
Kosak and Zoric (2011)	Panel	Pooled (ASL-MLE), Pitt and Lee(1981), BC (1995) and TRE[e](Greene, 2005)	Quazi time-variant & time-variant (depends on the model	Truncated; Half-normal	Translog

Source: Author's own compilation
Note: a) Iterative Seemingly Unrelated Regressions technique; b) Maximum Likelihood Estimation; c) Battese and Coelli; d) Aigner, Lovell and Schmidt (1977) and e) True Random Effects Model

The choice of functional form. The choice of the functional form is another important issue when employing the SFA. Although, there are theoretical advantages of Fourier Flexible (FF) over the translog functional form as discussed in Section 2.4, it is not always feasible to use FF because of the computational difficulties it brings and the far more parameters that need to be estimated.

The FF functional form requires larger data sets, which are not usually available for transition economies. Kraft et al. (2002) use both translog and FF functional form and argue that regardless of the time dimension of the inefficiency and the distributional assumption of the error term, the preferred functional form is the FF functional form as suggested by the Likelihood Ratio Test. Apart from this study, the FF functional form is used only in two other studies, Rossi et al. (2005) and Kasman and Yildirim (2006). The translog functional form is far more used in the studies of transition economies, for example, Mertens and Urga (2001), Hasan and Marton (2003), Weill (2003), Fries and Taci (2005), Bonin et al (2005), Kasman (2005), and Yildirim and Philippatos (2007). Table 3.2 summarises the method of investigation as well as the distributional assumptions and the functional forms used in the literature on transition economies.

3.3.3 Definition of variables in SFA

As discussed in Section 3.1 one of the aims of this chapter is to identify the variables of relevance in conducting the SFA in order to estimate cost efficiency in banking. To that end we recall Eq. 2.6 and augment it by the additional vector of exogenous variables, the Zs that may influence the total costs and their structure in the production of the given output(s), as discussed in Section 2.3.3. The Zs may also directly affect cost (in)efficiency rather than the frontier itself, but this issue is further discussed in Section 4.3.1. At this stage we are interested in the identification and definition of the variables required for efficiency estimation, hence for now we include Zs as a part of the frontier as follows:

$$lnC_{it} = \alpha_o + \beta lny_{it} + \gamma lnxw_{it} + \delta lnZ_{i(t)} + \varepsilon_{it} \quad \text{... (3.1)}$$

where C_{it} presents total costs, y_{it}, w_{it} and $Z_{i(t)}$ represents the outputs, input prices and the additional exogenous variables, respectively. This section discusses the importance of the data used and the variables of interest in the context of the banking sector. Coelli et al. (2005) stress that the quality and appropriateness of data used in the sophisticated techniques for estimating efficiency are just as important as the techniques themselves. No matter how powerful a given statistical technique or mathematical tool, it cannot overcome problems that fundamentally reside in data themselves. In the context of cost efficiency measurement, as presented in Eq. 3.1, three categories of variables are important: (i) output quantities, y_{it}; (ii) prices of inputs, x_{it} and (iii) the additional exogenous variables, $Z_{i(t)}$. Choosing between various output indicators in the case of service industries may be particularly challenging. A good understanding of the industry under consideration is a first and foremost requirement and banking is a complex industry and as such it can be considered either as a production or an intermediation activity, but as discussed in Sections 2.5 and 2.7 we regarded it as the latter. Berger and Humphrey (1991) state that with this approach flow data of monetary units of loans and deposits are appropriate to be included in the analysis. However, since flow data are not usually available, they argue that flows are typically assumed to be proportional to the stock of the loans and deposits expressed in monetary units. This approach is widely taken in the literature since the data used is based on financial reports.

In order to define the variables to be later used in the empirical investigation of cost efficiency in banking in SEECs (in Chapter 4), we again focus on the studies conducting the respective analysis in transition economies. As discussed in Section 3.1, data on transition economies is still limited (this is further discussed in Section 4.3.2), but the studies on developed economies are not of much use. Table 3.3 presents the definition of the variables used in the empirical investigation of cost efficiency in transition countries which treat the bank as an intermediary (see Appendix to Chapter 3, Section 3.1, Table A3.1 for complete table including the definition of the variables in studies for transition economies using the production approach as well). Other than the production parameters, in this table the *Z* variables (macroeconomic indicators, banking industry and bank-specific variables) used in the reviewed studies are also presented.

By analysing Table 3.3, it seems that, given data availability, the choice and the definition of variables in estimating efficiency in the banking sector is already well established. The dependent variable in the cost efficiency model is the total cost (Table 3.3, Column 2), comprised of total interest expenses, personnel expenses and other operating expenses. Total loans and other earning assets are the two outputs used (Table 3.3, Column 3). The input prices are presented in Column 4. The first input price, the price of borrowed funds is equal to total interest expenses divided by total deposits/borrowed funds. The second input price, the price of labour is represented as personnel expenses per employee. The price of physical capital is defined as the ratio of non-interest (operating) expenses, excluding personnel costs, to fixed assets.

Most of the studies use the ratio of total costs to total assets and ratios of each output to total assets (Table 3.3). This way of defining the variables is in line with Berger and Mester (1997) who use the equity capital as denominator in the ratio. They argue that this normalization is to control for heteroscedasticity and for scale biases in estimation as well as convenient economic interpretation of the findings. Therefore, this thesis, in particular Chapter 4 also considers this approach and considers total costs and outputs in terms of total assets. As discussed above, the price of labour is personnel expenses per employee, but data on the number of employees across banks and time is very restricted in Bankscope (Section 4.3). Given that there is a significant portion of missing data on number of employees, the reviewed empirical studies for transition economies measure the labour price as a ratio of personnel expenses over total assets, instead of number of employees (Table 3.3, Column 4). Therefore, this definition of the labour price will also be employed in Chapter 4, following this well-established approach in this literature for transition economies.

Table 3.3 Summary of the variables used for cost efficiency estimation in the studies for transition economies employing the intermediation approach

Author(s)	Dependent variable	Independent variables		Environmental factors		
	Total costs (TC)	Output(s)	Input prices	Individual bank's characteristics	Structure of the banking industry	Country level variables
Kosak and Zoric (2011)	Σ of personnel, interest and other expenses	Loans Securities OEA[b]	*Labour* (personnel expenses/TA) *Borrowed funds (* interest expenses/funding) *Physical capital* (noninterest expenses/FA[d])	Equity ratio Foreign ownership (dummy variable)	EBRD Index[e] , HHI[f] Number of banks Intermediation ratio	Population density GDPP[g] , Financial deepening ratio[h]
Kosak et al. (2009)	Σ of personnel, interest and noninterest expenses	Loans Securities OEA	*Labour* (personnel expenses/TA) *Borrowed funds (* interest expenses/funding) *Physical capital* (noninterest expenses/FA)	Equity ratio Ownership status, ROA market share net interest margin	EBRD Index, HHI number of banks intermediation ratio	Population density, GDPP, Financial deepening ratio
Mamatzakis et al. (2008)	Σ of personnel, administrative, interest, fee and commission expenses/TA[a]	Loans/TA OEA/TA	*Labour* (personnel expenses/TA) *Borrowed funds* (total interest expenses/ total interest bearing borrowed funds) Fixed netputs: Equity/TA and FA/TA	Ownership Type of institution Bank size Listed/non-listed banks	NO	NO
Staikouras et al (2008)	Σ of operating and financial cost/TA	Loans/TA OEA/TA	Price of non-financial inputs [operating (non-interest) expenses/TA Price of funds (Interest paid on borrowed funds/total funds)	*In the first stage:* Equity, Cash/TA *In the second stage:* Equity/TA, LLP*/Loans, Deposits/Total funds ROA, Bank size, TA Ownership status	Deposits per km^2 HHI	GDPP Population density
Mertens and Urga (2001)	Σ of variable costs, noninterest and administrative expenses/TA	Inter-bank loans/TA Consumer loans/TA Others[c]/TA	*Labour* (total labour costs/TA) *Deposits* (interest expenses/deposits) *Physical capital* (Σ of furniture, premises and other administrative expenses/FA)	*Input variables:* Bank capital, FA *Bank-specific variable:* NPLs**/total loans		

***Notes**: a stands for total assets; b denotes other earning assets; c is other investments (government and risky securities and investment in other enterprises); d denotes fixed assets; e stands for EBRD Index of banking sector development; f represents Herfindahl-Hirschman Index; g denotes GDP per capita, h presents financial deepening ratio, which is a ratio of the total banks' on country level over GDP; * Loan Loss provisions; ** Non-performing loans*

Source: Author's own compilation

Finally, the last three columns in Table 3.3 present the *Z* variables, in particular macroeconomic indicators, banking industry and bank-specific variables included in the reviewed studies. As can be noticed, again there is considerable consensus among those studies that incorporates all the three categories of Z variables which adjust the cost frontier or enter the mean/the variance of the one-side error term, u_i (this issue is further discussed in Section 4.4). The rationale for inclusion of the three categories of controlling variables can be found in the arguments of Berger (2007) and Greene (2008) as discussed in Section 2.5 and 2.3.3, respectively. In addition, the empirical results regarding these variables for some of the reviewed studies are presented in Table 3.4 below. As suggested by Berger (2007), country-specific and industry-specific variables are included to adjust the frontier against which the (in)efficiency is measured relative to the macroeconomic and industry environment in which the bank operates, given that this thesis, in particular Chapter 4, focuses on eight transition countries. Furthermore, as suggested by Greene (2008), bank-specific variables are included to control for potential heterogeneity resulting from different output quality, as the omission of variables from the model which explain differences across banks may affect the efficiency estimates.

Following the studies presented in Table 3.3 we identify four environmental variables to be included in the empirical analysis in Chapter 4: real GDP per capita, the inflation rate, demand density and population density. Some of these factors are expected to have a negative impact on the total costs, that is, they contribute to a decrease of the total costs and thus reduce the cost frontier, shifting it to the right. Such factors include the level of economic development, measured as real **GDP per capita**, which influences the demand and supply for deposits and loans and is expected to be negatively related to total costs as a result of economies of scale.

The reviewed empirical studies in this chapter considering transition economies, find an inverse relationship with GDP per capita/GDP growth and total costs (Fries and Taci, 2005; Kasman and Yildirim, 2007; Kosak et al., 2009; Kosak and Zoric, 2011; Kasman, 2005 and Yildirim and Philippatos, 2007), in other words the economic development contributes to total costs reduction. The **inflation rate** is closely related with the level of the interest rates. Additionally, high inflation is expected to have a negative impact on financial development. It is assumed that in economies with high level of inflation bank costs increase because of increased costs in credit screening and risk management. This is consistent with the findings of Kasman (2005) and Kasman and Yildirim (2007).

The **density of demand**, the total deposits of the banking sector divided by area in square kilometres, is also expected to be negatively associated with total cost, because where banks operate in an economic environment with a lower density of demand they may incur higher expenses to collect deposits and offer loans. The expected relationship is found in Kasman (2005) and Kasman and Yildirim (2007). Finally, the **population density** ratio of inhabitants per square kilometre is also expected to have inverse relationship with total costs, given the fact that in areas of low population numbers, the demand for banking services is limited with respect to the number of customers. However, the empirical results in the reviewed studies are mixed; the expected inverse relationship is found in the studies of Kasman (2005), Kasman and Yildirim (2007) and Staikouras et al. (2008), but the opposite of the theoretical prediction, a positive relationship between total costs and population density is found in Kosak et al. (2009) and Kosak and Zoric (2011). Although the last two indicators seem to be similar, they represent different country specificities. The population density may serve as an indicator for the market size with respect to demand, which is fairly constant over a short period of time. Thus, in the countries with low population density, the banks by default face the problem being unable to exploit fully economies of scale. On the other hand, demand density is expected to reflect simultaneously people's wealth and trust in the banking system (the latter being an important factor in the transition period, since people lost the faith in the banking system because of the systematic failures at the beginning of the transition).

Figure 3.1 and Figure 3.2 serve as an evidence for the complementarity of these two indicators. Figure 3.1 displays the averages of the both indicators for each of the eight countries under consideration in this thesis and Figure 3.2 maps the average increase of demand density across these countries. According to Figure 3.1 although Albania and Serbia are the countries (only

Slovenia is more populated than Serbia), they are substantially lagging in terms of demand density compared to Slovenia and Croatia, the two countries with the highest average demand density. The differences between the two counties with the lowest and highest average demand density is enormous.

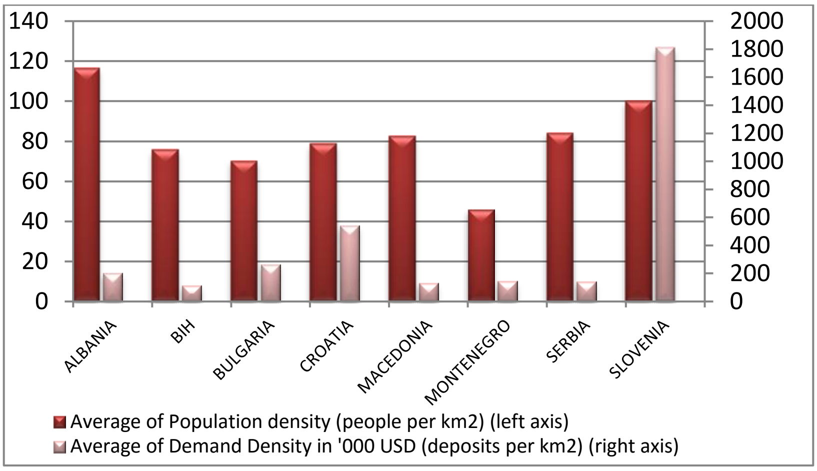

Figure 3.1 Population density and demand density across countries (average over time)
Source: Author's own calculation (based on data from National Banks and World Bank)

In addition, Slovenia and Croatia are the two countries with lowest average increase in the demand density over time, whereas Montenegro has the highest average increase in the demand density (Figure 3.2). In a nutshell, inclusion of only the one of these indicators may adjust the frontier inadequately. Consequently, this can be a criticism of the transition papers which do not control for the two indicators simultaneously (only Staikouras et al., 2008 controls for both the characteristics, while the others either include one of them or none).

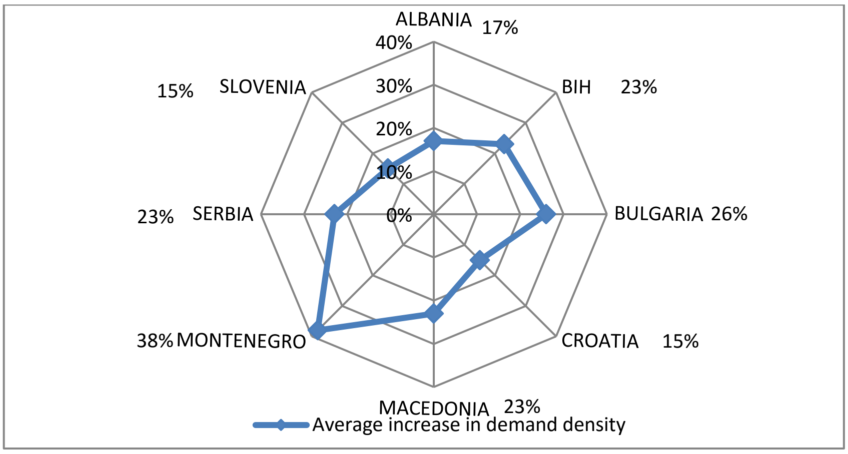

Figure 3.2 Average increase of demand density across countries
Source: Author's own calculation (based on data from National Banks and World Bank)

The **banking industry specific features** are usually represented by two indicators: the intermediation ratio and concentration ratio. The **intermediation ratio**, measured as total loans to total deposits in the overall banking sector, captures the differences among the banking sectors in terms of their capacity to convert deposits into loans, which may be related to bank holdings of government securities leading to the crowding out of private borrowing by the public sector, or inadequate institutions to support lending to the private sector with the absence of effective secured transactions and bankruptcy laws (Fries and Taci, 2005). Therefore, the relationship of the intermediation ratio to total cost is expected to be negative. The **Herfindahl-Hirschman Index (HHI)** is a measure of concentration. There is still an ongoing debate on the relationship between concentration and the cost/profit. If higher concentration enables some banks to exhibit market power, total cost may increase because of negligence and inefficiency as suggested by the Hicks's quiet-life hypothesis (1935) and Leibenstein's X-efficiency theory (1966). On the other hand, if a higher concentration results from superior banks' management and the exploitation of economies of scale and scope, then higher market concentration leads to lower costs (Dietsch and Lozano-Vivas 2000; Fries and Taci 2005; Lensink et al. 2008), consequently higher cost efficiency (Berger, 1995). This can implicitly provide supportive evidence for the efficiency-structure hypothesis (Demsetz, 1973). Moreover, improved efficiency could also result if the market remains contestable, which depends on the ease that firms can enter the industry, given that the existing industry is now more concentrated and more efficient. The discussion above suggests that concentration ratio is closely related to both cost and (in)efficiency implying that the "position" of this indicator in the model is dubious. However, given that this is an aggregated indictor on a country level rather than an individual indicator, such as market share, it is considered as an industry-specific, rather than bank-specific feature in the empirical estimations in Chapter 4.

Several bank-specific characteristics that might affect the total costs, but primarily (in)efficiency should be included in the empirical analysis (the position of these variables in further discussed in Sections 4.2 and 4.4). Berger and Mester (1997) argue the importance of considering the **financial capital** when analysing efficiency, primarily because a bank's insolvency risk depends on its financial capital available to absorb portfolio risks and losses, thus it affects a bank's costs and profits. Moreover, they maintain that if a bank is a risk averse, it may hold a higher level of financial capital than maximizes profits or minimizes costs. Therefore, if financial capital is ignored, the efficiency estimates may be under/overestimated, despite the optimal behaviour of the bank conditional on its risk preferences.

The transition economies have undergone substantial structural reforms during the last two decades as discussed in Section 1.4. Market liberalization has been a crucial element of those reforms, opening up the markets for foreign investments. In the banking sector this has resulted in a situation in which a significant share is owned and operated by foreign banks. Following theoretical underpinnings and empirical findings, the effect of ownership is dubious (discussed in the next subsection), hence it is relevant the empirical analysis in Chapter 4 to control for this element and investigate the ownership effect on costs/efficiency in SEECs, given that ownership restructuring has been one of the main reforms in the banking sector.

From the theoretical point of view it is assumed that producers provide outputs with same quality (homogenous products). However, in practice this assumption usually does not hold, especially in the banking industry which is highly specialized in "customer-tailored" products and the presence of asymmetric information in the lender-borrower relationship. Therefore, there is a need for model adaptation with respect to product quality. For that purpose, a measure for output quality is introduced in the model. The first step towards taking into account this complication is to consider total net loans, which do not include impaired loans, but introduce loan loss reserves or non-performing loans as a proxy for the quality of the output as it is a usual practice in the empirical studies in transition economies (Table 3.3). Both items are part of the balance sheet statement and present a stock of loan loss reserves and non-performing loans. So far, the empirical studies for transition economies do not control for the level of loan impairment charges, which are a position in the income statement and present the flow of loan impairment charges for the particular year. Therefore, they have direct impact on the total costs which means on the (in)efficiency level as well. The level of loan impairment charges is expected to be procyclical (for instance at the outset of the financial crises in 2009, the level of loan impairment charges more than doubled in many of the countries, especially in Slovenia, Croatia and Bulgaria, see Figure 3.3), therefore their inclusion in the empirical analysis in Chapter 4.

However, it should be noted that the use of loan impairment charges, as a measure of the loan quality, is not without problems. In particular, they appear in the income statement as charges for impaired loans in the current year, but they in fact reflect bad loans approved in past years as well as the current year; therefore they represent the quality of the loans over a longer period of time. Thus, from economic theory perspective, they represent accounting costs, rather than opportunity costs, but given that loans are a stock not a flow of loans, which also incorporates approved loans in the past, it is considered to be the best measure for quality from the data available (further discuss in Section 4.3).

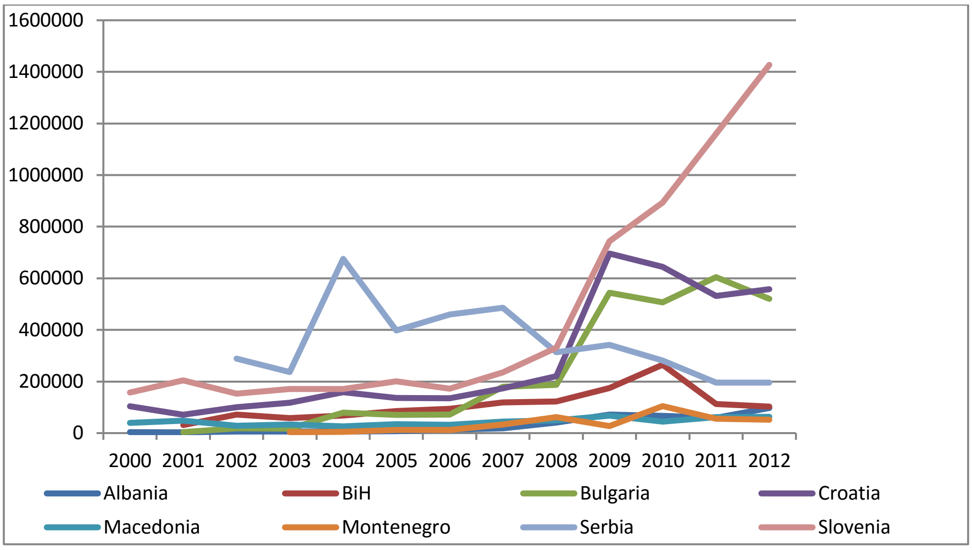

Figure 3.3 Loan impairment charges across countries and time (constant price as of 2005)
Source: Author's own calculations (based on Bankscope and other data collected by the author)

Finally, given that in the last decade many of the transition economies became EU member states it is reasonable to control for EU accession to capture any heterogeneity across EU and Non-EU countries as well as through time. However, none of the reviewed empirical studies control for this, which could be considered as a shortcoming of these studies. It is expected that EU dummy will capture the effect of accessing EU, which means changes in the current environment/regulations faced by the banks. Additionally, it is expected that EU accession will force the banks to lower their costs in order to stay in the market. Therefore, the empirical analysis in Chapter 4 will consider this issue as well.

Briefly, the empirical analysis in Chapter 4 considers the three categories of *z* variables discussed above, and the choice of their inclusion in the empirical model relies on the common practice already established in this literature, as presented Table 3.3. However, as discussed above the empirical work in this study will employ a different measure for output quality compared to the recent studies and will control for EU membership.

One-step versus two-step approach and the inclusion of the Zs. The aim of this section is twofold. First, it aims to present the trend in the reviewed studies regarding the treatment of the additional explanatory variables, that is whether they are an integral part of the empirical model (one-stage) or these possible determinants of efficiency (the Zs) are regressed on the estimated banks' efficiency levels (the two-stage approach). This issue is theoretically discussed in Section 2.3.3. Second, it aims to summarize the empirical findings regarding the aforementioned explanatory variables. The rationale for inclusion of macro level variables is to enable comparison across countries and control for the differences in the economic development, but also because the macroeconomic environment is expected to affect banks' efficiency. However, some of the other explanatory variables of banks' efficiency considered in the models are primarily included on intuitive rather than theoretical grounds as presented in Section 3.3.3.

Table 3.4 Summary of the reviewed studies with respect to the stages employed in the empirical analysis and the empirical results in terms of the Zs

One-stage	Quasi	Two-stage

	Fries&Taci (2005)	Kasman&Yildirim (2006)	Kosak et al. (2009)	Kosak&Zoric (2011)	Kasman (2005)	Staikouras et al. (2008)	Yildirim&Philippatos (2007)
GDP per capita	insignificant		positive	negative	positive	insignificant	
GDP growth		negative			negative		Negative
Income per capita		negative			positive		
Inflation		positive			positive		
money/GDP					positive		
Population density		negative	positive	positive	negative	negative	
Density of demand		negative			negative		
Intermediation ratio	negative	negative	Insignificant	positive	negative		
EBRD index	Nonlinear		insignificant	negative			
No. of banks			negative	negative			
HHI		positive	insignificant	insignificant		positive	
CR3/5	insignificant						Positive
Market share	negative		negative				
Panzar-Rose H-statistics							Negative
Financial development		negative	positive	positive			
Foreign ownership	negative	Insignificant	negative	insignificant	Mixed		Negative
Capital/TA	negative				negative		Negative
ROA			negative				
NIM			negative				
Nominal interest rate	positive						
Non-loans assets/loans	positive						
NPL/loans	positive						
LLP/Loans						Insignificant	
Cash/assets						positive	
Large banks							Negative
Loans/assets							Negative
LLR/TL							Negative
Short-term/Total fund							Negative
Off-balance sheet							Negative

Source: Author's compilation

Table 3.4 summarizes the empirical studies according to the number of stages in the procedure of estimation taking into consideration the treatment of the efficiency determinants. We divide them into three groups: one-stage, quasi and two-stage procedures. The one-stage procedure incorporates the macroeconomic/environmental variables, the banking industry variables and the individual bank's characteristics in the empirical model for efficiency estimation likewise the production factors and the outputs as discussed in Section 2.3.2 and 2.3.3. In the two-stage procedure the efficiency determinants are regressed on the obtained cost efficiency levels in the second stage, where the efficiency estimates are obtained in the first-stage after performing the SFA or any other method for estimation efficiency. Although some researchers discuss the problems of the two-stage efficiency estimation procedure (Section 2.3.3), such an approach is often used in the literature for the transition countries. The quasi group, classification created by the author, comprises of studies that include macroeconomic and bank-industry specific variables in the first stage when efficiency is estimated, while regress the individual bank's characteristics on the efficiency estimates in the second stage. There is also another group of papers, not considered in the table, which estimate cost efficiency for different countries, but do not control for the differences in the economic and financial development. The lack of these variables could easily lead to biased efficiency estimates. Several studies such as Mamatzakis et al. (2008), Rossi et al. (2005), Yildirim and Philippatos (2007), Bonin et al. (2005) ignore this issue and estimate efficiency under common frontier with no control for differences in development, except some of them include country dummies. Studies that follow the one-stage approach are Fries and Taci (2005), Kasman and Yildirim (2006), Kosak et al. (2009), Kosak and Zoric (2011), whereas Yilidirim and Philippatos (2007) represent the two-stage group.

3.3.4. Comparison of the efficiency estimates in the reviewed studies

Table 3.5 presents a summary of the cost efficiency scores in the banking sector in majority of the transition economies. The results indicate differences in the efficiency level obtained from the various studies. Serbia and Montenegro which are subject to analysis only in one study; therefore there is no counterpart for comparing the efficiency results for these particular countries. However, the new EU member countries are subject to analysis in the majority of the studies reviewed in this section. For instance, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia are analysed in Fries and Taci (2005), Rossi et al. (2005), Kasman and Yildirim (2006), Yildirim and Philippatos (2007), Mamatzakis et al. (2008), Kosak and Zajc (2006), Kosak et al. (2009) and Kosak and Zajc (2011). Analysing the results, it is very difficult to reveal any pattern of behaviour with respect to the estimated cost efficiencies, although the results vary across studies. However, a substantial difference in the estimated efficiency scores is found in the results of Mamatzakis et al. (2008) and Kosak et al. (2009). The difference in the estimated results per country is in range of 20 and 30 per cent (except for the case of Slovakia, where the difference of the average estimated efficiency score is 10). In addition, Kosak et al. (2009) estimate efficiency levels between 77 and 95 per cent, while Mamatzakis et al. (2008) gives the range as from 61 to 69 per cent for the same set of countries in close to the same time span. In order to understand the grounds for such difference in the obtained result, both empirical studies have been thoroughly examined. Many details of the investigation are different and might be considered as potential reasons for the differences in the results.

First, the studies make use of a different model: Mamatzakis et al. (2008) use maximum likelihood as originally proposed by Aigner et al. (1977) on a pooled data set, whereas Kosak et al. (2009) employ the Battese and Coelli (1995) model for panel data. This indicates that the former is a time-invariant estimator, while the latter is a time-variant estimator. Mamatzakis et al. (2008) estimate efficiency in a one-step procedure using dummies for country, time, size and type of the bank, but ignore the additional variables, the Z(s). The Kosak et al. approach is also one-stage, but this study includes environmental variables and bank-specific characteristics. Both studies use the translog functional form for the multiproduct model and apply the intermediation definition. In short, the aforementioned features of the two studies indicate that the primary reason for the substantial difference in the results is a consequence of the time-(in)variant estimator employed and possibly the inclusion of the Z(s) in the Kosak et al. (2009) study.

Table 3.5 Efficiency estimates by country and author(s)

Country	Mertens and Urga (2001)	Kraft et al. (2002)	Hasan and Marton (2003)Average and range through time	Fries ansd Taci (2005) With (w/o) country-level factors:	Rossi et al (2005) Over time range	Kasman and Yildirim (2006) Avg efficiency (efficiency range through time)	Yildirim and Philippatos (2007) Range due to different level of truncation:	Kasman (2005) Nation frontiers:	Kasman (2005) Common frontier w/o country-specific variables	Kasman (2005) Common frontier with country-specific variables	Mamatzakis et al (2008)	Staikouras et al al (2008)	Kosak et al. (2009)	Kosak and Zoric (2011)
Bulgaria				0.62(0.42)								0.67		
Bosnia and Herzegovina												0.58		
Czech				0.47(0.42)	0.47 – 0.64	0.79 (0.74-0.84)	0.73 – 0.80	0.74	0.59	0.80	0.61		0.81	0.72-0.81
Croatia		0.66		0.72(0.67)			0.77 – 0.84					0.63		
Cyprus											0.68			
Estonia				0.85(0.82)	0.78 – 0.80	0.83 (0.68-0.92)	0.70 – 0.76				0.65		0.95	0.84-0.92
Hungary			0.71 (0.62-0.78)	0.76(0.62)	0.71 – 0.79	0.79 (0.75-0.85)	0.73 – 0.80				0.69		0.90	0.74-0.84
Kazakhstan				0.83(0.78)										
Latvia				0.76(0.75)	0.64 – 0.77	0.79 (0.70-0.89)	0.66 – 0.78				0.62		0.93	0.77-0.94
Lithuania				0.82(0.80)	0.75 – 0.79	0.79 (0.74-0.83)	0.60 – 0.74				0.66		0.94	0.81-0.93
Macedonia				0.60(0.47)			0.73 – 0.79					0.53		
Malta											0.69			
Poland				0.74(0.66)	0.78 – 0.82	0.80 (0.73-0.85)	0.75 – 0.85	0.78	0.77	0.82	0.64		0.92	0.81-0.87
Romania				0.55(0.47)	0.55 – 0.76		0.71 – 0.79					0.64		
Russia				0.70(0.46)			0.63 – 0.75							
Slovakia				0.78(0.76)	0.63 – 0.66	0.79 (0.75-0.83)	0.66– 0.80				0.67		0.77	0.73-0.83
Slovenia				0.78(0.75)	0.87 – 0.92	0.80 (0.74-0.87)	0.74-0.84				0.69		0.91	0.82-0.89
Serbia and Montenegro												0.63		
Ukraine	0.67			0.73(0.59)										

Note: *Weill (2003) does not provide efficiency scores separately for Czech and Poland, thus not included in this table. This also applies for Bonin et al. (2005)*

The two studies, Rossi et al. (2005) and Kasman and Yildirim (2006), deserve to be considered separately from the rest of the other transitional empirical studies. There are some of the features of the studies that are the alike are: the same time span, the same set of countries (except that Rossi et al. included Romania), the same database exploited for collecting the banks' data and both studies use the Fourier-flexible functional form with three outputs. There are the differences in the methods of investigation, which certainly could be the explanation for the diversity in the efficiency scores in the empirical estimates. Having presented the grounds for feasible comparison of the two articles, the emphasis is directed towards the differences in the methods of investigation involved in the studies, which could be possibly considered as a source of diversity in the efficiency scores. What makes this comparison interesting is that both studies employ a time-varying panel estimator, but Rossi et al. use Battese and Coelli (1992) estimator, while Kasman and Yildirim use Battese and Coelli (1995). Although, both of them are time-varying estimators, the procedures applied differ, namely the former uses a two-step approach, whereas the latter a one-step. The choice of outputs in Rossi et al. is based on the modified approach, while Kasman and Yildirim use the value-added approach for the same purpose. Consequently, the analysis suggests that employing a time-variant efficiency estimator (which is considered as the main factor for variety in the results, see arguments in Section 2.3.2) in both studies was not enough to secure similar results. The discrepancies in the efficiency estimates arguably may be explained by the differences in the other issues regarding the methods of investigation, such as the definition of bank (intermediary or producer) and/or the stages in the estimation procedure (one-stage and two-stage). This further supports that any issue regarding the methods of investigation should be carefully approached.

To sum up, the findings from the analysed set of papers, so far, are that there is diversity in the technique and the detailed application used between studies. The reasons for the differences in the obtained empirical estimates for efficiency are not fully established, but there is intuitive support for it relating to the type and the nature of the estimator and the number of stages in the process of empirical investigation.

3.3.5 The two most relevant studies

This section aims to critically assess the two most relevant studies regarding our empirical investigation in Chapter 4 with respect to the set of countries and the methods of investigation. Staikouras et al. (2008) estimate cost efficiency for part of the SEECs, which are subject of our interest, whereas Kosak and Zoric (2011) analyse efficiency for the more advanced transition economies, using the same methods of investigation as we intend to use in Chapter 4, as discussed in Section 2.7.

Staikouras et al. (2008). This study analyses cost efficiency in the banking sector of six South East European (SEE) countries (BIH, Bulgaria, Croatia, Macedonia, Romania, Serbia-Montenegro) over the period from 1998 to 2003. They use SF approach, incorporating firm-specific and country-related variables. Features of the model specification are the translog functional form and the intermediation approach when choosing input prices and output(s). In line with the other studies, Bankscope is the main data source. The empirical findings reveal a generally low level of cost efficiency of 62 per cent average cost efficiency of all six countries, where the Macedonian banking sector is on average least cost efficient and the Bulgarian banking sector is the most efficient one. The authors explain the low efficiency scores as a consequence of both exogenous and endogenous factors. They argue that the most significant exogenous factors are the legislature and macroeconomic environment, whereas the skills of bank managers and the inappropriate system of corporate governance in SEECs banks are very prominent endogenous factors. However, the GDP per capita is not statistically significant in their study, indicating the country development does not influence the banks' cost efficiency in these set of countries.

Other factors that are found to have no impact on cost efficiency are output quality, risk preferences and population density. The results suggest that some of the factors are associated with cost efficiency. For example, the liquidity ratio and HHI are negatively associated with cost efficiency. The latter finding provides evidence in favour of the "quiet life" hypothesis which argues that the banks that enjoy market power are not under pressure to lower their costs.

Medium-sized banks are found to be slightly more cost efficient compared to the both small and large banks. The results suggest that the foreign banks and banks with dominant foreign ownership are the most cost efficient, while the government-owned banks are at the other far end of the spectrum. In order to boost the cost efficiency in the banking sector, a possible solution is the privatization of the government-owned banks and/or the entry of foreign banks.

Another objective of the study is investigation of the determinants of lower/higher cost efficiency at a second stage. However, this seems to be superficial, especially because some of the variables are included in both the two stages. In particular, Staikouras et al. regress cost *inefficiency* values obtained from the SFA on a vector of explanatory variables, such as the loans to assets ratio and the ratio of bank deposits to total funds to capture the asset portfolio composition and funding mix. Specifically, in order to control for the financial capital ratio, the equity to assets ratio is included (already included in the first stage); as a proxy for default risk the loan loss provisions to loans is included; ROA is considered as a measure for profitability; the market share of each bank is used as a proxy for market power while to study the pattern of "learning by doing" they include the bank's age and finally to control for the macroeconomic environment, the growth rate of GDP (GDP per capita included in the first stage) is introduced in the model. Both country and ownership dummies are also included in the two stages of the empirical analysis. The empirical results suggest absence of association between the cost efficiency and the variables describing the deposit mix, loan quality and profitability. A positive and significant relationship of cost efficiency is found with the GDP growth, the age of the bank and the asset portfolio composition, whereas a statistically negative relation is found with the equity ratio (supporting the "moral hazard" hypothesis) and the market share.

The authors interpret the positive and significant age variable as a consistent with the "quiet life" hypothesis, arguing on page 495, that "*at some stage, efficient management might become less* *prominent and opt, instead, for a less proactive style, leading to a decrease in efficiency*". However, Hicks (1935) "quiet life" hypothesis draws special attention to the management of the companies with high market power not opting for profit maximization, since managers find their subjective costs for efficient resource allocation greater than the gains they get from it. Therefore, in our opinion the age variable cannot be necessarily be interpreted in the spirit of the "quiet life" hypothesis. Similarly, the estimated parameter of the market share variable is negative and statistically significant and this effect is interpreted by the authors, page 495, "*banks with dominant share of domestic assets could facilitate more efficiently their operation and thus, register lower average total cost".* This is in line with the Demsetsz's efficiency-concentration hypothesis. Given this, if the effect of HHI on cost efficiency is considered from the first stage of estimation there are contradictory results. The HHI is estimated to have a positive effect on the total costs, hence implicitly negative effect on cost efficiency, which suggests support of the "quiet life" hypothesis (market power-concentration hypothesis), whereas in the second stage of estimation, the estimated coefficient of market share supports the opposite, namely the efficiency-concentration hypothesis. The main criticism related to this study is the use of two-stage approach, because its drawbacks as discussed in Section 2.3. Another important issue is the potential endogeneity, due to the causality between inefficiency and the market share variable according to the efficiency-structure hypothesis in the second stage, but this issue is not considered in this study. Finally, this study does not precisely reveal the estimation method, in particular which SF panel estimator is applied and it is not consistent in the presentation of the model equations, since the notation of the inefficiency error term is presented first as time-variant and then as time-invariant.

Kosak and Zoric (2011). This paper presents a first attempt to investigate the significance of adequately accounting for (un)observed heterogeneity in estimating efficiency in the banking sector in the eight new EU members from Central and Eastern Europe and Baltic countries[18] (CEEB) covering the period from 1998 to 2007. They employ four different SFA methods to analyse the issue of (un)observed heterogeneity including the influence of controlling variables composed of environmental factors, either macroeconomic or bank level variables. The four models applied are: (i) the pooled frontier model estimated by ML method as initially proposed by Aigner, Lovell and Schmidt (1977) and Meeusen and van den Broeck (1977); (ii) the Pitt and Lee (1981) model also estimated by ML procedure; (iii) the Battese and Coelli (1995) model where the inefficiency term is specified to depend on exogenous variables and (iv) the Greene (2005) true random-effects model which deals with the unobserved heterogeneity. The first three models are estimated by the ML method, while the fourth model is estimated by simulated ML.

All four models are specified with the translog functional form and use the intermediation approach for defining input prices and outputs of the cost function. Besides the basic variables, several country-specific and banks specific variables are included in the models (see Table 3.3 for details of the variables included). Kosak and Zoric (2011) make use of different sources to construct an unbalanced data set including Bankscope, central bank publications, IMF International Financial Statistics, EBRD Transition Reports, banks' annual reports and their home web-pages.

Their findings suggest no substantial differences in the efficiency estimates when the models are extended by the inclusion of environmental variables in the four models, although some of the environmental variables are significant. Moreover, the Spearman rank correlation is high and significant for the ranks of inefficiency scores obtained from the models 1, 2 and 4 with and without country-specific factors, suggesting a similar ranking pattern. They argue that this might

[18]Czech Republic, Hungary, Poland, Slovakia and Slovenia from Central and Eastern Europe; Latvia, Lithuania and Estonia from the Baltic countries.

be the case because of the similar level of development of the investigated countries. However, it should be noted that the rank correlation estimates tell different story when the four models are compared to each other with respect to efficiency ranking, which suggests that the model specification and the estimator chosen do to some extent matter. For example, while the ranks from the pooled model are highly correlated with the ranks obtained from the other models, the correlation between the efficiency ranking scores from the true random-effects model compared to the efficiency scores from the Pitt and Lee and the Batesse and Coelli models are quite low.

The empirical findings of the additional possible efficiency determinants suggest diversity in the results, since the sign, magnitude and significance of the coefficients vary across the models. Looking at the estimated average country efficiency levels, the BC model estimates range from 73 to 94 per cent, whereas the TRE model estimates range between 81 and 84 per cent. This big difference in the efficiency range it is likely to be due to the fact that TRE accounts for both observed and unobserved heterogeneity which enables separation of the latent heterogeneity from the inefficiency. Kosak and Zoric emphasize possible sources for unobserved heterogeneity among which differences in bank type, type of customers, location in relation to the customer density and competitors. Because of the similar efficiency level in the latter model, the authors argue for a “single” frontier for CEEB countries, in line with single EU market.

While the authors, in the abstract, maintain that “*different methods result in similar average cost efficiency levels, while the rankings depend on the econometric specification of the model-probably partly attributed to different ability of the models to control for unobserved heterogeneity as proposed by Greene (2005)*”, there are unequivocal differences in average efficiency estimates within countries with respect to the model employed. For instance, the average efficiency estimates for Latvia are in range of 77 to 94 per cent, for Lithuania between 81 and 93 per cent (see Table 3.4), that is over 10 percentage points difference in the estimated efficiency. Moreover, there is a lack of discussion in this study regarding the diagnostics of the four different models employed and how they differ among each other. By shedding light on the model diagnostics and discussing their differences, the authors could accentuate possible preferences between the models. Also, the model diagnostics are not revealed even when the models are estimated with and without inclusion of the environmental variables. Another issue, not considered in this study, is the change of the banks efficiency score ranking at the individual bank level. For example, there is no evidence provided whether the banks in the top/bottom 5 per cent in the rank table are changed or whether the frontier bank remains the same across the four models.

Furthermore, the authors acknowledge the difference in the specification of the BC model and TRE model, namely in the former model the environmental variables are included as factors that directly influence cost efficiency, while in the TRE model they are assumed to determine the cost frontier and because of that to have indirect influence on cost efficiency. However, this kind of provisional inclusion of the environmental variables could seriously affect the results, and therefore researchers should at least try to find, if any, theoretical ground to distinguish between the factors that directly affect the cost frontier and/or cost inefficiency. This might be one reason for the (in)significance of some of the variables in the BC model and TRE model. For instance, The EBRD index is found to be positive and significant in BC model, whereas it is negative and insignificant in TRE model. The effect of both number of banks and intermediation ratio are negative and significant in TRE model, while insignificant in BC model.

The critical assessment of this study is extended also to the variables included in the models. First, the number of banks in each country is considered as a proxy of competition in the banking industry. Given that the number of population varies substantially from 1.3 million (in Estonia) to 38.3 million (in Poland)[19], it seems that the number of banks is misleading indicator for the competition in the banking sector. Instead, a more appropriate measure would be a *relative* measure such as banks per capita. In this case, our own calculations present different story. A simple hypothetical example is: if we take all the active banks as recorded in Bankscope (ignore

[19] This data is obtained from World Bank Data and the figures represent average population in the countries in the period 1998-2007, which is the time span used in this paper.

the banks with status dissolved, in liquidation and bankruptcy) and assume that all the banks operate throughout the period, in Estonia the number of banks is 8, while in Poland is 68, which in absolute values indicates higher competition in Poland. On the other hand, considering a relative measure of competition (banks per capita) we come to figures of approximately 6 banks per 1 million people in Estonia and about 2 banks per 1 million people in Poland, suggesting far greater competition in Estonia compared to Poland. Second, throughout the paper there is no definition provided for the ownership variable, namely what is considered to be a foreign owned bank.

3.4 CONCLUSION

Empirical studies on estimation of efficiency in banking in SEECs have been conducted since the late 1990s. From then onwards many researchers have contributed in this literature. As a result, this chapter critically assessed the empirical studies on cost efficiency in banking conducted for the transition economies. Specifically, this literature review aimed to (i) identify the knowledge gap in the field of cost efficiency in banking with special reference to transition economies; (ii) identify the variables which should be included in the estimation of cost efficiency in banking, including the those reflecting observable differences across countries (and the banking industries) and across banks and (iii) following the discussion in Chapter 2, confirming our choice regarding the methods of investigation for the empirical analysis in Chapter 4. This chapter presents a bridge between Chapter 2 and Chapter 4. Specifically, while the former discusses the theoretical grounds for efficiency estimation, the latter is empirical estimation of the cost efficiency in the banking sector in SEECs.

In order to provide a review consistent with the theoretical discussion in Chapter 2, this chapter replicated the same structure and topics as in Chapter 2. After reviewing the empirical studies on cost efficiency in the transition economies, the main findings, with respect to the aims of this chapter, are summarized in this section. In terms of the possible knowledge gap, we found that the empirical contributions considering transition countries deal almost exclusively with the countries that recently joined EU; the exceptions were several studies that include Croatia in their set of countries (this country is now also an EU member) and Macedonia (in three studies only). Specifically, to our best knowledge, there is only one empirical study evaluating cost efficiency in the banking sector for the SEECs, that is BiH, Bulgaria, Croatia, Macedonia, Romania, Serbia-Montenegro, conducted by Staikouras et al. (2008). Although, the EU member countries (Bulgaria, Croatia and Romania) are subject to analysis in the other empirical studies, most of the successors of Yugoslavia (Serbia and Montenegro as a separate countries and BiH) are not examined before this study, indicating the small amount of research on this region. Moreover, Albania is not included in any of the reviewed studies. In addition to this, the time span of investigation in the reviewed studies is largely in the period from 1993 to 2003. Hence, the estimation of cost efficiency for the selected SEECs countries considered in this thesis would close a gap in the applied literature for this field of studies.

Next, the literature review facilitated the definition of the variables necessary for the estimation of the cost efficiency. In particular, we learnt that there is a consensus in the literature regarding the definition of the production factors and the outputs in the banking sector. Furthermore, this review provided list of explanatory variables, the so-called Zs, which present possible determinants either of the position of the frontier or the bank's inefficiency. These variables are usually divided in three categories, that is macroeconomic, industry-specific and bank-specific variables. The knowledge of the definition of the variables will be further used in Chapter 4.

In terms of the methods of investigation, the literature review did not provide much evidence to support the choice of a specific estimator. Although the choice of which SFA estimator is the key issue among the methods of investigation, there are not enough empirical studies which employ the theoretically preferred models, namely the time-varying RPMs (including the special case of the Greene's true random effects model) as discussed in Chapter 2. In fact, to our best knowledge, only Kosak and Zoric (2011) estimate time-varying efficiency and control for unobserved heterogeneity using, among the other models, the true random effects model proposed by Greene (2005). It is important to note that none of the empirical studies on efficiency in banking in transition economies makes use of RPMs. Based on this discussion we can identify a knowledge gap in the empirical literature on efficiency estimation. In particular, the estimation of efficiency in banking using RPMs will further contribute to this literature; hence these models will be employed in Chapter 4. Moreover, it was apparent that most of the studies estimating time-varying efficiency were making use of the Battese and Coelli (1992, 1995) models. Hence, for comparative purposes this stream of models will also be used in Chapter 4.

Finally, the findings from the empirical studies reviewed here suggested the diversity of the techniques and the detailed application used in these studies. Moreover, the estimated levels of banks' efficiency are found to be different across these studies, but the reasons for the differences are not fully established. Arguably, this could have resulted from the type and the nature of the estimator and the number of stages in the process of empirical investigation. This is another issue which will be considered in Chapter 4.

CHAPTER 4

EMPIRICAL ANALYSIS OF COST EFFICIENCY OF BANKS IN SOUTH-EAST EUROPEAN COUNTRIES

4.1 INTRODUCTION

The previous two chapters presented the theory of efficiency, methods of investigation with respect to cost efficiency (hereafter CE) (Chapter 2) and the empirical evidence on CE, mainly in transition economies (Chapter 3). Having reviewed these issues in detail, a solid theoretical and econometric basis is created on which the empirical investigation can be developed. The main aim of this chapter, thus, is the estimation of banks' CE in SEECs for the period 2000-2012. In pursuing this aim, Farrell's definition of economic efficiency (discussed in Chapter 2.2) is employed for the purpose of this empirical analysis, particularly since it encompasses both technical and allocative efficiency. Additionally, as discussed in Section 2.3.2, this chapter employs SFA in context of a panel data set and, based on the argument in Section 1.4.3 and Section 2.3.2, estimates time-variant CE. Moreover, the empirical analysis in this chapter measures CE against a common frontier (based on Section 2.5), using a translog functional form (Section 2.4) and treating banks as intermediaries (Section 2.6).

Chapter 3 presented an extensive literature review on efficiency estimation in the banking sector with special reference to transition economies which provided a basis for the methods of investigation, the choice of variables used and the identification of the knowledge gap. In addition, the review in Chapter 3 was a critical assessment of the examined studies, which identified the potential drawbacks in the current literature.

Consequently, based on this review, this chapter aims to contribute to the empirical literature on banks' CE, using different econometrics techniques some of which (for example the RPMs) have not yet been used for examining CE for transition economies. Moreover, the set of SEE countries covered in this empirical analysis (the six Western Balkan countries of Albania, Bosnia and Herzegovina, Croatia, Macedonia, Montenegro and Serbia, and two relatively new EU members, Bulgaria and Slovenia) have not been considered in any of the studies reviewed in Chapter 3. Additionally, the dataset used in this analysis is unique because although the basis for creation of our dataset is, as in most other studies, the Bankscope database, we have extensively supplemented the respective data by collecting data from reports published on the individual banks websites or national banking agencies because there is a significant amount of missing data for the countries under consideration in Bankscope. A further contribution to knowledge related to this analysis is the investigation of the implicit role of technical change on banks' CE.

This chapter is of importance not only because it attempts to fill a gap in the literature on cost efficiency estimation in the banking sectors in transition economies, but also because the predicted efficiency scores are used as a determinant of the market share in the banking sector in SEECs, the focus of the second part of this thesis (specifically, Chapter 6).

The structure of this chapter is as follows. Section 4.2 specifies the baseline empirical model for the estimation of CE based on the discussions in Chapters 2 and 3. Section 4.3 discusses the data used in this empirical analysis, including the definition of the variables used and the data sources. Section 4.4 presents alternative model specifications associated with the positioning of the factors reflecting the observed differences across countries and banks (the Zs) based on the discussion in Section 3.3.3. Section 4.5 discusses the estimated CE of banks in SEECs, specifically across countries and time. Finally, Section 4.6 concludes the chapter.

4.2 THE MODEL

This section aims to develop a model according to the economic theory of production, a process which considers the transformation of a bundle of inputs (factors of production) into outputs (products), explicitly taking into account that this transformation is not always fully efficient (as discussed in 2.2). The conventional approach to studying the economic theory of production, while allowing for inefficiency in the production process, is estimation by frontiers. As discussed in Chapter 2, there are many issues that need to be considered when developing a model for cost efficiency estimation in the banking industry. Hence, Section 4.2.1 presents the process of creating the baseline model. Given that there are various empirical models and possibilities for the estimation inefficiency (reviewed in Chapter 2.3.2), Section 4.2.2 focuses on the choice of models appropriate for this analysis.

4.2.1 Model specification

The focus of this section is on the stochastic frontier baseline model specification that is used later in the chapter, and further extended in Section 4.4. For that purpose, it is necessary to refer back to the issues discussed in Chapter 2. After considering the arguments regarding the advantages and disadvantages of greater flexibility of the functional forms (Section 2.4), this analysis employs the translog functional form. This form is deemed appropriate because there is a substantial loss of degrees of freedom[20] relative to the sample size if the alternative Fourier-flexible functional form was to be employed. Additionally, some of the variables used in our empirical investigation (as shown in section 4.3) are characterized by limited variability and, therefore the use of Fourier-flexible functional form could potentially exacerbate the multicolinearity problem. Equation 4.1, represents the model for the estimation of CE with the above issues taken into consideration (that is, SFA with translog cost functional form).

$$\ln TC_i = \alpha_0 + \sum_{r=1}^{n} \alpha_r \ln Y_{ri} + \sum_{j=1}^{m} \beta_j \ln P_{ji} + \frac{1}{2}\sum_{r=1}^{n}\sum_{k=1}^{n} \sigma_{rk} \ln Y_{ri} \ln Y_{ki} + \frac{1}{2}\sum_{j=1}^{m}\sum_{h=1}^{m} \gamma_{jh} \ln P_{ji} \ln P_{hi} + \sum_{r=1}^{n}\sum_{j=1}^{m} \delta_{rj} \ln Y_{ri} \ln P_{ji} + \nu_i + u_i \quad \text{… (4.1)}$$

Where TC_i, Y_r and P_j represent total costs, outputs quantity and input prices of a bank, respectively and $\alpha, \beta, \sigma, \gamma$ and δ are parameters to be estimated. These terms are defined in details in Table 4.1, Section 4.3. The "composed" error term, includes the traditional symmetric random noise component, ν_i and a one-sided inefficiency component, u_i (the properties of the "composed" error term were presented in Section 2.3.2). The bank is i, the number of outputs is n and m is the number of inputs.[21]

As discussed in Section 2.3.2 the cost frontier, or the cost function, requires the theoretical restrictions on the parameters to obtain homogeneity and symmetry. Applying the homogeneity restriction on the above function means that the sum of the coefficients of the input prices equals 1. That is,

$$\sum_j^m \beta_j = 1\,; \quad \sum_j^m \gamma_{jh} = 0 \quad and \quad \sum_j^m \delta_{rj} = 0 \qquad \text{… (4.2)}$$

[20] Calculation of the degrees of freedom is not straightforward and depends on factors determined within the empirical procedure, mainly by the researcher. At this stage they could not be calculated; however a small change in these factors could cause substantial increase in the parameters to be estimated, and it can easily reach over 100 parameters to be estimated.

[21] The time subscript denoting the panel model is not included at this stage for the sake of simplistic illustration of the model.

This restriction is imposed by normalization with respect to input prices. According to the Young's theorem a symmetry restriction should be imposed, such that

$$\gamma_{jh} = \gamma_{hj} \quad \text{and} \quad \sigma_{rk} = \sigma_{kr} \qquad \text{... (4.3)}$$

After imposing these restrictions on Equation 4.1 and assuming a multiproduct translog frontier with two outputs and three input prices, the model specification becomes:[22]

$$ln\left(\frac{TC}{P_3}\right)_i = \alpha_0 + \alpha_1 lnY_{1i} + \alpha_2 lnY_{2i} + \beta_1 ln\left(\frac{P_1}{P_3}\right)_i + \beta_2 ln\left(\frac{P_2}{P_3}\right)_i + \sigma_{11}\frac{1}{2}ln^2Y_{1i} + \sigma_{22}\frac{1}{2}ln^2Y_{2i} + \sigma_{12}lnY_{1i}lnY_{2i} + \gamma_{11}\frac{1}{2}ln^2\left(\frac{P_1}{P_3}\right)_i + \gamma_{22}\frac{1}{2}ln^2\left(\frac{P_2}{P_3}\right)_i + \gamma_{12}ln\left(\frac{P_1}{P_3}\right)_i ln\left(\frac{P_2}{P_3}\right)_i + \delta_{11}lnY_{1i}ln\left(\frac{P_1}{P_3}\right)_i + \delta_{12}lnY_{1i}ln\left(\frac{P_2}{P_3}\right)_i + \delta_{21}lnY_{2i}ln\left(\frac{P_1}{P_3}\right)_i + \delta_{22}lnY_{2i}ln\left(\frac{P_2}{P_3}\right)_i + \nu_i + u_i \qquad \text{... (4.4)}$$

Consequently, a departure point for the model specification is the common multiproduct translog function as presented in Equation 4.4. Panel data is at our disposal for the banking sectors under investigation, thus the estimation of CE is conducted by SF panel models because they: (i) have advantages over the cross–sectional models (Section 2.3.2) and (ii) offer many different possibilities in empirical investigation, due to the numerous SF panel data models adjusted for estimation of CE, as discussed in detail in Section 2.3.2. The choice of which panel data models to use is discussed in the next section. Also, given that our dataset covers eight countries, comparable CE estimates are necessary because they are used as an explanatory variable in Chapter 6. Hence, as suggested by Berger (2007) in Section 2.5, the common frontier is preferred over the country-specific frontier. However, applying the common frontier requires the inclusion of control variables to control for the differences in the economic environments and banking sectors of different countries. Second, according to Greene (2008) the efficiency distribution can be affected as a result of observed and unobserved heterogeneity (Section 2.3.3). This is partially related to the discussion of Berger (2007), but appears to be a broader issue because it includes the issue of output quality and the omission of variables from the model which explain observable differences across banks, which may affect the efficiency estimates. For example bank-specific

[22] Again for the sake of brevity the time subscript is not included.

variables, such as the quality of the bank assets (loans) and the ownership structure (foreign or domestically owned bank), in addition to being control variables, also reflect the differences in the economic environments. To incorporate the arguments of Berger (2007) and Greene (2008), a vector of macroeconomic, banking industry and bank-specific variables are included in the model, Z_{it}, based on the discussion in Section 3.3.3 and how these are best included in the model is discussed in Sections 4.3 and 4.4. The last issue in the specification of the empirical model is related to the treatment of the bank either as producer or intermediary (Section 2.6). According to the broad economic literature the origin of a bank is in its role of matching creditors with borrowers, that is acting as an intermediary. Although the bank activities have increased significantly over the past two decades in countries under consideration, the mediator role still remains its primary role (IMF, 2012).

TIME DUMMIES OR TIME TREND. The inclusion of year dummies and/or time trend in the model is another issue that merits attention, especially because this has not been discussed in the empirical studies for transition economies (Chapter 3). The majority of papers do not include either year dummies or a time trend, or if they do they are not reported or commented on (Fries and Taci, 2005; Kraft et al., 2002; Rossi et al., 2005; Nikiel and Opiela, 2002; Kasman, 2005; Hasan and Marton, 2003). Some papers include year dummies (Yildirim and Philippatos, 2007; Mamatzakis, 2008), while some other papers include a time trend (Kosak and Zoric, 2011; Kosak et al., 2009; Kasman and Yildirim, 2006; Staikouras, 2008). However, in these papers there is no discussion of the effect of the time trend and none of them incorporates the time trend into the translog model (this issue is explained in greater detail later in this section). In a nutshell, this discussion is largely marginalized by previous researchers dealing with banking sector in transition economies.

In the standard panel models, year dummies are included to reduce the cross-sectional dependence, capturing heterogeneity as a result of important events that occur over the years covered in the dataset. On the other hand, a time trend is commonly used in the banking literature to measure the technical change, since due to data limitation there is no indicator or proxy for measuring technological progress, such as the value of R&D or the average age of capital equipment, as used in other industries (Humphrey, 1993). In addition, Frame and White (2009) argue that the financial innovations in the banking sector are primarily encouraged by technological changes in telecommunications and data processing (using software and hardware for client credit scoring, risk management, automated clearing house, etc.) which are very difficult to include directly in an empirical model. There are number of new products and services introduced over the period of this investigation in the banking sector in transition economies, given that these countries lag behind the developed economies with respect to financial innovations, such as introduction of ATMs, debit/credit cards and on-line banking, which are quantifiable and feasible to be included in the model, but availability of such data is very limited.

A time trend is the simplest and most commonly used measure in the empirical studies for modelling technical change. By formulation, it assumes and provides a smooth rate of technical change. This is considered as a limitation of this approach, because year-to-year variation in technical change may be inadequately depicted when this process is not constant or smoothly increasing or decreasing (Nelson, 1986). Humphrey (1993), in addition to time trend, uses another two approaches for the first time in the context of banking: an index approach (Caves, Christensen and Seanson, 1981; Baltagi and Griffin, 1988); and shifts in cross-section (Berger and Humphrey, 1990), using a cost translog function. The index approach accommodates a non-smooth technical change, which allows year-to-year variations to be estimated more accurately, if present in the data. The shifts in cross-section cost functions approach is a more general form than the index approach and allows for discontinuous year-to-year rates of technical change (Humphrey, 1993).

The way in which the technical change is built into the model in all three approaches is now discussed. Using the time trend approach in the translog specification, technical change is introduced by including a continuous variable from 1 to T, (where T denotes the last year in the dataset) and cross-products of this variable with the outputs and input prices are included, in the same manner as for the production variables in the model. However, the papers that used a time trend for transition countries (referenced above), include only the 1 to T continuous variable and not the cross-products with outputs and input prices. In the index approach, technical change is modelled by including year dummies (for all years) which act as intercepts as well as cross-products of each year dummy with outputs and input prices. In the standard econometric analysis, year dummies are included to control for heterogeneity resulting from important events that occur over the years covered in the dataset. The index approach seems to assume that year dummies serve only as a proxy for technical change and are **not** capturing any other heterogeneity. It is likely that such assumption can be appropriate only for a stable period of time during which no significant events occur, which is not the case in SEECs as discussed in Section 1.4. Lastly, in the shifts in cross-section approach, as well as the elements that are allowed to be affected by technical change in the previous two approaches, all parameters are allowed to vary over time by running cross-section regressions for each year. Using this approach, the advantages of panel data models are lost. Nevertheless, Humphrey (1993) finds that the last two approaches have greater flexibility as they provide better representation of the year-to-year variations of the technical change. He also adds that a time trend is not able to capture this disaggregated technical change but, if one is satisfied to consider the average technical change over the whole period under investigation, all the three models yield similar results. Furthermore, Esho and Sharpe (1995) argue that the index number approach is volatile, not suitable for small samples or in the context of multiproduct production, while the time trend approach provides estimates which are relatively stable and steadily evolve over time.

The choice of the approach for analysing technical change in this thesis is constrained by the data at hand and the method of estimation employed. As discussed earlier in this section, the panel data models will be used which renders the third approach inapplicable. In addition, employing the shifts in the cross-section approach implies that the advantages of panel data models are lost. In particular using a panel model, the non-modelled differences between banks that are constant over time may be captured in the "composed" error term. The second approach requires inclusion of 45 additional parameters. The consequent loss of degrees of freedom from this approach is more than 50 per cent of the observations from the first three years in this study. More importantly, as discussed in the previous paragraph, the index approach considers the year dummies only as a proxy for technical change. Given that the empirical analysis includes eight

SEECs, during a period in which the transition process was progressing as discussed in Section 1.4 and these countries still experience systematic reforms during this period, it is inappropriate to assume that the year dummies in this dataset will capture only technical change. Moreover, this analysis also covers the years of the last financial crisis (2008 and 2009), which makes the above assumption even more restrictive. Consequently, considering all of the above arguments, this empirical analysis employs the time trend approach. This approach, despite its lack of flexibility, still continues to be widely used in empirical research (see for instance, Greene, 2005b estimating CE for US banks using Cobb-Douglas functional form). As discussed above, the time trend approach has not been yet integrated in translog specification in transition countries. In terms of bank efficiency in transition economies, Kasman and Kasman (2006) are, to our knowledge, the only researchers who investigate the relationship between efficiency and technical change by employing a time trend, in their case, in a Fourier-flexible functional form. They find an increased rate of cost reduction resulting from technical change in CEE countries in the period 1995-2002. Although, no empirical research has been conducted considering this issue for SEECs yet, it is likely that financial innovations spurred by technological changes in these countries have contributed to faster pace of efficiency changes in these countries' banking sectors. Hence, this analysis of banks' cost efficiency controls for the technical change in the SEE countries, which is a contribution to the current literature.

Also, given the time period of our data, it is important to control for the effects of the financial crisis, as this is likely to have affected all banks in the region (and the omission could give rise to cross-sectional dependence). Hence, two year dummies for 2008 and 2009 are included in the model in addition to the time trend variables, so a "combined" effect of technical change and year dummies for two years is investigated. For the purpose of comparison of the estimation results with those of previous studies for transition economies, a version of the model will also be run with year dummies (D_t) for each year instead of the time trend (T).

Based on Berger (2007) and Greene (2008), given the discussion above two models are proposed. Firstly, a simple model with just year dummies (D_t) and a vector of additional explanatory variables (Z_{it}) is:

$$ln\left(\frac{TC}{P_3}\right)_{it} = \alpha_0 + \alpha_1 lnY_{1it} + \alpha_2 lnY_{2it} + \beta_1 ln\left(\frac{P_1}{P_3}\right)_{it} + \beta_2 ln\left(\frac{P_2}{P_3}\right)_{it} + \sigma_{11}\frac{1}{2}ln^2Y_{1it} + \sigma_{22}\frac{1}{2}ln^2Y_{2it} + \sigma_{12}lnY_{1it}lnY_{2it} + \gamma_{11}\frac{1}{2}ln^2\left(\frac{P_1}{P_3}\right)_{it} + \gamma_{22}\frac{1}{2}ln^2\left(\frac{P_2}{P_3}\right)_{it} + \gamma_{12}ln\left(\frac{P_1}{P_3}\right)_{it}ln\left(\frac{P_2}{P_3}\right)_{it} + \delta_{11}lnY_{1it}ln\left(\frac{P_1}{P_3}\right)_{it} + \delta_{12}lnY_{1it}ln\left(\frac{P_2}{P_3}\right)_{it} + \delta_{21}lnY_{2it}ln\left(\frac{P_1}{P_3}\right)_{it} + \delta_{22}lnY_{2it}ln\left(\frac{P_2}{P_3}\right)_{it} + \sum_i^n \varphi_i Z_{i(t)} + \sum_i^n \tau_i D_t + \nu_{it} + u_{it} \qquad \text{... (4.5)}$$

The second (and preferred) model, is an extended version of Equation 4.4 which includes a time trend (T) integrated into the translog framework, year dummies to control for the financial crisis and a vector of additional explanatory variables (Z_{it}) in line with the previous discussion:

$$ln\left(\frac{TC}{P_3}\right)_{it} = \alpha_0 + \alpha_1 lnY_{1it} + \alpha_2 lnY_{2it} + \beta_1 ln\left(\frac{P_1}{P_3}\right)_{it} + \beta_2 ln\left(\frac{P_2}{P_3}\right)_{it} + \sigma_{11}\frac{1}{2}ln^2Y_{1it} + \sigma_{22}\frac{1}{2}ln^2Y_{2it} + \sigma_{12}lnY_{1it}lnY_{2it} + \gamma_{11}\frac{1}{2}ln^2\left(\frac{P_1}{P_3}\right)_{it} + \gamma_{22}\frac{1}{2}ln^2\left(\frac{P_2}{P_3}\right)_{it} + \gamma_{12}ln\left(\frac{P_1}{P_3}\right)_{it}ln\left(\frac{P_2}{P_3}\right)_{it} + \delta_{11}lnY_{1it}ln\left(\frac{P_1}{P_3}\right)_{it} + \delta_{12}lnY_{1it}ln\left(\frac{P_2}{P_3}\right)_{it} + \delta_{21}lnY_{2it}ln\left(\frac{P_1}{P_3}\right)_{it} + \delta_{22}lnY_{2it}ln\left(\frac{P_2}{P_3}\right)_{it} + \rho_T T + \frac{1}{2}\rho_{TT}(T)^2 + \theta_{1T}lnY_{1it}T + \theta_{2T}lnY_{2it}T + \vartheta_{1T}ln\left(\frac{P_1}{P_3}\right)_{it}T + \vartheta_{2T}ln\left(\frac{P_2}{P_3}\right)_{it}T + \sum_i^n \varphi_i Z_{i(t)} + \tau_{2008}D_{2008} + \tau_{2009}D_{2009} + \nu_{it} + u_{it} \qquad \text{... (4.6)}$$

In the above equations the subscript *t* is added to denote the time component in the panel data models; $\mathrm{v_{it}} \sim N[0, \sigma_v^2]$ is the same for all the specifications, but $\mathrm{u_{it}}$ is modelled differently, as discussed in the next section below and detailed in Section 4.4.

4.2.2 The choice of time-varying panel models

The choice of panel data models that are employed in the analysis is primarily driven by the aim of this chapter, that is estimating CE for each bank through time based on the discussion in Section 1.4, which implies that a priori there are strong reasons for expecting time varying CE due to the extensive reforms in the banking sectors in the respective countries for the period under consideration (2000-2012). Given this argument we need to employ time-varying panel models, otherwise we would have a mis-specified empirical model. More generally in the literature on bank efficiency, it is not usually expected that CE will change over very short periods of time, hence the time dimension of the panel data is important for the feasibility of estimating time-varying CE. According to Greene (2011), an appropriate time span for analysis of time-variant CE is ten years as it is expected that this gives sufficient time for CE variation, though a time span of between five and ten years can sometimes also be considered as sufficient for such analysis. He further suggests that, by the same token, the characteristics of the unit of analysis are important in determining the necessary time span for estimating a time-variant CE. In addition to the previous discussion, in the banking sector in SEECs it is expected that the efficiency variations are likely to occur over shorter time-span because of competitive pressures, especially as a result of entry of foreign banks in these markets (Section 1.4). Moreover, as discussed in the previous section, Kasman and Kasman (2006) find an increased rate of cost reduction resulting from technical change in CEECs in the period 1995-2002. Although no empirical research has been conducted on this issue for SEECs yet, it is likely that there has been financial innovations spurred by technological changes in these countries as well, which contributed to faster pace of CE changes. Given the availability of data, we aim to cover the longest possible time span (more on this discussion in the following Section 4.3).

Many researchers offer different model extensions and adjustments to allow for time-variant CE estimates (see Section 2.3.2). Recent empirical studies on CE in the banking sector in transition economies which consider time-varying CE, presented in Chapter 3, mainly employ the Battese and Coelli (1992, 1995) (hereafter BC) panel models. However, these papers, as discussed earlier, do not explain the specific reason for choosing these particular time-varying panel models, therefore the reason for the popularity of the use of BC models is not clear. Since no clear justification is found in favour of the BC models over other time-varying panel models, it is possible that their attractiveness has increased because of the ease of implementation after their incorporation into the STATA econometric software (no other SFA panel model estimators is available in STATA). Our analysis applies two panel data model estimators for time-varying CE, that is BC (1992, 1995) and the Random Parameters Models (hereafter RPMs) [including the special case of the so-called "true random effects" model – Greene (2005), hereafter TRE] as discussed in Sections 2.3.2 and 2.7. The rationale for choosing these particular models is multifold. The well-known models of BC (1992, 1995) are primarily chosen because of their popularity among the researchers, and because these models allow for modelling the inefficiency component of the error term to be expressed as a function of explanatory variables, which are assumed to explicitly affect a bank's inefficiency. Also estimating efficiency using BC models allows for comparison of the estimates with the ones obtained in other similar studies (Section 3.3.4).

However, the models of special interest in this thesis are the RPMs because of their specific way of: (i) accounting for heterogeneity as well as firm inefficiency, and (ii) allowing for random variation in the CE estimates across time as discussed in Section 2.3.2. These panel data models differ from the other SFA panel models, because of their unique approach to disentangling heterogeneity from inefficiency. To our knowledge, this is the first empirical study that employs RPMs for estimating efficiency for the banking sectors in transition economies.

4.3 DATA

The countries subject to analysis are eight SEECs: Albania, Bosnia and Herzegovina (BiH), Bulgaria, Croatia, Macedonia, Montenegro, Serbia and Slovenia. The rationale for choosing this group of countries is mainly their similar process of transition to a market economy (Section 1.4), their geographical position and their historic relations. Until 2012 (the end period of this analysis) only Bulgaria and Slovenia had become members of the European Union (EU). The other four successor states of the Former Yugoslavia (BiH, Macedonia, Montenegro and Serbia) and Albania are still working on their political and economic reforms aiming at fulfilling the EU's accession criteria. This particular set of countries enables the empirical analysis to respond to several research questions such as: (i) measuring the CE of banks in each country; (ii) analysing the pattern of CE across countries and through time; (iii) investigating the effect of technical change explicitly on the banks' total costs and implicitly on their CE; (iv) whether the EU accession has accompanied improvements in CE; and (iv) analysing the effect of the last financial crisis explicitly on the banks' total costs and implicitly on their CE. To our knowledge, none of the existing papers have analysed these questions in this particular set of countries.

4.3.1 Definition of variables

Table 4.1 summarizes the description of the variables used in the empirical model, based on the discussion in Section 3.3.3 where details on the identification of the variables and their expected signs were discussed. For the sake of brevity the subscripts which denote panel data model ($_{it}$) are omitted in the table. Descriptive statistics of the respective variables is presented in Appendix to Chapter 4, Section 4.1.

As discussed in Section 3.3.3, the production parameters included in the model are the variables used in the other empirical studies for estimating cost efficiency for the transition economies. In particular, the dependent variable represents the total costs to total asset ratio, the two used outputs are total net loans and other earning assets (total earning assets less total loans) and the three input prices are the price of borrowed funds, the price of labour and the price of physical capital.

Table 4.1 Description of the variables used in the empirical analysis of cost efficiency

Variables	Description
Dependent variable	
Total costs (LnTC)	Natural logarithm of total cost (interest expenses, personnel expenses and other operating expenses) over total assets ratio
Independent variables	

Outputs (LnY)	
Loans (LnY_1)	Natural logarithm of total net loans over total assets ratio
Other earning assets (LnY_2)	Natural logarithm of other earning assets (Loans and Advances to Banks, total securities and other earning assets) over total assets ratio
Input prices (LnP)	
Price of borrowed funds (LnP_1)	Natural logarithm of total interest expenses over total deposits ratio
Price of physical capital (LnP_2)	Natural logarithm of non-interest (operating) expenses to fixed assets ratio
Price of labour (LnP_3)	Natural logarithm of personnel expenses divided over total assets ratio
Time	
Year dummies (D_i)	From 2000 to 2012, where 2000 is the base year, thus omitted to avoid perfect collinearity
Time trend for technical change	t=1,2, … , 13, where 1=2000 and 13=2012
Environmental variables (Z)	
Country specific	
Level of economic development	Natural logarithm of GDP per capita in constant 2005 prices (USD '000)
Density of demand	Natural logarithm of total deposits of the banking sector per km^2 ratio
Inflation	Inflation based on Consumer Price Index
Population density	Natural logarithm of the number of inhabitants per km^2
EU/Non-EU country	Dummy variable 1 for the year before EU accession, 0 otherwise
Industry specific	
Intermediation ratio	Natural logarithm of total loans to total deposits in the banking sector ratio
Measure for concentration	Natural logarithm of Herfindahl-Hirschman Index (HHI)
Bank specific	
Capital	Natural logarithm of total equity to total assets ratio
Ownership structure	Domestic (if the share of foreign owners is < or = to 20 per cent of a bank's capital, the base category) Mixed (1=if the share of foreign owners is between 21 and 89 per cent, otherwise 0) and Foreign (1=if the share of foreign owners is = or >90 per cent, otherwise 0)
Loan impairment charges	Natural logarithm of loan impairment charges to total assets ratio

<u>Note:</u> The value of the ratio for each variable is not multiplied by 100, i.e. it is a "pure" ratio and not a percentage. The subscripts i and t are excluded

In addition to the discussion in Section 3.3.3 the three variables, ownership structure, loan impairment charges and EU dummy variable deserve further explanation. Specifically, regarding the ownership structure three categories of ownership considered include (i) domestic (<20 per cent of foreign ownership), (ii) mixed (from 21 to 89 per cent of foreign ownership) and (iii) foreign (>89 per cent of foreign ownership). This categorization of the ownership status is not based on a conventional definition for foreign ownership for two reasons. First, it is assumed that even a small stake of foreign ownership in the SEECs will affect the decision-making process and second, as presented in Section 1.4.3 after 2000 the extensive inflow of foreign capital quickly resulted in banking sectors with predominantly foreign capital, often far above 50 per cent. In particular, by the end of 2012 in some of the banking sectors under consideration around 90 per cent of the capital is foreign owned. These categories, in addition, allow for distinguishing the impact among the “partially” and “completely” foreign owned banks on costs/efficiency.

The loan impairment charges is a measure of the quality of loans only. Data on the indicator measuring the quality of other earning assets is either restricted or not available for majority of the banks, therefore, this is not included in the model. There is around 10 per cent of the total 1667 observations where the other earning assets are higher than loans, and this is mainly because of the loans and advances given to other banks, which we assume are placements of high quality. The rest of the other earning assets such as trading securities, at-equity investments and other securities are substantially less than the amount of loans. Consequently, omitting to control for the quality of other earning assets is expected not to affect the findings. The position of the loan impairment charges in the income statement indicates their positive impact on the overall costs of the bank. However, their exclusion from total costs is twofold. First, they are not an input for providing a particular service by the banks and second they serve as a proxy for loan quality. Given this, loan impairment charges can be considered as an indicator that shapes the cost frontier, but also the level of loan impairment charges can directly affect a bank’s efficiency. Finally, European Union dummy has a value of 1 for the year before a country enters EU (for Slovenia is 2003, for Bulgaria is 2006 and for Croatia is 2012), since it is assumed that the banking sectors of the three countries have been harmonized with the banking sectors of the EU members and by that point in time already adopted the “conditions” under which these banking sectors operate.

The Z is the vector of country-specific, industry-specific and bank-specific characteristics. The purpose of inclusion of the three categories of controlling variables is to incorporate the arguments of Berger (2007) and Greene (2008) as discussed in Section 4.2.1. As previously discussed in Section 2.3.3, a defined procedure related to the position of the Z(s), either as affecting the frontier or the level of efficiency does not exist, hence in the absence of firm theoretical arguments, this is left to be a researcher call. Based on the discussion in Section 3.3.3 some inferences regarding this issue can be made. In particular, country-specific and industry-specific variables are included to adjust the frontier against which the inefficiency is measured relative to the macroeconomic and industry environment in which the bank operates, given that this empirical analysis encompasses eight transition countries (Berger, 2007).

Furthermore, as suggested by Greene (2008), bank-specific variables are included to control for potential heterogeneity resulting from different output quality and omission of variables from the model which explain differences across banks and may affect the directly the efficiency estimates. However, some the positioning of the concentration ratio (the industry-specific variable) in the deterministic part of the model may be questioned, given that according to the discussion in Section 3.3.3, the concentration ratio is closely related to both cost and inefficiency implying that the "position" of this indicator in the model is unclear. Nevertheless, given that this is an aggregated indictor on a country level rather than an individual indicator, such as market share, which explicitly affects the inefficiency of that particular bank, it is reasonable to be expected that this industry-specific indicator would determine the cost frontier. Another example is the loan impairment charges, which as presented above given their position in the income statement, can be considered as an indicator that shapes the cost frontier, but it is expected that as a measure of quality, the level of loan impairment charges would primarily affect the bank's inefficiency, rather than the frontier itself. Our personal belief is that this indicator, along with the other bank-specific variables, mainly result from management decisions, hence it is more reasonable to be considered as a factor that directly affects inefficiency. As presented in the baseline model specifications in Equations 4.5 and 4.6, all of the Z(s) variables, including the bank-specific variables, are part of the deterministic part. In Section 6.4 the alternative model specifications are presented where these bank-specific variables enter u_{it} and directly affect bank's inefficiency.

4.3.2 Data sources

Three broad data sources are used for estimation of CE. The first source includes data for individual banks. This data is extracted from the Bankscope database, created by Bureau Van Dijk, on several occasions. When the data was first obtained in December 2009, it was in the form of original financial statements put together by Bankscope. This data was not comparable across countries or years because of different accounting standards used (IFRS, IAS, Local GAAP). For many years, the Bankscope database used templates to present banks' data which reflect the particular accounting systems of each of the countries for which it collects the data. However, in April 2010, Bureau Van Dijk announced a new "universal" representation of the banks' data in order to put the accounting systems on same basis and to facilitate the empirical analyses across the entire set of banks. Thus, a second attempt at extracting data was made during May and June 2010 directly from the Bankscope database, to use the advantage of collecting comparable bank data. However, the newly obtained data-set, though comparable, had the drawback that the time series data for most of the banks became shorter, possibly due to the difficulties in the process of data transformation. Given that the aim of the analysis is to estimate the time-variant cost efficiency for individual banks, a long time span of data is preferable. Although we reconsidered the use of Bankscope for years going back to 1995, the data for these additional years was very restricted as most banks did not publish annual reports of this period on their websites. Also, the data for the years before 2000 are not available in Bankscope's new "universal" format, but provided in individual bank's financial statements format. Furthermore, the additional data is not available on Bankscope's new platform. Therefore, the time span for the empirical investigation was chosen to be from 2000 to 2009, so that a period of ten years suggested by Greene (2011), and discussed in Section 4.2.2 is covered. Initial regressions were run for this period of time.

However, before conducting the empirical analysis of determinants of market share in banking (Chapter 6), we decided to update the dataset and include the data for the period 2010-2012, and for the empirical analysis of this chapter to be conducted on this new dataset too. To that end the Bankscope data was once again accessed in January 2014 to extract data for the required period. For the last three years, the availability of data had substantially improved, hence there was little need to supplement the data from other sources to reduce the missing observations for these last three years as had been the case for the period 2000-2009. In what follows we discuss the process of data augmentation which was performed after the second attempt at accessing Bankscope data in 2010, given that Bankscope has not filled the gaps in data for the earlier years (at least as of January 2014).

For countries under consideration the Bankscope database has a large number of missing information on important variables for the period 2000-2009. A major shortcoming of most studies using this database is that the issue of missing variables is ignored. The missing observations may be random ("ignorable") or non-random ("nonignorable"), where in the case of missing at random the "missingness" is not associated with the value of the variable itself, but it does (missing at random-MAR) or does not (missing completely at random-MCAR) depend on the values of the other variables in the dataset (Rubin, 1976). When the aforementioned assumptions for the pattern of missingness do not hold, then such missingness is referred as to "nonignorable". In the case of ignorable missingness the parameters for the missing data-generating process are not related to those which are estimated in the complete model (Cameron and Trivedi, 2005).

The most common assumption (often implicit) in the empirical literature is MAR, however this may be considered as too optimistic an assumption, given that information about the value of the variable that is missing is unknown. Schafer and Graham (2002, p.152) emphasize: *"When missingness is beyond the researcher's control, its distribution is unknown and MAR is only an assumption. In general, there is no way to test whether MAR holds in a data set, except by obtaining follow-up data from nonrespondents or by imposing an unverifiable model."* If data missingness is assumed to be MAR and the probability of missing data on any regressor does not depend on the values of dependent variable the commonly used method is listwise deletion – all observations with missing values on one or more variables in the dataset are deleted. However, the listwise deletion can significantly reduce the amount of available information and thus the efficiency of estimation in small samples when missingness occurs for a non-trivial proportion of regressors (Cameron and Trivedi, 2005, p. 928).

Therefore, we decided to embark on finding the missing data from secondary sources to augment the Bankscope data. Additional data was collected from the annual reports of individual banks, as well as reports by other agencies which summarize data related to the banking sector for of individual countries (in the case of BiH for instance). During this process we have cross-checked the available data from Bankscope with those from secondary sources and no major inconsistencies were observed. Accordingly, we decided to increase the sample size with the data from other sources that were not available in Bankscope in order to increase the representativeness and size of the dataset.

Table 4.2 is an example of the data augmentation work. It summarizes the data augmentation process for BiH. The first column shows the name of the banks included in the study. The second column presents the missing variables and the relevant years for each bank in Bankscope. As discussed in Section 4.2, personnel expenses is a crucial variable in our models and their absence reduces the number of observations. As seen in the table, data on personnel expenses (PE in the Table) is very restricted in Bankscope, implying a substantial loss of observations. The third column presents the years for which data is extracted from the financial reports from the individual bank's website, while the fourth column displays the years for which data is gathered from one of the banking agencies in BiH, depending on whether the bank is established in the Federation or in Republika Srpska. The last column displays the time span of data for the particular bank after augmenting the Bankscope data with data from the additional sources. A similar process was followed for other countries under consideration and much of the missing data was recovered.[23]

Table 4.2 Data augmentation process for Bosnia and Herzegovina up to 2009

Bank name	Bankscope	Official web page	Banking Agency (FBiH)	Final data (obs. added)*
BOR Banka Sarajevo	2002-2004 (n/a PE for 2002-2004) 2008-2009	for 2009 only	2000-2001; 2005-2007 PE data 2002-2004	2000-2009 (8)
Balkan Investment Bank	2004-2007 (n/a PE for 2007)	Reports w/o notes	2001-2003; PE for 2007	2001-2007 (4)
Bobar Banka	2002-2004 (n/a PE for 2002-2004) 2007-2009	2005-2006 PE for 2002-2004	2000-2001	2000-2009 (7)
Bosna Bank International	2004-2009		2002-2003	2002-2009 (2)
Hypo Alpe-Adria-Bank B. Luka	2005-2009		2002-2004	2002-2009 (3)
Hypo Alpe-Adria-Bank Mostar[1]	2003-2009 (n/a PE for 2003)		2000-2002	2000-2009 (4)

[23] For the sake of brevity, these notes and accompanying tables are not presented in the thesis but they are available if needed.

Intesa Sanpaolo Banka[2]	2003-2009 (n/a PE for 2003-2004)	PE for 2003-2004	2000-2002	2000-2009 (5)
IK Banka Zenica	2005-2009 (n/a PE for 2005-2006)	PE for 2005-2006	2000-2004	2000-2009 (7)
Investment Bank of FBiH[3]	2004-2007		2000-2003; 2008-2009	2000-2009 (6)
Komercijalno-Investiciona Banka V. Kladusa	2002-2009 (n/a PE for 2002-04, 2007)	No reports	2000-2001 PE for 2002-04 and 2007	2000-2009 (7)
NLB Razvojna Banka[4]	2003-2009 (n/a PE for the period)	PE for 2006-2009	PE for 2003-2005	2003-2009 (all)
NLB Tuzlanska Banka	2001-2008 (n/a PE for 2001-2003)	2000 and 2009 PE for 2001-2003		2000-2009 (5)
Nova Banka Banja Luka	2001-2008 (n/a PE for 2001-2006)	2009; PE 2001-06		2001-2009 (7)
Privredna Banka Sarajevo[5]	2002-2003 (n/a PE for the period)	No reports	2000-2001; 2007-2009 PE for 2002- 2003	2000-2003 and 2007-2009 (all)
ProCredit Bank	2002-2009 (n/a PE for 2002-2003)	PE for 2003	PE data for 2002	2002-2009 (2)
Raiffeisenbank[6]	2007-2008	2000-06 and 2009		2000-2009 (8)
Sparkasse Bank[7]	2002-2009 (n/a PE for 2002-2003)	PE for 2002-2003	2000-2001	2000-2009 (4)
Turkish Ziraat Bank	2002-2009 (n/a PE for 2002-2003)		2000-2001	2000-2009 (4)
UniCredit Bank[8]	2002-2009 (n/a PE for 2002-2003)		2000-2001; PE for 2002-03	2000-2009 (4)
UniCredit Bank Banja Luka[9]	2002-2009 (n/a PE for 2002-2003)	No reports	PE for 2002-2003	2002-2009 (2)
Union Banka Sarajevo	2002-2009 (n/a PE for the period)		2000-2001; PE for 2002-09	2000-2009 (all)
Vakufska Banka Sarajevo	2002-2009 (n/a PE for 2002-2004)	2001; PE for 2002-04	2000	2000-2009 (5)
Volksbank Banja	2005-2009		2002-2003	2002-2009 (2) [11]
Volksbank BiH	2002-2009 (n/a PE for 2002-2007)		2000-2001; PE for 2002-07	2000-2009 (8)

Notes: * - the figure in the brackets denotes the number of additional observations added to the sample as a result from the augmentation process; **1**-Before 2001 Aurobanka; **2**-Before 2003 UPI banka; **3**-The special law regulates establishment and work of Development Bank of the FBiH Sarajevo, that has become a legal successor of Investment Bank of the FBiH Sarajevo since 01.07.2008; **4**-Before 2006 is LHB banka; **5**-The bank is under provisional administration for the period 2004-2006 and no data is available; **6**-Up to January 2003 is Raiffeisenbank; **7**-Sparkasse Bank Sarajevo, until July 2009, operated under the name ABS Bank Sarajevo; **8**-From 2004 it is UniCredit Zagrebacka banka Mostar, after merging Zagrebacka banka Mostar and Univerzal banka Sarajevo. HVB Central Profit Bank Sarajevo was integrated into UniCredit Zagrebacka bank Mostar (the new name of the Bank is UniCredit Bank Mostar); **9**-Since 1st June 2008 Nova Banjalučka Banka operates under the name of UniCredit Banka Banja Luka; **10**-Before 2007 this bank was operating as Zepter Bank; **11**-None of the sources provides enough disaggregated data (in the case of other operating expenses) for 2004, thus no data for that year.

Source: Author's own compilation

The information on the aggregate data for the banking system for each country is extracted from the statistics databases and the quarterly and annual reports using the websites of each country's National Bank. Country specific variables, such as development indicators for each country, are extracted from the World Development Indicators Database of the World Bank.

Banks for which data is available for less than five years are excluded from the dataset, since it can be expected that it would take at least five years for a bank to improve its efficiency due to:

(i) the extensive transition reforms; (ii) the substantial inflow of foreign capital and the expertise that comes along with the new ownership; (iii) the learning by doing processes; and (iv) the rapid technical changes in SEECs' banking industry in recent years. Our data set includes banking institutions listed by the National Banks of each country, namely commercial banks (131), investment banks (7), micro-finance institutions (6); cooperative banks (6); and savings banks (3). Additionally, to avoid survivorship bias, the sample consists of not only the currently active banks, but also banks that were active during part of the period under investigation but have gone bankrupt during the period. The banks which have been merged with other banks during the time span of investigation appear in the sample as the "old" banks prior to the merger and the "new" banks after the merger. In the case of takeovers, again the bank is included in the sample prior the takeover, and disappears from the database after the take-over. However, a bank that takes over another bank in the next period appears as same unit of analysis as prior to the takeover, but with increased financial position as a result of the takeover. Both mergers and takeovers are worth consideration in the empirical analysis. However, since banks from eight countries are included in the analysis for a period of time when the banking sectors is still in transition in terms of the ownership structure, it is not feasible to control for all those events. According to Rossi et al. (2005) the effects of consolidation process in the banking industry as well as international mergers and acquisitions is often manifested in the profit side rather than on the cost side. On the contrary, Yildirim and Philippatos (2007) argue that the primary motive for bank mergers is to improve performance and achieve cost synergies. Despite these arguments the majority of the banking studies for transition economies do not control for this trend in the industry (Mertens and Urga, 2001; Bonin et al., 2005; Kasman (2005); Kasman and Yildirim, 2006; Kosak and Zajc, 2006; Staikouras et al., 2008; Kosak et al., 2009; Kosak and Zoric, 2011). Hasan and Marton (2003) and Fries and Taci (2005) are the only two studies that have considered mergers in their empirical analysis. The former introduces an acquisition/merger dummy variable in the second stage in which possible correlation between profit inefficiency and other relevant factors is investigated. The dummy variable takes the value of 1 if the bank has acquired/merged with another bank during the post-1991 period, otherwise 0. The latter empirical study includes the merger variable in the mean of the inefficiency term, but no definition of the variable is provided. They found a negative but insignificant relationship between bank mergers and inefficiency. This approach of including only one dummy variable for bank mergers for all of the banks is somewhat dubious, because the effect of the merger in this case is expected to be the same for all banks, regardless of size and ownership. This might be a reason for the insignificant effect of the bank merger variable in the study of Fries and Taci (2005). As shown in Table 4.1, the empirical investigation uses the ratio of the outputs relative to total assets, which in a way cancels out the immediate substantial increase in the outputs as a result of a merger/acquisition/takeover.

The dataset is an unbalanced panel with 1667 observations for 153 banks covering a period of 13 years from 2000 till 2012, which on average presents about 11 years per bank. Table 4.3 provides a detailed overview across time of the number of banks operating in each country and the number of banks included in the sample. The data shows that there are considerable oscillations in the distribution of banks both across countries and over time. Moreover, this table displays the proportion of banks included in our sample across countries, which is an indicator for representativeness of the sample. Although, this indicator can be somewhat misleading, since it is only based on the number of banks, according to the total assets of the banking sectors, our data includes on average from 60 to 80 per cent of the total banking assets across countries and time. Given this argument, it is evident that the larger banks in all of the countries are included in the sample for all the years, since the share of total assets indicator is substantially higher than the number of banks indicator, on average and over time. In Table 4.3 it is noticeable that the representativeness of the sample increases substantially over time in all countries.

Table 4.3 Number of banks included in the sample as a proportion of the total banks

Year	No. of banks in the banking sector	No. of banks in the sample	% of banks included in the sample	No. of banks in the banking sector	No. of banks in the sample	% of banks included in the sample
	ALBANIA			BOSNIA and HERZEGOVINA		
2000	10	4	40	55	14	25
2001	13	6	46	48	18	38
2002	13	8	62	40	23	58
2003	15	9	60	37	24	65
2004	16	10	63	33	22	67
2005	17	9	53	33	23	70
2006	17	8	47	32	23	72
2007	16	9	56	32	24	75
2008	16	9	56	30	23	77
2009	16	8	50	30	23	77
2010	16	9	56	29	21	72

2011	16	9	56	29	21	72
2012	16	9	56	28	21	75
	BULGARIA			**CROATIA**		
2000				44	18	41
2001	35	7	20	43	19	44
2002	34	14	41	46	24	52
2003	35	19	54	41	27	66
2004	35	22	63	37	27	73
2005	34	24	71	34	28	82
2006	32	24	75	33	28	85
2007	29	23	79	33	28	85
2008	30	23	77	34	28	82
2009	30	23	77	34	27	79
2010	30	21	70	33	25	76
2011	31	21	68	32	25	78
2012	31	20	65	31	25	81
	MACEDONIA			**SLOVENIA**		
2000	22	8	36	28	13	46
2001	21	9	43	24	16	67
2002	21	9	43	22	16	73
2003	21	9	43	22	17	77
2004	21	12	57	22	17	77
2005	20	12	60	25	17	68
2006	19	13	68	25	17	68
2007	18	13	72	27	17	63
2008	18	13	72	24	17	71
2009	18	13	72	25	17	68
2010	18	12	67	25	17	68
2011	17	12	71	25	17	68
2012	16	12	75	23	17	74
	SERBIA			**MONTENEGRO**		
2002	50	8	16			
2003	47	18	38	10	5	50
2004	43	25	58	10	6	60
2005	40	26	65	10	9	90
2006	37	28	76	10	9	90
2007	35	28	80	11	9	82
2008	34	28	82	11	9	82
2009	34	28	82	11	9	82
2010	33	28	85	11	7	64
2011	33	27	82	11	8	73
2012	32	25	78	11	8	73

4.4 ALTERNATIVE MODEL SPECIFICATIONS

As discussed previously, CE is estimated by using RPMs (with Greene's TRE model being a special case) and BC (1992, 1995) models. The detailed model specifications estimated are explained in terms of the random parameters model. The departure point is the estimation of the baseline models, Eq. 4.5 (hereafter TRE1) and Eq. 4.6 (hereafter TRE1T) by the TRE model (with the constant term being the only random parameter). The baseline models, as well as the production factors, include all of the Z(s) (country, industry and bank characteristics) in the objective function (the cost frontier).

However, as discussed in Section 4.2.1 and Section 4.3, the bank-specific variables are more likely to have a direct impact on inefficiency, rather than to contribute in shaping the cost frontier and to affect the total costs. Fortunately, SFA allows for introduction of the observed heterogeneity (the Zs) in the variance parameters and in the mean of the underlying inefficiency. But, as previously discussed in Sections 2.3.3 and Section 4.3, there is no clearly defined theory that dictates how these variables should enter the model, hence we assume that the country and industry specific variables belong to the objective function (the frontier line), whereas the bank-specific characteristics directly affect the bank's efficiency and should enter in the mean of the underlying inefficiency and/or in the variance parameter. It should be noted that, in the case of RPMs (including the TRE model) heteroscedasticity in v_{it} cannot be accommodated, since it is assumed that v_{it} is constant. Moreover, the normal-truncated model (which allows for the explanatory variables to enter in the mean of the underlying inefficiency) at the same time with heteroscedasticity in u_{it} (observed heterogeneity introduced in the variance parameter of u_{it}) is not identified, that is it is impossible to obtain the parameter estimates (LIMDEP Manual, 2007, p. E33-92). Therefore, this empirical analysis considers the two different possibilities separately; first, placing the bank-specific variables in the mean of the underlying inefficiency and second in the variance parameter of u_{it}. However, the TRE truncated-normal model with bank-specific variables in the mean of the underlying inefficiency appears to be unidentified with this dataset. Similar failure is found in an example given by Greene (LIMDEP Manual, 2007, p. E33-97, when using the RPMs). Consequently, we proceed with the second model, that is, with heteroscedasticity in u_{it} (hereafter TRE2 for the model with year dummies and TRE2T for the model with time trend).

The next model specification goes beyond the TRE model and considers some of the parameters of the regressors as random, in addition to the constant term (Section 2.3.2). Usually, in the econometric modelling the parameters are treated as constant across observations (the effect of any individual explanatory variable is the same for each observation). However, the existence of unobserved factors may indicate that the estimated parameters may vary across individuals. The random parameters model account for the influences of this unobserved heterogeneity. The rationale for such a modelling approach is grounded in the argument of Berger and Mester (1997) who emphasise the lack of homogeneity in the quality of produced outputs. Given the high level of product differentiation in banking arising from, *inter alia*, various types of loans, repayment schedule, risk, level of information, controlling for quality is restricted. These differences are not fully captured by the available data (bank data on more disaggregated levels are usually not available for researchers, especially for transition countries). Consequently, the treatment of both outputs (total loans and other earning assets) as random parameters is supported by the argument put forth by Berger and Mester (1997). In addition, risk preferences are not quantifiable, but they are closely associated with the loan impairment charge. Moreover, a constant effect of loan impairment charges on inefficiency across individuals is questionable, since a marginal increase of loan impairment charges may have a lower negative effect on efficiency for more capitalized banks than for less capitalized ones or due to other factors that are not considered in the empirical models. Therefore, in the third model, the loan impairment charges, the total loans and the other earning assets are modelled as random parameters, whereas the bank-specific variables again enter the variance of u_{it} (hereafter TRE3 for the model with year dummies and TRE3T for the model with time tend).

The second tranche of models comprises the BC (1992, 1995) models. To allow for comparison between these strands of models, we keep the same model specifications as discussed in the previous paragraphs. First, the baseline model specifications as given in Eq. 4.5 (hereafter BC1) and Eq. 4.6 (hereafter BC1T) are estimated. As in the previous alternative model specifications, first the bank-specific characteristics are included in the mean of the underlying inefficiency (hereafter BC2 for the model with year dummies and BC2T for the model with time tend); and then in the variance parameter of u_{it}, (hereafter BC3 for the model with year dummies and BC3T for the model with time tend) (Section 2.3.2). Although, unlike the RPMs, the BC models allow for the truncated-normal distribution with heteroscedasticity in u_{it} simultaneously, this model is not estimated in order to have comparable specifications.

All variables included in the models, except the inflation rate, the dummy variables and the time trend, are expressed in natural logarithms. The econometric software used for this analysis is

LIMDEP 9.0. The RPMs (excluding the true random effects model) are estimated by maximum simulated likelihood, whereas the rest of the models are estimated by maximum likelihood. The estimation of the RPM is extremely time-consuming even with the current computing power. In order to achieve a reasonable approximation to the true likelihood function, a large number of random draws is required. Train (2002) suggests the use of "intelligent" draws, such as Halton sequences, which can reduce the number of draws required by a factor of five or ten, with a corresponding reduction in the amount of time needed to fit the models. Greene (2005) suggests the use of several hundreds of Halton sequences. Our models are estimated with 500 Halton sequences.

4.5 EMPIRICAL FINDINGS

As discussed in the previous section, CE has been estimated using three BC models and three RPMs, two of which are the TRE models (in one of them all the variables including the technology parameters are included in the frontier, and in the other bank-specific variables enter the variance of the one-sided error term, representing inefficiency). In addition, all of these models are estimated twice, once with year dummies and once incorporating a time trend in the translog formulation along with year dummies for 2008 and 2009 to control for the last financial crisis. For a comprehensive analysis, the empirical findings are presented in four separate sections in the following order. Section 4.5.1 presents a comparison of the BC models and RPMs based on the diagnostic statistics obtained from each model, although it is important to note that usually it is not feasible to perform various statistical tests between the models, because they are not nested (Goddard et al., 2014). Section 4.5.2 discusses the preferred set of models for the estimation of CE and identifies the preferred model within this group. The findings of the preferred model and the effect of technical change on banks' total costs are presented in Section 4.5.3, while a discussion on the CE levels across countries and times is presented in Section 4.5.4. Finally, in Section 4.5.5 we compare the efficiency estimates from the preferred model with those of other studies reviewed in Chapter 3.

4.5.1 Comparison of the BC and RPMs models

Based on Section 4.2.1 and Section 4.4, we identified six model specifications to be estimated using BC models and RPMs. This section provides a comparison between the BC models and the RPMs. Table 4.4, Table 4.5 and Table 4.6 present the estimated results from the BC and RPMs. Table 4.4 consists of the results of the estimation of six versions of BC models. Table 4.5 uses Pearson correlation coefficients to compare the efficiency estimates obtained from BC and RPM models. Table 4.6, which presents the results of the six RPMs, is given later in the following section (4.5.2), because the detailed consideration of these models is discussed at that point.

Starting with the comparison of the BC models and RPMs, the first important indicator to be considered is the lambda coefficient, $\lambda=\sigma_u/\sigma_v$ (in the lower panel of Table 4.4 and also Table 4.6 in Section 4.5.2), which is statistically significant in all of the models and suggests that banks are operating with some inefficiency in all cases where the test can be performed. Specifically, the standard error of lambda is given for all of the BC model specifications but only for the baseline model of the RPMs: this test is not produced by the estimation procedure for the other models. Greene (2004) argues that the bigger the lambda the greater is the inefficiency component of the model.

Table 4.4 Empirical results from Battese and Coelli models

	BC1	BC2	BC3	BC1T	BC2T	BC3T
Constant	-0.2744	0.2158	0.7231	0.1395	0.5072	0.8716***
Loans	0.1456*	0.2175**	0.2692	0.1504**	0.2221***	0.2604***
Other Earning Assets (OEA)	0.1638***	0.1917***	0.1941***	0.1661***	0.1975***	0.1895***
Price of borrowed funds (Interest)	0.0733***	0.1077***	0.0081	0.0210	0.0518***	-0.0557***
Price of physical capital (Capital)	0.0108	0.0159	0.1576***	0.0012	0.0044	0.1630***
Loans*OEA	0.0932***	0.1047***	0.0888**	0.0959***	0.1064***	0.0832***
½*Loans^2	0.0394***	0.0550***	0.0514	0.0349***	0.0500***	0.0468***
½*OEA^2	0.0035	0.0040	0.0013	0.0067***	0.0069***	0.0037**
½*Price of borrowed funds^2	-0.0041	-0.0110**	-0.0746***	-0.0055	-0.0102**	-0.0949***
½*Price of physical capital^2	0.0166***	0.0129***	-0.0520***	0.0202***	0.0187***	-0.0376***
Interest*Capital	0.0388***	0.0374***	0.0842***	0.0290***	0.0261***	0.0741***
Loans*Interest	-0.0061	0.0065	0.0039	-0.0203**	-0.0109	-0.0037
Loans*Capital	-0.0132	-0.0267	-0.0440	-0.0187	-0.0304**	-0.0463***
OEA*Interest	-0.0174***	-0.0135*	-0.0155	-0.0168***	-0.0116	-0.0066
OEA*Capital	-0.0332***	-0.0385***	-0.0369***	-0.0423***	-0.0482***	-0.0462***
Loan Impairment Charges	-0.0341**	***0.0001***	***1.1560***	-0.0310**	***0.0001***	***1.9434***
Equity	-0.0808***	***0.0001***	***2.1744***	-0.0794***	***0.0001***	***3.7256***
Foreign ownership	-0.0296*	***0.0001***	***0.1399***	-0.0298*	***0.0001***	***0.1088***
Mixed ownership	0.0545***	***0.0001***	***0.5286***	0.0520***	***0.0001***	***0.8032***
Population density	0.2580**	0.2398***	0.1709	0.2293*	0.2207**	0.1480***

Demand density	-0.0048	0.0318	0.0842	0.0345	0.0574	0.0895***
Intermediation ratio	0.0230	0.0178	0.0219	0.0204	0.0124	0.0126
GDP per capita	-0.0576	-0.0937*	-0.1501	-0.1011**	-0.1202**	-0.1589***
Herfindahl-Hirschman Index	0.0326	0.0336	0.0365	0.0355	0.0378	0.0402*
Inflation	1.5441***	1.5414***	1.3647**	1.5482***	1.5453***	1.3571***
EU Membership	-0.0561***	-0.0522***	-0.0400	-0.0836***	-0.0761***	-0.0528***
2001	0.0069	0.0112	0.0116			
2002	0.0393	0.0361	0.0195			
2003	0.0159	0.0066	-0.0177			
2004	-0.0260	-0.0429	-0.0820			
2005	-0.0890**	-0.1064**	-0.1229			
2006	-0.0901*	-0.1210**	-0.1490			
2007	-0.0493	-0.1019*	-0.1481			
2008	-0.0785	-0.1324**	-0.1751	-0.0299	-0.0398	-0.0323
2009	0.0249	-0.0309	-0.1039	0.0614**	0.0545*	0.0332
2010	0.0111	-0.0416	-0.1124			
2011	-0.0148	-0.0662	-0.1285			
2012	0.0046	-0.0486	-0.1113			
Time trend (TT)				-0.0338***	-0.0397***	-0.0478***
½*TT²				0.0060***	0.0064***	0.0060***
TT*Loans				0.0054	0.0049	0.0012
TT*OEA				0.0053***	0.0050***	0.0028**
TT*Interest				0.0113***	0.0124***	0.0144***
TT*Capital				-0.0029***	-0.0036***	-0.0038***
λ	1.8694***	1.5655***	3.8417***	1.9600***	1.6197***	8.8588***
σ_u	0.2833***	0.2634***	0.9575	0.2896***	0.2681	1.3047
σ_v	0.1515	0.1683	0.2493	0.1478	0.1655	0.1473
ETA	0.0100**	n/a	0.0087	0.0100**	n/a	0.0100**
AIC	-0.1797	-0.2527	0.0830	-0.1471	-0.2471	0.2915
Log Likelihood	190.75	250.62	-27.14	159.58	241.92	-204.93
Estimated cost efficiencies over the whole sample						
Mean	0.8091	0.8178	0.8258	0.8061	0.8157	0.8445
SD	0.1037	0.1003	0.1082	0.1045	0.1012	0.1103
Min	0.3603	0.3989	0.2857	0.3539	0.3928	0.3205
Max	0.9936	0.9938	0.9884	0.9941	0.9942	0.9956

*Note: ***, ** and * denote statistical significance of variables at 1%, 5% and 10% level of significance respectively.*
The original printouts related to the BC models are presented in Appendix to Chapter 4, Section 4.2.

On average, the estimated lambdas in the RPM estimations are higher compared to the ones from the BC models (except BC3T), implying that estimations by RPMs result in higher inefficiency. Thus, there is evidence that inefficiency effects are an important factor when explaining cost differences for banks in SEECs.

However, before going further with the analysis of the BC results, it is important to discuss a number of "signals" which appeared during the estimation of the different models, raising some concern. Specifically, the estimation of all BC models was accompanied by the error message "*Error 805: Initial iterations cannot improve function*", indicating that the models had not converged to provide a normal exit from the iteration process (only one iteration was completed).

This suggests limited validity of the findings obtained from the BC models. Greene (LIMDEP Manual 2007, p. E33-53) has a warning note for the BC models, arguing that “good” results using these models can emerge only when the data is highly consistent with them. Extreme results may emerge if the dataset is not of high quality or these models are not appropriate for the given data. Consequently, this view and the warning from the estimations suggest that the estimates of these models should be considered with caution.

The studies on transition economies reviewed in Chapter 3 which use these models, do not discuss the existence of such a problem, although they are all based on Bankscope data. It is not clear if the issue has been raised previously and ignored or that it is an outcome of our particular data, for instance the particular countries included or the augmentation of the Bankscope data. On the other hand, RPMs have not exhibited any problems during the estimation procedures. In particular, all the models converged and had a normal exit from the iteration process.

A more detailed analysis of the results of the BC models, reveals other indicators which raise concern about the appropriateness of these models. In particular, referring to the lambda estimates in Table 4.4, although they are statistically significant most of the values are fairly low, except for model BC3T which gives a high value, and such variations may support the previous argument that this set of models does not fit this data well. The specific parameter ETA (not available for BC with heteroscedasticity), which determines whether inefficiencies are time varying or time invariant, is significant in three variants, suggesting that the CE is time-variant over the period of investigation. However, when the estimated CE resulting from the BC models was closely examined, it was noted that the variation in CE seems to be negligible, something which is supported by the ETA’s low value of 0.01. In other words, the efficiency estimates for majority of the banks are almost constant over time. This finding is against the a priori expectations based on the discussion in Section 1.4 that during the period of 2000-2012 the banking sector in these countries has undergone a major restructuring, in particular with respect to an influx of foreign capital, mergers, acquisitions and takeovers, financial innovations and technological changes which facilitate the customer-orientated approach to bank services (on-line banking, increasing the numbers of ATMs, etc.). All of these are expected to have positively affected banks' CE during these years.

Amongst the empirical studies reviewed in Chapter 3, Rossi et al. (2005) and Kosak and Zajc (2006) find ETA to be significant, with values of 0.05 and 0.1, respectively, which are much higher estimates compared to our ETA estimates of 0.01. Kosak and Zoric (2011) find ETA to be insignificant, while Fries and Taci (2005), Kraft et al. (2002), and Kasman and Yildirim (2006) do not present this coefficient. The reason why some studies do not present the results with respect to ETA or have different results for this indicator is unclear. This might be due to the model in use (as discussed earlier the BC with heteroscedasticity model does not provide an estimate of ETA) or simply it is not presented. Slovenia is the only country included in these studies and our sample; and CE estimates are generally lower in the studies which do not report the ETA indicator (see Table 4.9 in this Section 4.5.5).

RPMs allow for random distribution of inefficiency over time in the formulation of the model, as opposed to BC models in which by construction inefficiency is a function of time (see Chapter 2.3.2 for technical details) and the variation in the inefficiency estimates in the BC models depends on this restrictive formulation. In this thesis, the CE estimates from the BC models are almost time-invariant, which can be observed by the analysis of the individual estimates through time, although the ETA coefficient is significant as previously discussed. Greene (2008) presumes that time-invariant estimates substantially incorporate heterogeneity, have higher σ_u compared to the time-varying models, which indicates a high variation of efficiency across banks for the former and low variation in the efficiency across banks in the latter case. This view can be applied in this analysis, since the σ_u of the BC models is much higher than the σ_u of RPMs (Table 4.4 and Table 4.6 in Section 4.5.2, respectively), suggesting that heterogeneity and inefficiency are confounded in the BC models. Moreover, there is a substantial difference in the σ_u across the BC models, suggesting possible instability of the BC estimates with respect to CE variations across banks. For example, the striking σ_u value of 0.96 and 1.30 in the BC3 and BC3T models respectively are about five times higher than the σ_u values of the other BC models (Table 4.4). In any case the failure of the BC models to converge and have a normal exit from the estimation procedure and the very high variation in the values of σ_u obtained from similar models, provides support for the view that this strand of models does not seem to fit our dataset. According to Greene (2011) the BC models are very close to time-invariant models, which do not control for latent heterogeneity, while RPMs by formulation account for this type of heterogeneity. Hence, it is expected the CE estimates from these models to differ due to the potential presence of heterogeneity in the estimated inefficiency scores. Greene's position presents another supporting argument for RPMs over BC models in this analysis.

Another issue that can be of particular use in the comparison of the two strands of models is the significance of the estimated coefficients of the bank-specific variables when they can directly influence inefficiency by considering them to be explanatory variables of u_i (regardless of whether they enter in the mean of the underlying distribution or in the variance of u_i). In particular, as presented in Table 4.4 all of these variables are statistically insignificant and those controlling for ownership do not have the a priori expected sign (that foreign ownership would increase the CE of banks) in BC2, BC2T, BC3 and BC3T. On the other hand, the bank-specific variables are highly significant with expected signs in all of the RPMs (Table 4.6, Section 4.5.2). Referring back to the other studies for transition economies, Fries and Taci (2005) and Kosak and Zoric (2011) find these variables significant (although these researchers have also used some different bank-specific variables). Kraft et al. (2002) do not present the results of the estimation; Rossi et al. (2005) do not employ such a model specification, whereas in Kasman and Yildirim (2006) the position of such variables is not clearly presented. Previous studies therefore provide some (limited) support for the significance of such variables and this discussion can be considered as an additional indicator that the BC models do not fit our dataset appropriately.

There is a lack of statistical grounds when choosing between different SF models. However, there are some indicators such as LR test for nested models and Akaike Information Criterion (AIC)[24] for non-nested models that can be used for this purpose. That the RPMs (including the special case true random-effects model) are preferred over the BC models is suggested by AIC, for all of the RPMs have a smaller AIC compared to BC models. Specifically, the AIC for BC models is in the range of 0.29 to -0.25 and for the RPMs the AIC is in the range of -0.54 to -1.19 (Table 4.4 and Table 4.6). It is evident, that even the "worst" performing RPM, according to AIC, is preferred over the "best" BC model. Moreover, σ_v in RPMs is about three times smaller than σ_v in the BC models. From this can be further surmised that there is a heterogeneity in this data set which has been moved out from the error, which contributes to a higher "purity" in the RPMs CE estimates, since σ_v is one of the components in the Jondrow et al. (1982) error term decomposition formula ($\varepsilon_{it} = v_{it} + u_{it}$). Consequently, the CE estimates of the BC models may also reflect heterogeneity besides efficiency. This is in line with the earlier argument regarding the possible existence of heterogeneity in the CE estimates obtained from the arguably time-variant BC models (since ETA is significant, but the size is negligible).

So far, the results of the two strands of models have been compared on statistical grounds. Briefly, the argument is in favour of RPMs. However, before selecting the preferred strand, a discussion over the individual estimates is provided in the context of their consistency across the two sets of models. The mean bank CE in SEECs is arguably similar across all models (BC and RPMs) and ranges from 80.6 to 87.5 per cent. However, in order to examine the efficiency distribution and the (dis)similarities of the individual efficiency estimates across banks obtained by different models, scatter diagrams of the individual estimates are presented for a simple visual comparison and Pearson correlation of the individual efficiency estimates are calculated to test for their correlation across different models.

[24] The smaller the value of this information criterion the better is the model, given the variant of the formula for the AIC used in LIMDEP.

Even though conclusions about the model performance cannot be drawn on the grounds of scatter diagrams, they present a significant intuitive way for understanding the relationship between the different sets of estimates. The scatter diagram in Figure 4.1 presents the relationship between the sets of estimates produced by the BC models, where BC1 (all the Z_{it} variables enter the frontier) is the base category for comparison. It can be noted that except for a few banks, all the other estimates are quite consistent regardless of the model specification and positioning of the Z_{it}.

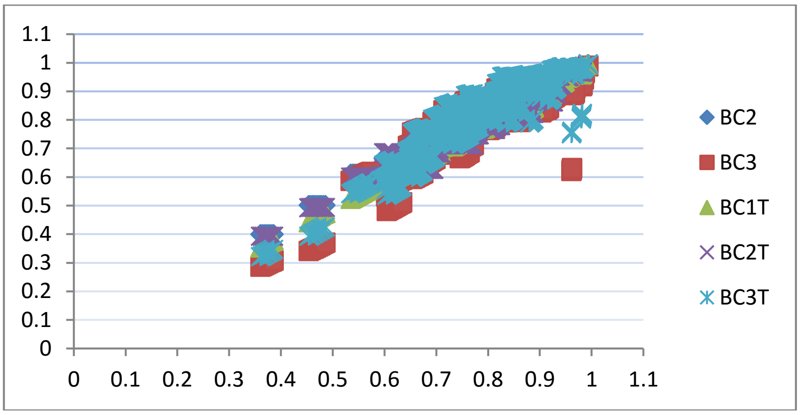

Figure 4.1 Scatter plot of estimated individual efficiencies using Battese and Coelli models
Source: Author's own calculations

In Figure 4.2 and Figure 4.3 the individual CE estimates of BC2T are compared with the estimated CE of TR2T and TR3T models, respectively. Since the estimated CE within the BC models are reasonably consistent as shown in Figure 4.1, BC2T is chosen as a representative from the BC models because bank-specific variables enter in the variance parameter of u_{it}, as in TR2T and TR3T. It is evident that both diagrams, Figure 4.2 and Figure 4.3 present a similar picture, indicating a lack of consistency of the BC estimates of CE and the "equivalent" RPM estimates.

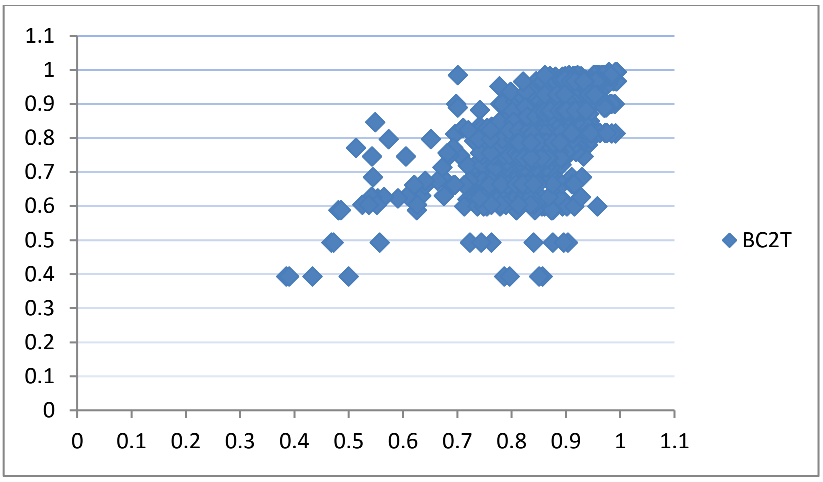

Figure 4.2 Scatter plot of estimated individual efficiencies using true random effects model and "equivalent" Batesse and Coelli

Source: Author's own calculations

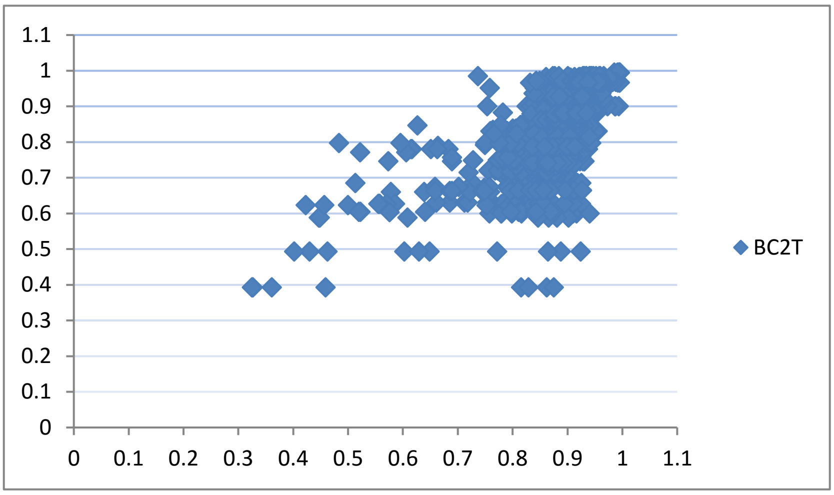

Figure 4.3 Scatter plot of estimated individual efficiencies using Random Parameters Model and "equivalent" Batesse and Coelli

Source: Author's own calculations

Figure 4.4 and Figure 4.5 give some insights into the relationship between RPM sets of CE estimates. In Figure 4.4, the base model against which the other models are compared is TR1T, whereas in Figure 4.5, TR2T is compared to TR3T. It can be noticed that the two sets of estimates in Figure 4.5 are more consistent than the ones in the Figure 4.4. The reason for the lower consistency of the estimates in Figure 4.4 is the choice of the base category against which the other two sets of estimates are compared. In particular, the base category is TR1T, where all the variables (including the bank-specific variables) are part of the objective function and contribute to shaping the frontier line. Consequently, *the position of the bank-specific variables* within the framework of the model *does matter and affects the efficiency estimates*. On the contrary, as previously presented in Figure 4.2, this is not the case with the BC model estimates of CE when the position of bank-specific variable are changed from the objective function into the u_{it}, presumably because of the insignificant effect of these variables in those particular models (Table 4.4). On the other hand, in Figure 4.5, although there is some consistency in the estimates, the relationship is far from fully consistent, presumably because of the treatment of some of the variables as random parameters (loans, other earning assets and loan impairment charges).

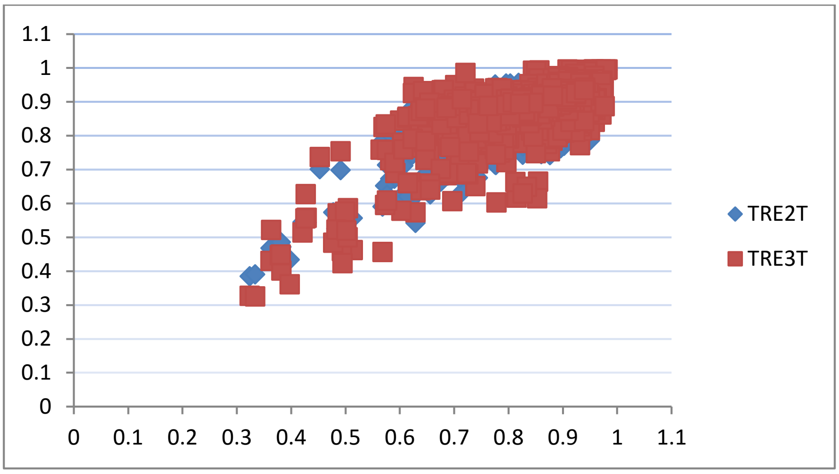

Figure 4.4 Scatter plot of estimated individual efficiencies using Random Parameters Models

Source: Author's own calculations

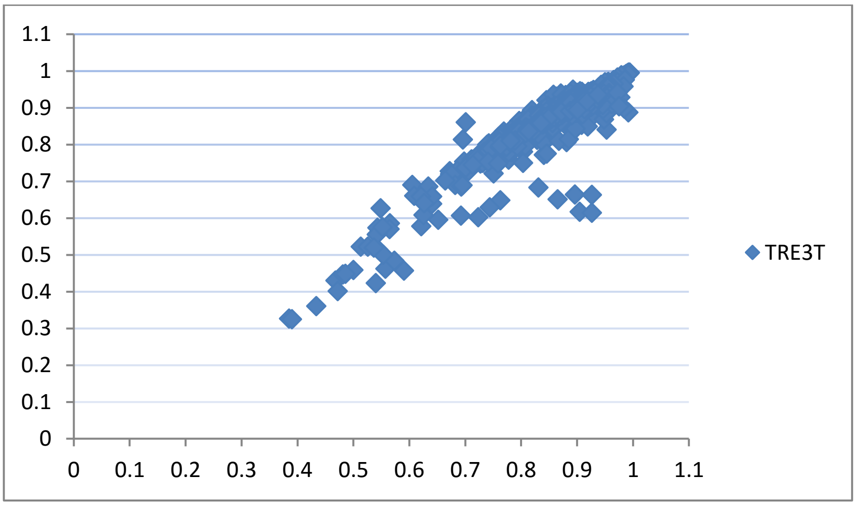

Figure 4.5 Scatter plot of estimated individual efficiencies using true random effects model and random parameters model

Source: Author's own calculations

To check the relationship between the different sets of estimates on statistical ground, Pearson correlation coefficient analysis is conducted (Table 4.5). All the correlation coefficients are significant at all conventional levels of significance. Given the sample size of 1667 observations, even fairly low correlations are very often significant – as they are in Table 4.[25] The correlation between BC and RPM models are presented in bold type.

Table 4.5 Pearson's correlation coefficient for Battese and Coelli models and Random Parameters models

	TRE1	TRE2	TRE3	TRE1T	TRE2T	TRE3T	BC1	BC2	BC3	BC1T	BC2T	BC3T
TRE1	1.0000											
TRE2	0.7146	1.0000										
TRE3	0.7062	0.9130	1.0000									
TRE1T	0.9893	0.7084	0.6997	1.0000								
TRE2T	0.7153	0.9907	0.9199	0.7196	1.0000							
TRE3T	0.7178	0.9196	0.9600	0.7150	0.9195	1.0000						
BC1	**0.1689**	**0.6362**	**0.6016**	**0.1674**	**0.6355**	**0.6049**	1.0000					
BC2	**0.1487**	**0.6441**	**0.6105**	**0.1475**	**0.6416**	**0.6075**	0.9678	1.0000				
BC3	**0.2181**	**0.6252**	**0.6218**	**0.2151**	**0.6254**	**0.6426**	0.8897	0.8898	1.0000			
BC1T	**0.1739**	**0.6358**	**0.6039**	**0.1724**	**0.6396**	**0.6112**	0.9957	0.9623	0.8972	1.0000		
BC2T	**0.1530**	**0.6459**	**0.6138**	**0.1518**	**0.6479**	**0.6148**	0.9656	0.9954	0.8977	0.9688	1.0000	
BC3T	**0.2148**	**0.6374**	**0.6070**	**0.2138**	**0.6461**	**0.6311**	0.9148	0.9212	0.9701	0.9277	0.9346	1.0000

Source: Author's own calculation

These correlation coefficients provide support for the above discussion. In particular, the correlation coefficients of the CE estimates from the BC models are very strong at about 0.90. However, there is a weak correlation between some of the BC and RPM sets of estimates and only moderate correlation between the rest (in Table 4.5 these correlation coefficients are bolded). The correlation coefficients of the estimates obtained from the RPMs models are moderate to very strong, ranging from 0.70 to 0.99. This is a supporting evidence for the argument regarding the consistent and less consistent sets of estimates within the RPMs, presumably due to the position of the bank-specific variables and the treatment of some variables as random parameters.

So far, the two sets of models, BC and RPMs, have been compared on statistical grounds using the diagnostic statistics and other indicators provided by each model as well as regarding the

[25] For brevity, the p-values are omitted in the Table 4.5, since all the coefficients are significant at all levels of significance.

consistency of the individual efficiency estimates across models. Briefly, to summarize the discussion over the preferred set of models, all the arguments presented above are in favour of estimation by RPMs. RPMs are preferred because: (i) they account for heterogeneity, which purifies the efficiency estimates; (ii) no problems were faced during the estimation procedure; (iii) by formulation RPMs allow for free variation of the individual efficiency estimates within one bank, whereas in the BC models the time-variant component of the estimates are conditioned on a particular function of time, which in this analysis although significant is negligible in magnitude, hence resulting in almost time-invariant CE estimates. Greene (2008) argues that the major reason for the inconsistency when comparing the sets of efficiency estimates is the assumption of time (in)variance. In this analysis, the efficiency estimates from the BC models are almost time-invariant although by formulation they are time-variant models; (iv) the AIC provides support; and (v) the bank-specific variables are all insignificant in the BC models when they enter u_{it}, which is strongly against the a priori expectations. On the basis of these reasons,, we can now turn to a detailed analysis of the results of RPMs (the original printouts related to the six RPMs are presented in Appendix to Chapter 4, Section 4.3).

4.5.2 Comparison of Random Parameters Models (RPMs)

Several issues are considered in order to identify the "best" set of the CE estimates among the RPM set. The first issue is the decision for the choice of models either with year dummies (TRE1, TRE2 and TRE3) or the models with time trend and two year dummies (2008 and 2009) controlling for the financial crisis (TRE1T, TRE2T and TRE3T). The empirical results of the two types of models are presented in Table 4.6. The first three columns present the empirical findings for the models with year dummies (the year 2000 is the base category) and the last three columns present the estimates of the models with time trend. The models with a time trend have the almost the same values of AIC, hence this information criterion is not of much use in this case. When comparing the values of σ_u and σ_v across the models, it can be noticed that $\sigma_u(\sigma_v)$ is marginally lower (higher) in the models with time trend compared to the models with year dummies, however σ_u is substantially the lowest in TRE3T (Table 4.6). This could be interpreted as taking a "little" heterogeneity out of u_{it} (Greene, 2004) and a support in favour of the models with time trend, especially TRE3T with the three random parameters (presented in bold type to be distinguished from the other parameters and they are discussed later in this section) in addition to the constant term and the bank-specific variables modelled to affect directly inefficiency. Since, there are no econometric testing procedures available, the above arguments can be considered as a support for the models with time trend and financial crisis year dummies over the models with year dummies, although the supportive evidence is quite marginal.

Next, the analysis of the estimated parameters of the year dummies and time trend estimates along with its cross-products with the technology parameters may facilitate deciding between the two types of models (Table 4.6). The year dummies from 2004 to 2012 are all highly significant and negative in all models, except in TRE2 where the 2004 year dummy is insignificant. The results suggest a constant decrease of the total costs in banking through time. It can be noticed that the estimated magnitude of cost reductions over years depends on the model specifications; the position of Z_{it} and the treatment of the outputs and their quality as random parameters are found to have an effect on the year dummies coefficients.

Considering the estimated coefficients associated with the time trend, the empirical results suggest that all the estimates, except one in each regression, are highly significant, indicating the presence of autonomous trend with respect to technical change. Moreover, the year 2008 and 2009 dummies although positive are insignificant in these models, except the 2009 time dummy which is significant and positive in TRE1T. Given that the technical change is found to be a significant indicator of the banks' total costs and the marginal support of the statistical diagnostics, the models with time trend seem to fit our data better. Hence, in what follows the focus is on the results obtained from the random parameters models with time trend (the last three columns in Table 4.6).

Table 4.6 Estimation results from the Random Parameter Models

	TRE1	TRE2	TRE3	TRE1T	TRE2T	TRE3T
Constant	0.0403 (0.2290)	-0.0881 (0.3287)	-0.8925 (0.4289)	0.1998 (0.2292)	0.0106 (0.3190)	0.4566 (0.3591)

Loans	0.1651**	0.1947***	***-0.0562 (0.1426)***	0.1703**	0.1558***	***-0.0289 (0.2592)***
Other Earning Assets (OEA)	0.1813***	0.2028***	***0.0897 (0.0780)***	0.1604***	0.1824***	***0.0931 (0.0694)***
Price of borrowed funds (Interest)	0.1668***	0.2283***	0.1980***	0.1587***	0.2224***	0.2227***
Price of physical capital (Capital)	-0.0188	-0.0158	0.2231***	-0.0096	0.0029	0.1718***
Loans*OEA	0.0804***	0.0546***	0.0093	0.0585***	0.0246	0.0053
½*Loans^2	0.0161	0.0176	-0.0370***	0.0252	0.0184	-0.0407***
½*OEA^2	0.0064**	0.0040	0.0040**	0.0067**	0.0023	0.0061***
½*Price of borrowed funds^2	0.0852***	0.0600***	0.0811***	0.0832***	0.0565***	0.0678***
½*Price of physical capital^2	0.0421***	0.0227***	-0.0340***	0.0446***	0.0290***	-0.0231***
Interest*Capital	0.0011	0.0233***	0.0265***	-0.0012	0.0113***	0.0244***
Loans*Interest	-0.0394***	-0.0139	-0.0123*	-0.0382***	-0.0282**	-0.0047
Loans*Capital	-0.0145	-0.0365***	-0.0124	-0.0074	-0.0136	-0.0146
OEA*Interest	0.0129**	0.0307***	0.0212***	0.0101***	0.0323***	0.0411***
OEA*Capital	-0.0362***	-0.0479***	-0.0248***	-0.0418***	-0.0504***	-0.0332***
Loan Impairment Charges	-0.0297**	***0.1671****	***0.3185 (0.4136)***	-0.0241*	***0.1693****	***0.3447 (0.3778)***
Equity	-0.0392***	***0.6120****	***0.2667****	-0.0374***	***0.6396****	***0.3486****
Foreign ownership	-0.0476***	***-0.1153****	***-0.0432***	-0.0511***	***-0.1055****	***-0.2211****
Mixed ownership	-0.0065	***-0.4631****	***-0.3882****	-0.0075	***-0.4634****	***-0.3695****
Population density	0.2315***	0.2182***	0.5797***	0.2472***	0.2497***	0.2504***
Demand density	0.0270	0.0231	0.0601***	0.0421*	0.0265	0.0787***
Intermediation ratio	0.1120***	0.0798***	0.2204***	0.1141***	0.0639***	0.1505***
GDP per capita	-0.1064***	-0.0661**	-0.2361***	-0.1377***	-0.0978***	-0.2105***
Herfindahl-Hirschman Index	0.0701***	0.0627***	0.0753***	0.0789***	0.0723***	0.0759***
Inflation	0.6839***	0.6081***	0.2912***	0.4715***	0.4966***	0.2119***
EU Membership	-0.0270*	-0.0100	-0.0097*	-0.0418***	-0.0243**	-0.0151**
2001	-0.0046	0.0324	0.0163			
2002	-0.0112	0.0254	-0.0104			
2003	-0.0597*	-0.0040	-0.0561***			
2004	-0.1059***	-0.0566**	-0.1083***			
2005	-0.1489***	-0.0820***	-0.1343***			
2006	-0.1667***	-0.1002***	-0.1471***			
2007	-0.1416***	-0.0955***	-0.1592***			
2008	-0.1342***	-0.1012***	-0.1659***	0.0290	0.0077	0.0132
2009	-0.0934**	-0.0745**	-0.1682***	0.0540**	0.0274	0.0131
2010	-0.1143***	-0.0894**	-0.1752***			
2011	-0.1301***	-0.1066***	-0.1856***			
2012	-0.1290***	-0.1103***	-0.1773***			
Time trend (TT)				-0.0584***	-0.0414***	-0.0458***
½*TT^2				0.0076***	0.0044***	0.0052***
TT*Loans				-0.0095***	-0.0128***	0.0002
TT*OEA				0.0038***	0.0009	0.0029***
TT*Interest				0.0024	0.0078***	0.0040***
TT*Capital				-0.0028***	-0.0037***	-0.0021***
λ	2.3990***	3.8804	5.2947	2.4112***	3.6776	4.0923
σ_u	0.2217	0.2440	0.2469	0.2225	0.2417	0.1929
σ_v	0.0924	0.0629	0.0466	0.0923	0.0657	0.0471
AIC	-0.5444	-0.6714	-1.1892	-0.5448	-0.6775	-1.1851
Log Likelihood	494.74	600.59	1035.18	491.11	601.67	1027.81
Estimated cost efficiencies over the whole sample						
Mean	0.8509	0.8555	0.8654	0.8502	0.8574	0.8745
SD	0.0860	0.0704	0.0677	0.0865	0.0701	0.0670
Minimum	0.3267	0.3876	0.3284	0.3237	0.3847	0.3248
Maximum	0.9828	0.9942	0.9957	0.9821	0.9939	0.9957

The estimates of the production technology coefficients give the direction of the effects mostly as expected, and are largely significant. Given that the translog functional form is used, the interpretation of the technology parameters is complicated, because of the squared and cross-product terms of the outputs, the inputs and the time trend. For example, at first glance, the coefficients of loans is negative in TRE3T (the last column in Table 4.6), raising some doubts for the appropriateness of the model, since the main output is insignificant and the coefficient on loans has the opposite sign to that expected. However, given that this is a random parameter its interpretation is not straightforward (more on this issue later in this section), especially given the effect of this output is also demonstrated in several cross products with the other output, the two input prices, the time trend and itself, as it is required by the translog specification; all of these cross products coefficients except one are statistically significant at all conventional levels. On the other hand, the price of physical capital is significantly positive as expected only in TRE3T (all of the cross-products are highly significant except one).

As already acknowledged the coefficients of the technology parameters are of second-order importance, therefore for brevity detailed interpretation is not presented, especially because their interpretation is complex. Furthermore, complexity in interpretation of the results is also common for the coefficients of the random parameters (loan impairment charges, loans and other earning assets). As argued by Greene (2005b) the standard errors cannot be used straightforwardly to assess the significance of the estimated parameters, as it is a usual practice in the econometric analysis. The reason for this is that there is no unique "parameter" to assess when the parameters are randomly distributed across the units of analysis. In particular, Greene (2005b) emphasizes that the structural parameters provide the moments of distribution, not the asymptotic mean and the variance of a sampling distribution. For example, for the loan impairment charges, the unconditional normal distribution of Z_{LICi} across banks is estimated to have a mean of 0.3447 and a *standard deviation* of 0.3778, as given in Table 4.6 (the last column). According to Greene's argument in this case it is very likely that any realization of the process generating Z_{LICi} will produce both positive and negative values, suggesting that LIC would have a positive effect on inefficiency for some banks, whilst negative for others. In addition, as previously argued, because of the translog functional form in use, the generating process of α_{1i} and α_{2i} is complex, since the effect is "spread" among the cross products as well (see Equation 4.6 for details). Therefore, the standard deviations are presented in the parentheses in Table 4.6 for the random parameters and the “stars” which indicate the statistical significance of the parameters are not presented, since as discussed it is not a proper indicator for significance.

Figure 4.6, Figure 4.7 and Figure 4.8 below present plots mapping the mean and the standard deviations for each of the 153 banks for the loans, other earning assets and the loan impairment charges respectively, in order to display variations in the individually estimated parameters. As noted, the conditional means (the dots in the centipede plot) are not actually estimates of α_{1i}, α_{2i} and Z_{LICi}, but are draw from a conditional distribution instead. The spikes in Figure 4.6, Figure 4.7 and Figure 4.8 represent estimates of a range of the density that should capture a large portion of the mass of the distribution. In particular, the estimated conditional mean plus/minus two conditional standard deviations will capture at least 95 per cent of any but the most pathological distribution (LIMDEP, 2007). Hence, subject to couple caveats (Greene, 2008 and LIMDEP, 2007), the lines in the three figures below do present confidence intervals for α_{1i}, α_{2i} and Z_{LICi}, respectively.

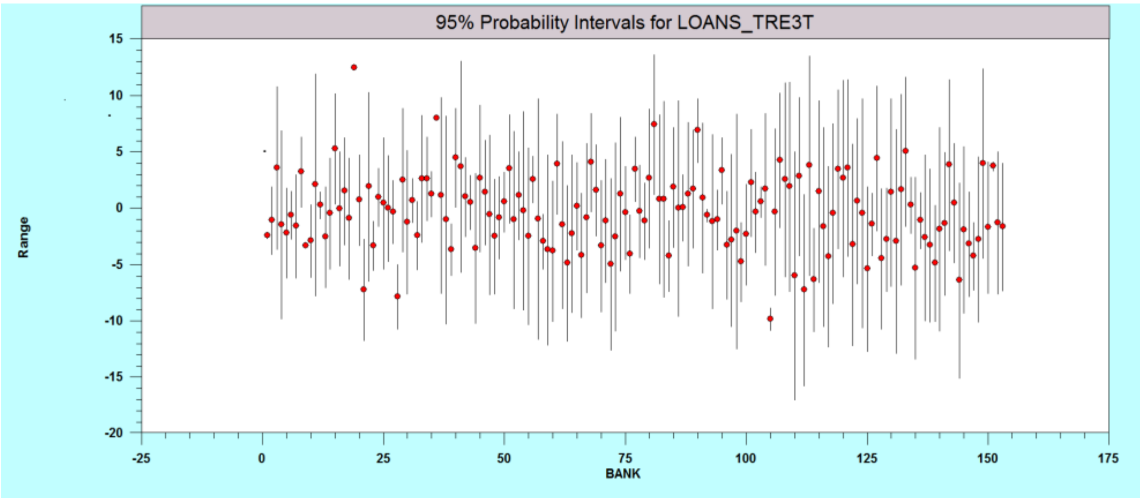

Figure 4.6 95% Confidence Intervals for Bank Specific Coefficients on Loans
Source: Author’s own calculation

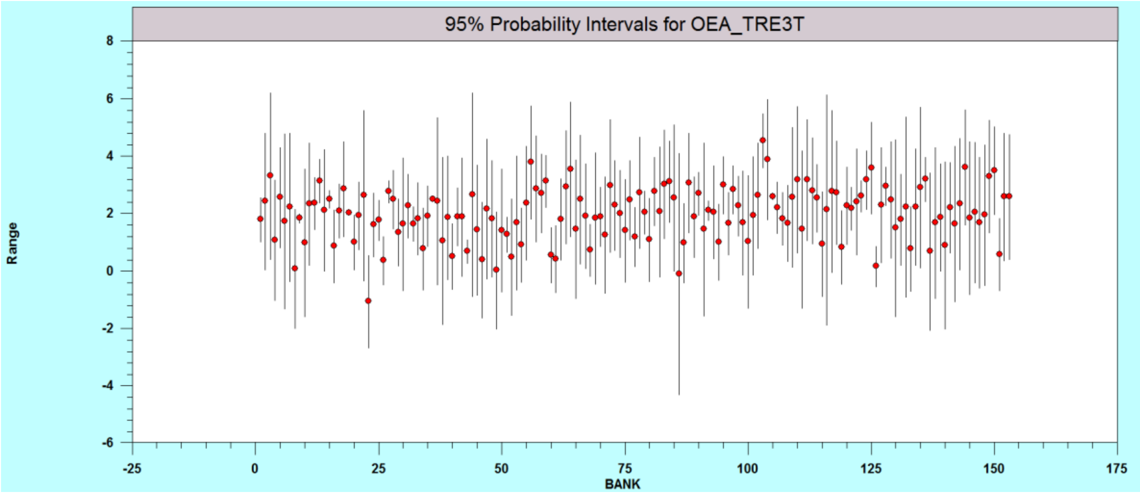

Figure 4.7 95% Confidence Intervals for Bank Specific Coefficients on Other Earning Assets

Source: Author's own calculation

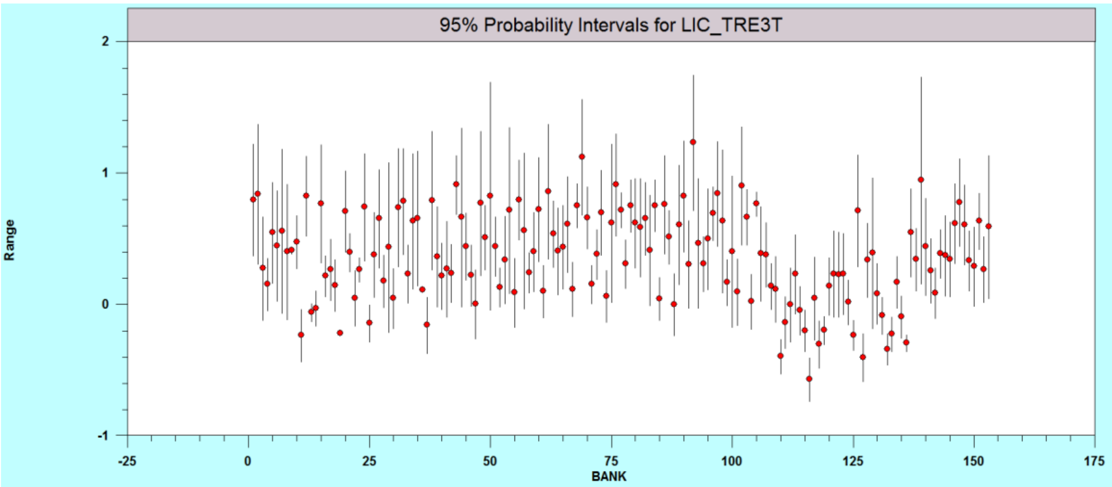

Figure 4.8 95% Confidence Intervals for Bank Specific Coefficients on Loan Impairment Charges

Source: Author's own calculation

Considering the three figures above, there are considerable amount of variation across banks in both means and standard deviations, especially in loans and loan impairment charges as expected. This indicates that the random parameter "treatment" of these three variables may be justified. Moreover, comparing the three models with time trend among each other using the AIC (Table 4.6), again there is a supportive evidence in favour of this model over the other two models (TRE1T: -0.55; TRE2T: -0.68 and TRE3T: -1.2). In addition, both σ_u and σ_v are lowest in this model compared to the other two (Table 4.6), suggesting that heterogeneity is reduced the most in this particular model (TRE3T). Therefore, since all the arguments support the random parameter model with time trend and the two year dummies, where loans, other earning assets and loan impairment charges are considered as random parameters and the bank-specific variables enter the variance of the inefficiency component, this is the model which results are discussed in detail and the one chosen for Chapter 6, when the CE estimates are considered as a determinant of bank's market share.

4.5.3 Interpretation of the Preferred Random Parameters Model (TRE3T)

Although the choice of the "preferred" model was made above, given that this was made on marginal grounds, all RPM models are referred to in the discussion of the detailed results that follows in this section. GDP per capita coefficient has a negative sign as expected and it is significant at the one per cent level of significance. This implies that the higher levels of GDP per capita are associated with increase in cost efficiency gains. Inflation, as expected has a positive impact on costs and is also significant at the one per cent level of significance, suggesting that in an inflationary environment firms experience a loss in cost efficiency. The dummy variable controlling for EU accession, as expected, has an inverse relationship with the total costs and it is statistically significant. Banks operating in the EU common market are expected to face greater competition, which in turn is expected to bring about gains in cost efficiency. Population density and demand density coefficients have a positive impact on the total costs and are highly significant at 1 per cent level of significance. However, the coefficient signs of the two parameters are the opposite of the a priori expected signs, as it is assumed that banks operating in markets with a higher density of demand and in higher population density areas would face lower costs as there is higher probability of having more clients for whom they will execute various services (collecting deposits and approving loans) which leads to decrease in the costs per service. However, as explained by Dietsch and Lozano-Vivas (2000), if banks compete by opening more branches for strategic reasons, this may create excessive bank operating costs, hence higher total costs. Similarly, contrary to expectations, the level of intermediation has a positive and significant effect on total costs.

The HHI is estimated to have a positive effect and is significant at the one per cent level of significance, providing evidence in favour of the Hicksian quiet life hypothesis. Additionally, this finding suggests that the higher concentration is at least partly a result of market power, since higher concentration is associated with higher costs (Leibenstein, 1966). If the assumption is that big banks in one banking industry most probably behave in line with the Hicksian quiet life hypothesis, then this is further supported by the effect of a bank's equity. In particular equity is found to be positively and significantly associated with banks' inefficiency, because in TRE3 and TRE3T equity enters the variance parameter of u_{it}. However, in TRE1 and TRE1T (where equity is a part of the goal function), its coefficient is negative and significant, suggesting an inverse relationship with total costs, meaning that banks with higher equity have lower costs. Therefore, the findings with respect to equity are inconclusive.

As expected, given the know-how introduced in the banking sector in SEECs with the entry of foreign capital, the coefficient on the ownership variable indicated that mixed and foreign banks are more efficient relative to domestic banks. In particular, the coefficients of both variables (foreign and mixed), are negative, as expected, in all of the RPMs specification. Moreover, both coefficients are significant in most specifications, including the preferred TRE3T model (where they are highly significant).

A striking finding is the effect of the loan impairment charges on total costs/inefficiency. In the case of the preferred model, TRE3T as explained earlier in this section, the interpretation is not straightforward, because the effect of loan impairment charges on inefficiency is estimated individually for each bank in the sample and, as presented in Figure 4.8, there is an evident variation of this effect among banks. The effect of loan impairment charges is negative and significant at 10 per cent level of significance when they are included in the goal function, TRE1T (the effects is on total costs), indicating that higher level of loan impairment charges would decrease total costs, which is the opposite of the expectations. However, this variable is positively associated with banks' inefficiency (statistically significant at 1 per cent level of significance) in the formulations when loan impairment charges enter the variance of u_i (TRE2T), which is in line with the expected effect. Briefly, these findings support the important role of loan impairment changes regarding the banks' CE.

Table 4.7 presents the average technical change and its component across countries and time for the preferred random parameter model (TRE3T). The first column presents the average technical change, which is calculated using the equation above the table. The average technical change can be decomposed in three types of technical change: (i) radial (neutral) technical change; (ii) disembodied (nonneutral) technical change and (iii) scale augmenting technical change (Ashton, 1998). The radial technical change accounts for reductions in total costs holding the marginal substitution between factors constant, which is an equivalent of Hick's neutral technical change. Since, this type of technical change is $-(\rho_T + \rho_{TT}T)$, it quantifies the shifting of the cost frontier towards the origin (Table 4.7 column 3). The scale augmenting technical change reflects the changes in the sensitivity of total cost to variations in the efficient scale of production, namely the technical change linked to changes in scale of banks within sample. It is calculated as $-(\theta_{1T}\overline{lnLoans} + \theta_{2T}\overline{lnOEA})$, hence If the coefficient is positive for all *i*, the scale of production which minimizes average cost for a given output mix is increasing over time (Table 4.7 column 4). The disembodied technical change shows the change in the efficiency or quality of the factor inputs in the production process. It is $-(\vartheta_{1T}\overline{lnInterest} + \vartheta_{2T}\overline{lnCapital})$ and explains the sensitivity of total cost to variations in unit input prices (Table 4.7 column 5). Hence, if this coefficient is positive the share of input *i* in total cost is decreasing over time. This would represent a shift towards the cost frontier or homogenization within the sample.

Overall, significant average technical change is observed as shown in the last column of Table 4.6, because all the coefficients related to the time trend (including the cross products of time trend with the outputs, input prices and itself) are statistically significant, except the cross product of time trend and loans. All the countries in the sample exhibit certain levels of technical progress per annum ranging from 1.4 per cent (Bulgaria) to 2.2 per cent (BiH) (Table 4.7 column 2), while the overall effect in SEECs over the period 2000-2012 is 1.8 per cent.

Table 4.7 Average estimates of technical change for banks in SEE across countries and time (2000-2012)

$$-(\rho_T + \rho_{TT}T + \theta_{1T}\overline{lnLoans} + \theta_{2T}\overline{lnOEA} + \vartheta_{1T}\overline{lnInterest} + \vartheta_{2T}\overline{lnCapital})$$

Country	Technical	Radial	Scale Augmenting	Disembodied
Albania	0.0165	0.0093	0.0030	0.0043
BiH	0.0223	0.0093	0.0063	0.0067
Bulgaria	0.0140	0.0041	0.0046	0.0053
Croatia	0.0185	0.0093	0.0044	0.0048
Macedonia	0.0196	0.0093	0.0050	0.0053
Montenegro	0.0130	-0.0011	0.0074	0.0067
Serbia	0.0174	0.0041	0.0066	0.0067
Slovenia	0.0168	0.0093	0.0036	0.0038
Year				
2000	0.0477	0.0406	0.0034	0.0037
2001	0.0433	0.0354	0.0035	0.0044
2002	0.0392	0.0301	0.0036	0.0055
2003	0.0348	0.0249	0.0039	0.0059
2004	0.0304	0.0197	0.0044	0.0063
2005	0.0255	0.0145	0.0046	0.0064
2006	0.0202	0.0093	0.0048	0.0061
2007	0.0148	0.0041	0.0053	0.0054
2008	0.0095	-0.0011	0.0062	0.0045
2009	0.0045	-0.0064	0.0058	0.0050
2010	-0.0003	-0.0116	0.0058	0.0055
2011	-0.0052	-0.0168	0.0060	0.0055
2012	-0.0098	-0.0220	0.0063	0.0058
Overall SEECs (2000-2012)	0.0178	0.0076	0.0049	0.0054

Note: Coefficients are presented using reverse sign ("-" in front of the equation), so that a positive technical change is interpreted as a factor that contributes in lowering the total costs.
Appendix to Chapter 4, Section 4.4, in details, presents the technical change and its component across countries and time for the random parameter model (TRE3T)
Source: Author's own calculations

The spread of this range across countries is not wide, suggesting similar technological progress. An interesting finding is the effect of technical change analysed through time. Specifically, as shown in Table 4.7 in the bottom panel, the effect of technical change is positive in the period 2000-2009, but the positive effect of technical change on cost reductions diminishes through time. In other words, this effect is 4.8 per cent in 2000 with decreasing trend in the following years to reach only 0.5 per cent in 2009. From then onwards (2010-2012) the technical progress has a negative, but negligible effect in 2010 (0.3 per cent) and this negative effect increases in the last two years when in 2012 it becomes 1 per cent. Hence, in the last three years of the analysis the lack of technical progress leads to increase of the total costs of the banks in SEECs. The reason for the negative effect of technical change on total costs (increase in total costs), as presented in Table 4.7 bottom panel, is the calculated negative effect of the radial technical change, which quantifies the shifting of the cost frontier to the origin. Moreover, radial technical change is the dominant component of the overall technical change. However, given that scale augmenting and disembodied technical change are always positive, although their effect is small, these indicate a steady "catching up" to the average state of technology (Ashton, 1998).

4.5.4 Cost efficiency in the banking sector in SEECs

This subsection discusses the cost efficiency estimates for the banks in the eight SEECs during 2000-2012 on the sample of 153 banks. Prior to the presentation of the empirical results it is important to note that CE estimates as a part of the error term are not estimated along with their standard errors (more on this issue see Kumbhakar and Lovell, 2000 and Greene, 2008). As a result, we cannot test whether any difference in CE across countries and through time is statistically significant. This of course presents a caveat of this type of empirical analysis.

Table 4.8 presents the estimated cost efficiencies of the banks across SEEC countries and time obtained from TRE3T, while Figure 4.9 and Figure 4.10 present the average cost efficiency across countries and time, respectively.[26] The average estimated banks' cost efficiency in SEECs for the observed period is 87.5 per cent, in particular the average banks' cost efficiency across countries ranges from 81.5 to 90 per cent. It is a striking finding that the average banks' cost efficiency in SEECs is the highest at the beginning of the investigated period, 2000, at 88.8 per cent while the lowest average efficiency is at the final year of analysis, 2012, at 86.2 per cent. In general, the findings suggest that there is a deviation from the full efficient level (100 per cent)

[26] The estimated cost efficiencies from the other TRE models are presented in Appendix to Chapter 4, Section 4.3.

Table 4.8 Cost efficiency estimates across country and time based on TRE3T model (in %)

Country/Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Avg
Albania	84.4	80.3	83.2	84.3	86.4	88.8	89.3	89.3	88.7	89.1	89.6	89.9	90.6	87.2
BiH	87.5	86.8	87.1	87.6	90.1	89.9	90.1	89.8	89.9	89.8	88.9	88.9	86.8	88.7
Bulgaria		86.9	85.8	87.1	88.4	88.2	87.4	88.4	87.9	87.0	87.0	87.1	86.9	87.3
Croatia	90.1	88.8	88.0	89.0	88.7	88.9	89.2	89.1	89.3	89.0	89.0	89.1	88.9	89.0
Macedonia	89.6	87.3	85.7	88.8	89.8	89.7	90.1	88.9	88.3	88.7	88.1	88.9	88.7	88.7
Montenegro				86.4	86.3	86.6	87.6	88.7	88.3	86.2	87.3	88.3	88.5	87.4
Serbia			83.2	82.9	78.8	82.8	84.2	85.9	88.0	80.2	78.2	76.3	75.4	81.5
Slovenia	89.3	87.2	88.2	88.9	91.0	91.0	90.7	90.5	88.9	91.2	91.5	90.4	90.6	90.0
Average	88.8	86.9	86.6	87.1	87.2	88.0	88.3	88.7	88.7	87.2	86.7	86.4	86.2	87.5

Source: Author's own calculations

The Slovenian banking sector is the most cost efficient with an average of 90 per cent, while the Serbian banking sector is the least cost efficient with an average of 81.5 per cent. The banking sectors of Croatia, Macedonia and BiH are characterized by a similar cost efficiency of around 89 per cent, while the banking sectors of Montenegro, Bulgaria and Albania are by two percentage points less efficient. Although there is a gap for improvement of the banks' CE in SEECs of between 10 and 18.5 per cent, it seems that the banking sectors in SEECs are highly competitive.

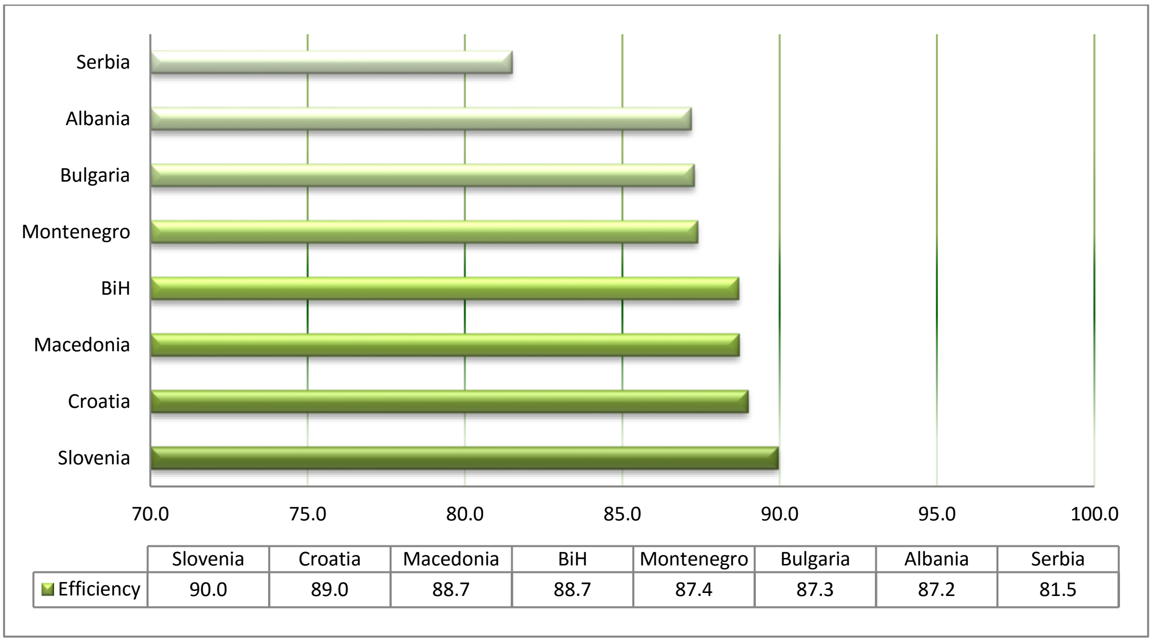

Figure 4.9 Average cost efficiency across countries based on TRE3T (in %)

Source: Author's own calculations

Figure 4.10 presents the trend of CE in the banking sectors in SEECs for the period 2000-2012. It can be noticed that the countries, except Serbia and Albania (the latter only in the early period), do not exhibit noticeable differences in their CE and, as mentioned above, we cannot discuss whether these differences are statistically significant, given that the standard errors are not available. The banking sector of Slovenia remains the most cost efficient, although it is characterized by slight decreases in CE prior to the EU accession until the financial crisis in 2008 (2004:91% and 2008:89%), as well as during 2011-2012 which has been a turbulent period for the this banking sector.

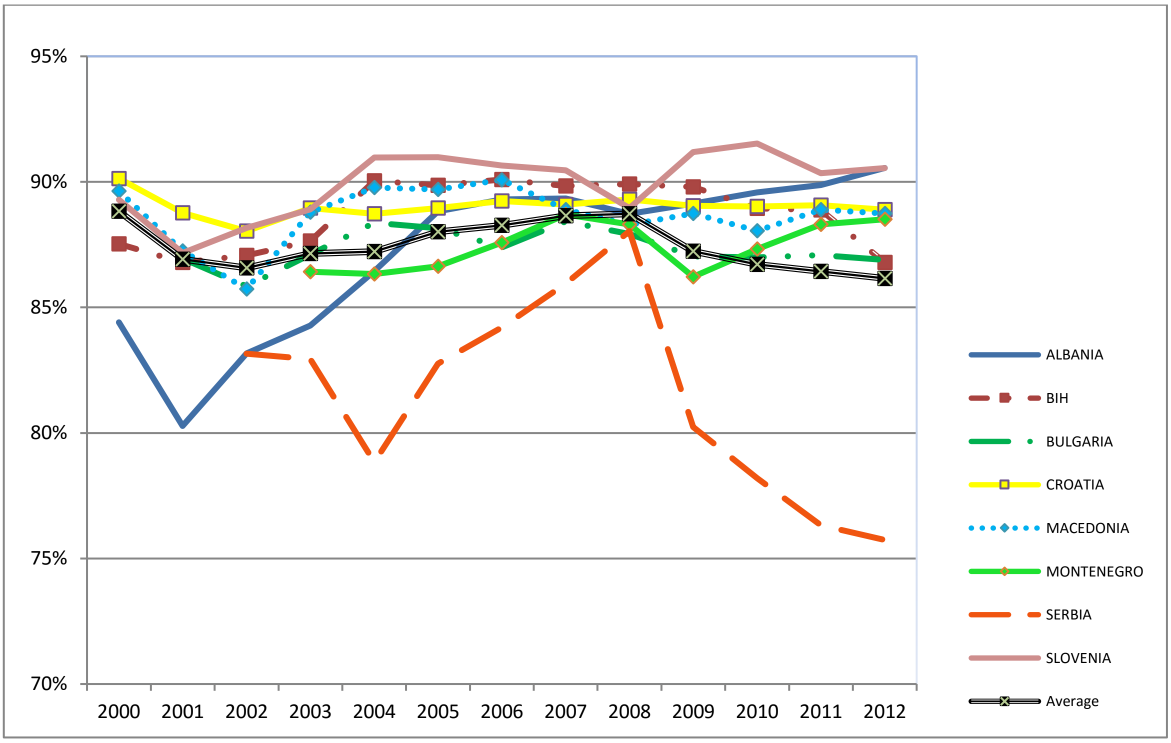

Figure 4.10 Cost efficiency in the banking sector in SEECs through time based on TRE3T

Source: Author's own calculations

The highest improvement in terms of banks' CE is found in the banking sector of Albania, whose banks' CE has been improving continuously from 2001 until the financial crisis (overall in this period by 11 per cent). After the financial crisis, the positive trend of banks' CE in Albania again reappears. This substantial improvement arguably may be due to the regained confidence in the banking sector, after the systemic failure of this banking sector as a result of the Ponzi schemes in 1997. The Serbian banking sector has a decreasing trend in terms of CE until 2004, followed by a trend of substantial improvement in CE until the financial crisis, since when CE is considerably decreased (2008: 88% and 2012: 75.7%). The banking sector of Croatia, BiH Bulgaria, Macedonia and Montenegro demonstrates a constant level of banks' CE during the whole period 2000-2012, even for the period of the financial crisis, which indicates that this banking sector has remained to some extent immune on the crisis with respect to CE.

4.5.5 Comparison of cost efficiency results with other studies

Table 4.9 presents the estimates of the average bank CE in transition economies obtained from the studies reviewed in Chapter 3. As it can be noticed, none of these studies analyse CE for Albania, while BiH, Serbia and Montenegro are considered in one study only, where Serbia and Montenegro are analysed as a single country. By the same token, Macedonia and Bulgaria are rarely included in the empirical studies on efficiency in banking in transition economies.

The estimates of the average CE of banks in SEECs obtained from our empirical analysis and those the reviewed studies are presented in Table 4.9 for the purpose of comparison. The higher figures for our study could be due to the following two reasons. First, the period of analysis covers a later stage of transition (2000-2012) and an evolution (improvement) in CE may be expected. Second, there are the differences in the methods of investigation, as explained earlier in this chapter and shown in the table. In particular, the use of RPMs in the context of SFA control for the unobserved heterogeneity across the banks, which was not the case in the reviewed studies, where heterogeneity and inefficiency were largely confounded, and treated as "inefficiency". Almost all of the reviewed studies in Table 4.9 use the BC models (1992, 1995) in their empirical analysis, which exhibited many problems when applied to our dataset. Only, Kosak and Zoric (2011) use the true random effects model by Greene (2005b) but they incorrectly introduce the time trend in their analysis. However, their results for Slovenia of 87 per cent of cost efficiency in the banking sector are similar with our CE estimates for Slovenia of 86 per cent and 89 per cent according to TRE1T and TRE2T, respectively.

Table 4.9 Average cost efficiency (%) in the banking sector in transition economies and the methods of investigation in selected studies

Country	Kraft et al. (2002)	Fries ansd Taci (2005)	Rossi et al (2005)	Kasman and Yildirim (2006)	Yildirim and Philippatos (2007)	Mamatzakis et al (2008)	Staikouras et al (2008)	Kosak and Zajc (2006)	Kosak et al. (2009)	Kosak and Zoric (2011)	Cost efficiency from this study - using RPMs
Bulgaria		62					67				85-87
BiH							58				85-89
Croatia	66	72			77-84		63				86-89
Macedonia		60			73-79		53				86-89
Slovenia		78	87 – 92	74-87	74-84	69		84	91	82-89	86-90
Serbia and Montenegro							63				$80-82^{S}$ $85-87^{M}$
Methods of investigation (all the studies use the intermediation approach and estimate cost efficiency)											
Period of analysis	’94-00	’94-’01	’95-02	’95-02	’93-00	’98-03	’98-03	’96-03	’96-00	’98-07	‘00-12
Type of analysis	Panel	Panel	Panel	Panel	Panel	Pooled	Pooled		Panel	Panel	Panel
Estimator	BC	BC	BC	BC	BC	/	/	BC	BC	BC, TRE	RPM
Functional form	FF	T	FF	T	FF	T	T	T	T	T	T

Note: S stands for Serbia, while M for Montenegro, because in our study the two countries are examined separately; BC stands for Battese and Coelli models; TRE denotes true random effects model; RPM denotes Random Parameter Model; FF stands for Fourier-Flexible functional form and T stands for translog functional form.

4.6 CONCLUSIONS

This chapter empirically investigated the cost efficiency in the banking sector in eight SEECs (Albania, BiH, Bulgaria, Croatia, Macedonia, Montenegro, Serbia and Slovenia) in the period 2000-2012 using a sample of 153 banks. The methods of investigation applied in this chapter resulted from the theoretical discussion in Chapter 2 and the empirical evidence in the literature reviewed in Chapter 3. In particular, cost efficiency is estimated using the SFA, specifically the Random Parameters Models, including the special case of the true random effects model by Greene (2005), because of their superior characteristics as discussed in Chapter 2, that is they allow for estimation of time-varying CE and control for latent heterogeneity. However, as presented in Chapter 3, Battese and Coelli (1992, 1995) are the most widely used models in the studies of cost efficiency in banking in transition economies. Therefore, this strand of models was estimated in our empirical analysis as well, mainly for purpose of comparison. However, while estimating the Battese and Coelli models we encountered certain “signals” which raised some concerns regarding the validity of these models. Moreover, the limited statistical inferences available for the BC models provided an additional reason for preferring the RPMs over the BC models. The preferred model among the family of RPMs was the model where the macroeconomic and industry-specific variables influence the frontier while the bank-specific variables affect the bank’s inefficiency. Regarding other issues related to the methods of investigation, and based on the discussion in chapters 2 and 3, the estimated model had a translog functional form, the estimation was conducted under common frontier, and the bank was considered to be an intermediary.

The main findings can be summarized as follows. The banking sector of Slovenia is the most efficient with average CE of 90 per cent, while the banking sector of Serbia is the least efficient with average CE of almost 81 pe rcent. The Croatian, Macedonian and BiH banking sectors have average CE of almost 89 per cent, while the Albanian, Bulgarian and Montenegrin banking sectors have average efficiency of almost 87.5 per cent. During the period of analysis (2000-2012), the banking sectors in SEECs experience improvements in their CE but the differences in the CE of these countries are not high. The exception is the Serbian banking sector which has not managed to catch up with the CE of other countries. The highest improvement in CE is found in the banking sector of Albania and the highest decline in Serbia. The individual estimates of CE for each bank across time are used in the empirical analysis in Chapter 6.

In terms of technical change, the empirical results suggested that all the countries in the sample exhibited significant levels of technical progress during 2000-2012, which lowered the total costs of banks. The technological progress was found to be similar in all the countries under consideration. Specifically, in SEECs over the period 2000-2012, the overall effect of technical change in reducing total costs was 1.8 per cent per annum. An interesting finding is the effect of technical change analysed through time. Specifically, the effect of technical change is positive in the period 2000-2009, but the positive effect of technical change on cost reductions diminishes through time.

Considering the research question regarding the impact of ownership, EU accession and the last financial crisis on the cost efficiency of banks in SEECs, our empirical findings suggested that ownership structure and the EU membership do matter, while the last financial crisis does not. Specifically, mixed and foreign banks were found to be more cost efficient than the domestic banks, which is consistent with the expectations that the entry of foreign capital would contribute to enhancing the positive impact of the introduction of new technologies, know-how expertise, new financial products, and managerial and organizational skills and techniques. Moreover, the EU member countries have a lower total costs compared to the other analysed countries. This is expected, since the banks operating in the single EU market face severe competition, which forces them to be more cost efficient in order to survive and grow (the Slovenian banking sector being a good example).

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CHAPTER 5

DETERMINANTS OF MARKET SHARE IN BANKING: DEVELOPMENT OF A FRAMEWORK FOR ANALYSIS

5.1 INTRODUCTION

The traditional industrial organization literature argues that market structure affects firms' conduct which in turn influences their performance. To date a vast number of theoretical and empirical studies have investigated the effect of market structure on competition and performance in the banking sector from different perspectives but, to our knowledge, only a few studies have investigated the determinants of "market structure".[27]

[27] We have searched the extensive Google Scholar and EconLit, the American Economic Association's electronic bibliography, for studies related to determinants of bank's market share, and found only a few studies which explicitly analyse market share. These will be discussed in Section 5.3.

The importance of market structure in banking is evidenced by numerous theoretical and empirical studies which analyse the effect of market structure at macro and micro level variables. For example, economic theory provides contrasting predictions about the effect of banking sector concentration on the well-being of the economy as a whole, namely the "concentration-stability" and "concentration-fragility" hypotheses.[28] At the microeconomic level, market structure and competition may affect a bank's access to finance which in turn influences firm performance and development (Pagano, 1993; Petersen and Rajan, 1995; Cetorelli and Peretto, 2000; Guzman, 2000; Cetorelli and Gambera, 2001; Bonaccorsi di Patti and Dell'Ariccia, 2003; Beck et al., 2004).

According to the Structure-Conduct-Performance (SCP) paradigm (Mason, 1939 and Bain, 1951 and 1956), higher concentration in the banking industry leads to higher market power which results in a lower credit supply and a higher cost, thus restricting the firm's growth. Some empirical studies provide evidence in favour of this paradigm, namely that concentration is associated with higher interest rates and/or credit rationing, which results in less new firm creation (Hannan, 1991; Jayaratne and Wolken, 1999; Boot and Thakor, 2000; Guzman, 2000; Ongena and Smith, 2001; Black and Strahan, 2002; Scott and Dunkelberg, 2005 and Elsas, 2005).

[28] The former view argues that a more concentrated banking structure leads to greater bank stability because of better diversification (Allen and Gale, 2004) and because of higher profits resulting from economies of scale (Demirgüç-Kunt and Levine, 2001) serve as a buffer against adverse shocks, hence in more concentrated banking sectors the incentive for excessive risk taking is reduced (Hellman et al., 2000). According to the "charter value hypothesis" (Keeley, 1990; Demsetz et al, 1996) banks behave in a risk-averse manner in order to keep their competitive advantage as their charter value increases (when banks can earn monopoly rents) by holding more capital in order to preserve it. In this case, therefore, higher concentration prevents excessive risk taking which implies a more stable banking system (Boyd and De Nicoló, 2006; Carletti and Hartmann, 2003). On the other hand, the "concentration-fragility" view maintains that more concentrated banking systems are more prone to fragility and systemic distress (Beck et al., 2006), because banks exert market power through higher interest rates, which may lead to higher levels of non-performing loans resulting from the enhanced risk-taking behaviour of borrowers (Boyd and De Nicoló, 2005). Tabak (2012) argues that the "competition-risk" trade-off disappears only when banks solve the optimal contracting problem arising from the multiple principal-agent relationships - banks are agents to their depositors and, at the same time, the principal to their borrowers. Additionally, banks in highly concentrated banking systems are "too big to fail", hence in times of potential failure they are heavily subsidised which, in turn, increases the incentive for excessive risk-taking (Boyd and Runkle, 1993; Mishkin, 1999). More on the concentration-stability and concentration-fragility controversy can be found in the comprehensive theoretical and empirical reviews by Beck (2008), Carletti (2008) and Carletti et al. (2002).

On the other hand, information asymmetries and agency costs which lead to adverse selection, moral hazard and hold-up problems, lead to a positive or nonlinear relation between market power and access to loans for opaque borrowers (Petersen and Rajan, 1995 and Zarutskie, 2003). Furthermore, Cetorelli and Peretto (2000) develop a dynamic general equilibrium model of capital accumulation where credit is intermediated by banks operating in a Cournot-type oligopoly, and demonstrate that concentration has both positive and negative consequences for firms' access to finance. In particular, higher concentration in banking shrinks the amount of loanable funds; however, the borrowers screening incentives are higher, leading to efficient lending. On this basis Beck et al. (2004) argue that, compared to perfect competition or monopoly, oligopoly is the optimal market structure in banking.

The market structure in banking may also affect the banks' performance (profitability) due to market power (SCP Paradigm) or higher efficiency (Demsetz, 1973 and 1974). There are empirical studies in banking that support the SCP paradigm (Gilbert, 1984; Berger and Hannan, 1989; Molyneux and Thornton, 1992; Athanasoglou, 2006; and Pasiouras and Kosmidou, 2007), and there are also studies that do not support this paradigm (i.e., they do not find a significant relationship between industry concentration and bank profitability (Maudos, 1998; Naceur, 2003 and Staikouras and Wood, 2003).

Demsetz's (1973, 1974) work challenges the concentration-collusion-profitability view and argue that the superior efficiency of large firms, rather than market power, explains the positive relation between profitability and concentration. In the context of banking, Demsetz's efficient structure theory (as opposed to the SCP paradigm) postulates that due to the cost advantages of the larger banks (economies of scale and/or scope) loan interest rates are lower and deposit rates are higher (Van Hoose, 2010). As with SCP, there are empirical studies that support the efficient-structure hypothesis in banking (Smirlock, 1985; Goldberg and Rai, 1996; Punt and Van Rooij, 2001). Evanoff and Fortier (1988) and Berger and Hannah (1993) find empirical evidence suggesting that the two views are complementary rather than mutually exclusive.

The importance of market structure and its implications at macro and micro levels discussed above, does not hide the fact that there is little empirical evidence on the determinants of market structure in banking. This chapter, therefore, aims to identify the potential determinants of market structure in banking by drawing on several related strands of theory as discussed in Section 5.2. Given that the focus of this thesis is the banking industry only, the use of standard measures of the structure of industries (market concentration measures such as HHI and CR_n) are not appropriate, given the limited number of countries included in our analysis (a total eight). However, even with higher number of countries the imperfections of these indices weaken the analysis. Evanoff and Fortier (1988), considering CR3, emphasize that the arbitrariness of taking three firms and the implicit assumption of the equal impact of these largest firms on performance, something which in turn may lead to inaccurate policy implications. Van Leuvensteijn et al. (2011) emphasize that HHI does not distinguish between large and small countries. Beck et al. (2008) argue that HHI and CR3 are rough indicators which do not incorporate bank ownership, treating domestic and foreign banks the same. Berger et al. (2004) emphasize that recent studies find a different competitive effect for large and small banks, but the empirical studies still make use of such concentration measures as indicators of market structure. Given that these indices are primarily based on individuals' market shares, higher market shares, ceteris paribus, suggests a more concentrated and less competitive market though this has to be treated with caution as the degree of competition, or concentration, in a market depends not just on the market share of one or a few large firms, but also on the share of remaining firms.

Given the arguments above this thesis uses "*market share*" (hereafter MS) as an indicator of the degree of competition in the banking sector. Additionally, while banks may be able to influence their MS, but they do not decide on market structure individually. According to Aghion and Stein (2008), MS is an essential target for many firms, especially if the firm's manager cares about the current stock price, and banks often assess their performance relative to each other on this basis (Berger and Bouwman, 2013). A bank's MS arguably reflects its competitive position (Berger and Bouwman, 2013), its market power (Relative Market Power Hypothesis; Shepherd 1986; Berger, 1995) and efficiency (Demsetz, 1973; Smirlock, 1985; Boone, 2000, 2004). By investigating determinants of a bank's MS, we may examine possible systemic variations in determinants across different bank size-classes, which is not possible when aggregated concentration indicators are used and banks exhibit different risk-taking behaviour.

From a policy point of view, the examination of the determinants of MS enables the regulators to gain and improve their knowledge of the overall market structure in banking. Berger and Bouwman (2013) argue that although the battle for MS is a zero-sum game, it matters to regulators because it affects banks' behaviour. Consequently, they will be able to influence particular determinants in order to regulate concentration and influence the behaviour of banks in the desired direction. This issue is further developed in Chapter 7.

In order to develop the conceptual framework for the determinants of MS in banking we use the few existing empirical studies as the point of departure in Section 5.2. Following the review of these studies, the conceptual framework of this part of the thesis, highlighting a range of potential determinants of MS, is developed in Section 5.3 using an eclectic approach for identification of the determinants because the theory on this subject is underdeveloped. To this end, we identify two broad categories, the "inside" and "outside" determinants of MS with the former referring to factors under the control of a bank and the latter to factors beyond the direct control of the bank, in particular regulatory and supervisory. The aim of this section is to facilitate the formulation of a model to investigate the determinants of a bank's market share which will be estimated in Chapter 6. Finally, conclusions will be presented in Section 5.4.

5.2 REVIEW OF EMPIRICAL STUDIES INVESTIGATING MARKET SHARE

This section offers a critical review of three major studies that have explicitly focused on a bank's MS (Gonzalez, 2009; Berger and Bouwman, 2013; and Stiroh and Strahan, 2003). Although the aim of the latter two studies are different from ours, their use of MS as the indicator of market structure serves as the basis for developing the conceptual framework of this study. The model estimated in Chapter 6 builds on and extends the work of Gonzalez (2009) which, to our best knowledge, is the only study investigating determinants of MS in banking in a similar manner to this thesis; hence the literature review starts with this study.

a. ***Gonzalez (2009).*** This study investigates the determinants of market structure by using both MS and concentration indices, but it is only the former that is considered here. It examines how the bank's efficiency and political economy variables (regulation[29], quality of institutional development and macroeconomic variables) influence the market structure in banking in 69 countries, covering more than 2,500 banks over the 1996–2002 period. He considers efficiency as the only factor which can be influenced by a bank and its managers (what we will refer to as the "inside bank determinant" of MS. While in our study this is also one of the main variables of interest, particularly given a significant part of this thesis is devoted to the estimation of banks' efficiency, we also aim to investigate whether there are other potential "inside" bank determinants of MS. However, similar to Gonzalez, we aim to go beyond "inside" bank determinants by analysing the effect of regulation and macroeconomic environment on a bank's MS.

Gonzales estimates banks' efficiency scores using the non-parametric approach of Data Envelopment Analysis and country-specific frontiers against which an individual bank's efficiency

[29] This includes indices reflecting the ease of entry into banking, the existence of an explicit deposit insurance scheme, moral hazard, official supervisory power and the presence of private monitoring,

is measured. He emphasizes that *"rather than compare efficiencies across banks in different countries, we analyze differences in levels of efficiency between banks in the same country, and consider whether the influence of efficiency differences on the structure of a national market varies across countries, depending on legal and institutional frameworks (p. 741)."* To being with, as already discussed in Section 2.5, efficiency estimates using a country-specific frontier cannot reflect which country has more efficient banks, instead the only possible comparison is in which countries the banks operate at an efficiency level closer to the best-practice bank within that country. However, given that he uses panel data models for his empirical analysis, it requires efficiency estimates obtained under a common frontier, so that efficiency estimates which are comparable across countries are used in the analysis (as argued by Berger, 2007 and further discussed in Section 2.5, and also applied in Chapter 4). Consequently, it is likely that the efficiency scores included in the analysis are problematic.

In order to conduct the empirical analysis he uses a static model estimated by two-stage least squares random-effects estimator (EC2SLS) to account for: (i) the presence of unobserved bank-specific effects, (ii) the potential simultaneity between banks' efficiency and market structure (market concentration and MS), and (iii) the potential endogeneity of the political economy variables. To control for endogeneity the author employs the instrumental variable method. For example, as an instrument for banks' efficiency the number of observations in each country is included in the analysis, because of the finding of Zhang and Bartels (1998) that efficiency levels estimated using DEA are negatively related to sample size. For political economy variables the author uses the instruments proposed by Barth et al. (2004) which include: the legal origin (English, French, German, Scandinavian, and Socialist legal systems), latitudinal distance from the equator, and religious composition (percentage of population in each country that is Roman Catholic, Protestant, Muslim, or other). However, the theoretical justification for the instruments is unclear and moreover he does not provide any diagnostic evidence of the strength of these instruments, which is a major weakness given the possible problems that can arise with weak instrumentation (Wooldridge, 2009 pp. 514-516).

The empirical findings of Gonzalez (2009) are in line with the efficiency-structure hypothesis discussed in Section 5.1, that is, a bank's efficiency is found to be a statistically significant determinant in both the market concentration and the MS equations. His empirical findings for the political economy variables suggest: (i) higher barriers to entry and a better-quality legal environment increase both market concentration and MS; (ii) greater private and official supervision favour lower market concentration and a smaller MS; (iii) restrictions on activities of banks and the presence of explicit deposit insurance have an ambiguous effect because the estimated effects are not consistent in the market concentration and MS equations.

Besides the analysis of the main effect of political economy variable on concentration and MS, Gonzalez (2009) also examines the effect of the political economy variables via bank's efficiency (using interaction terms, one at a time, between the bank's efficiency and each of the political economy variables). The inclusion of single interaction terms is widely used in the empirical literature especially when regressors are highly correlated, as Gonzalez explains. However, the correlation matrix presented in his study does not suggest that the individual variables are highly correlated, and the interaction terms are not included in the correlation matrix. Hence his rationale for "one at a time" inclusion of interaction terms is problematic. Indeed even if the variables are highly correlated, excluding a relevant variable is not appropriate as it can lead to specification bias (Wooldridge, 2009 p. 93). The empirical findings of these alternative empirical models with the interaction terms[30], give a negative and statistically significant coefficients on the interaction terms in the case of stricter entry restrictions and the presence of explicit deposit insurance, which do not support the efficiency hypothesis, but positive and significant coefficients of the interaction terms for greater private monitoring and a better-quality institutional environment, which are consistent with the EFS hypothesis. These, together with the findings of the direct effects discussed above, imply that the effects of regulation on MS may be explained by factors other than those related to banks' efficiency.

[30] The interpretation of the effects of the interaction terms is as follows: a positive (negative) coefficient on an interaction term suggests an increased (decreased) effect of efficiency on market share depending on the size of the political economy variable is in place (i.e.=1).

In summary, Gonzalez (2009) presents a solid foundation to build on in answering the research question related to the determinants of market structure in banking in SEECs. However, we aim to develop both theoretical and empirical dimensions of this paper. First, Gonzalez (2009) relies on the market structure–performance relationship and the efficiency hypothesis, while we use the efficiency hypothesis to recognize the potential simultaneity between market share and efficiency. We aim to go beyond these traditional views by elaborating the theoretical underpinnings of the new measure for competition proposed by Boone (2000, 2008a, 2008b), which is further discussed in Section 5.3.1. Second, as argued by Gonzalez, his analysis with respect to regulation is a purely empirical exercise but this chapter aims to derive testable hypotheses in this regard using studies analysing the effect of regulation on banks' performance and risk-taking. Given that Gonzalez's empirical findings suggest that the effect of regulation on market structure is for reasons other than bank's efficiency, the possibility of other bank-specific characteristics being potential factors through which regulation may affect competitiveness in banking should be explored. Third, following from the previous arguments, Section 3 of this chapter examines whether other "inside" bank characteristics such as quality, risk-taking, capital and ownership structure are important variables to be considered. Finally, from empirical perspective Gonzalez assumes a bank's MS to be of a static nature, an arguably unrealistic and restrictive assumption, especially for SEECs given the discussion in Section 1.4 of the extensive changes taking place during the transition period in these countries. This issue is further addressed in Chapter 6.

b. ***Berger and Bouwman (2013).*** Recently, Berger and Bouwman (2013) examine the effects of bank capital on two dimensions of bank performance (the probability of survival and changes in market share) during normal times and also during different types of financial crises for the US banking sector (using sub-samples according to size) covering the period 1984-2010. The rationale for this empirical analysis is in the divergent views in the literature on the effects of capital on a bank's performance, the size of these effects, and the relevance of different types of crises (banking crises and market crises) and normal times. Given that the focus of this part of the thesis is on the determinants of a bank's MS, this review is concerned only with the effects of capital on a bank's MS, or its competitive position as described by the authors.

The hypothesis tested in this study is that capital enhances a bank's MS during crises and normal times. In order to test this hypothesis they regress the percentage change in MS on the bank's average pre-crisis capital ratio interacted with separate dummies[31] for banking crisis (initiated in the banking sector), market crisis (initiated in the financial markets, excluding the banking sector) and normal times, and a set of control variables (proxies for risk and opacity, size and safety net protection, ownership, organizational structure and strategy, competition, and location). An important issue to note is that profitability is excluded from the MS equation as compared to survival equation (Gonzalez, too, does not include profitability even though his theoretical framework is the market structure-performance literature). Their empirical strategy is to examine the effect of a bank's pre-crisis capital on its performance during a crisis. The rationale for this is twofold: (i) the crisis is unpredictable, and (ii) such an approach allows for the mitigation of the potential simultaneity between MS and capital, since lagged capital and current MS are less likely to be jointly determined (alternative models using instrumental variables are also investigated in this study).

Berger and Bouwman (2013) define their dependent variable as the percentage change in a bank's MS, the bank's average MS during a crisis minus its average MS over the eight quarters before the crisis, normalized by its average pre crisis MS and multiplied by one hundred.[32] To estimate the empirical model they use ordinary least squares (OLS), with robust standard errors (clustered by bank) to control for heteroskedasticity as well as possible correlation between observations of the same bank in different years.[33] They split the sample into small, medium and large banks and estimate the models for each of the three defined groups.

In general, the empirical findings of Berger and Bouwman suggest that capital enables banks to improve the percentage change in their MS and the effects are argued to be economically

[31] Capital variable is not included in the model given that three interaction dummies (one for each "period") are included in the model. Their main approach pools the data to treat banking crises, market crises and normal times as a separate group.
[32] Given that in the period under investigation the authors have identified two periods of banking crises, three periods of market crises and two normal time periods, each bank has a maximum of seven observations.
[33] The regressions also include individual crisis and normal time dummies, which act as time fixed effects.

reasonable, with the effect being strongest for small banks. The findings could be summarized as follows: (i) higher capital facilitates small banks to improve their MS at all times (banking crises, market crises, and normal times) and (ii) higher capital supports medium and large banks to enhance their market shares only during banking crises. They explain the economic rationale behind the strongest effect of capital being on the MS of small banks in the following way. A bank's depositors are most concerned with the stability of the bank and higher level of capital deals with their concern since during crises it is the main defence against failure. Hence, to be a small bank with higher capital ratio during crises is a signal of stability and a competitive advantage over the lower-capitalized banks, which in turn leads to customers migrating from lower capitalized banks to higher capitalized banks, enhancing the MS of the latter. Furthermore, Berger and Bouwman find that capital is essential for the survival of small banks. Their literature review provides the evidence that small banks are mainly involved in relationship lending where long-term bank–borrower relationships are essential for value creation.

The threefold relevance of this study for our research are: (i) the capital ratio should be considered as an "inside" bank determinant of MS; (ii) capital is considered to be endogenous, as a bank's MS could affect its capitalisation choice; and (iii) there is a systemic variation in the effect of the capital ratio on MS by size of the bank in both normal times and times of crisis. These issues are considered in Section 6.2 where the empirical model is developed.

c. ***Stiroh and Strahan (2003).*** These authors focus on the post-deregulation period in the US in the 1980s and observing the increased correlation between the above average performers and MS gains in banking industry, they assess the effect of increased competition on the dynamics of the US banking sector for the period 1976-1994. The deregulation in the US refers to removing the regulations controlling interstate banking and interstate branching in the US. This study does not examine the effect of specific regulations on MS which is of interest in this thesis. However, given the rarity of studies on a bank's MS, this study serves to present that (de)regulation has "side effects" on MS allocation among banks. These authors investigate the relationship between a bank's performance[34] and its MS in the subsequent year (as the dependent variable). They find that the relationship strengthens significantly after deregulation (specifically of branching and interstate banking) as competitive reallocation effects mean that assets are transferred to better performers. They conclude that the earlier regulation of U.S. banks blunted the market mechanism and hindered the competitive process, thus suggesting that regulation does affect the allocation of MS among banks. Their results also indicate that relative profitability did not have a significant effect on MS in the period of regulation. They argue that banks' relative performance is more strongly linked to MS gains (in the subsequent year) in the deregulated environment, whereas during the period of regulation, such dynamics are dampened.

The authors also examine the effect of the deregulation in concentrated and less concentrated markets using the HHI.[35] It is expected that regulation enables some banks to be very large and exert greater market power, hence deregulation is expected to matter more in highly concentrated markets. The findings suggest a significant larger increase in the performance-MS relationship in concentrated markets compared to less concentrated markets, which is a priori expected. In addition, they investigate the performance-MS relationship by dividing the sample to "small" and "large" banks and find that although the relationship gets stronger for both large and small banks, the effect is much larger for large banks compared to small banks.

According to Stiroh and Strahan such result may not be only due to the deregulation, but also to cost advantages of large banks, thus highlighting the importance of efficiency for MS (further discussed in Section 5.3.1). They explain that in a static model the relationship between MS and performance reflects basic characteristics of the production technology (economies of scale and scope or market power) where size is primarily taken as exogenous. But their results indicate a

[34] Normalized return on equity (Bank's ROE minus the mean ROE for all banks in the same state and year, divided by the standard deviation of ROE for those banks) in the baseline model and two other performance measures for robustness checks: dummy variable for lagged ROE above median (Dummy variable equals 1 for banks with lagged ROE above the median of their peers, otherwise 0) and dummy variable to distinguish banks with below median costs (Dummy variable equals 1 for banks with below-median costs (the ratio of non-interest expenses to total operating income).
[35] A dummy variable for HHI>1800

dynamic explanation where increased size is the result of successful performance as better performing firms grow at the expense of their weaker competitors. In addition, their findings suggest that a bank's performance is a "better" predictor of future MS after more than five years after deregulation, suggesting that an adjustment period is needed in order for the dynamics of competition to affect market outcomes, that is MS. This finding implies that it is reasonable to consider market share as dynamic, which casts doubt on the use of a static models (for example that of Gonzalez, 2009).

The relevance of this study to our study is threefold. First, this study provides evidence that (de)regulation affects the competitiveness of the banking sector and supports the view that regulation is an "outside" bank determinant. Hence it could be considered as a departure point for developing the conceptual framework in terms of regulation and supervision in banking. Second, the effect of (de)regulation varies across different bank size-classes. Finally, unlike Gonzalez (2009), this study supports the view at MS should be modelled dynamically.

5.3. DEVELOPING A FRAMEWORK FOR ANALYSIS OF MARKET SHARE

Given that, to the best of our knowledge, there is a lack of theoretical and empirical studies on the determinants of a bank's MS (also confirmed by Barth et al., 2006 and Gonzalez, 2009), the aim of this section is to develop a framework which draws on various strands of economic literature and to introduce potential "inside"- and "outside"-bank determinants of MS by looking at various theoretical and empirical studies, which will provide a basis for our empirical model. The "outside" bank determinants (regulation and supervision) are even less investigated than "inside" bank determinants, because the main concern of the literature on regulation in banking is securing safe and sound banking sector with special reference to the consequences of risk-taking on financial stability. The effect of regulation on the MS has not been studied yet. Hence, the aim is to produce intuitive predictions of the effect of potential determinants on a bank's MS and to provide the basis for further investigation of this topic. The result will serve as the basis for the empirical model in Chapter 6.2.

5.3.1 Market share and efficiency (The Boone Indicator)

Boone (2000, 2008a, 2008b) uses the argument that higher concentration does not necessarily imply less competition and proposes a new measure of competition. The empirical literature usually interprets higher measures of concentration (higher HHI or CR_n) as reduced levels of competition. However, Boone demonstrates that a rise in competition does not necessarily lower the HHI (it is not a monotonic function of competition), hence a change in HHI can be a misleading indicator of competition. Given this, he aims to answer two questions: (i) is there a variable which is a monotonic function of competition?; and (ii) if so, can this variable be used to measure competition empirically?

In this framework, competition intensifies when: (i) the number of firms increases as the exogenous entry cost decreases; (ii) the interaction between firms is more aggressive (decrease in conjectural variation[36], products become closer substitutes and there is a switch from Cournot to Bertrand type competition); and (iii) (marginal) costs are reduced. In addition, when firms want to increase competition (as a strategy) or face increased competition (new entry for example) firms with high levels of X-inefficiency could fairly easily cut some of the "excess fat". However, under increased competition, all firms may be forced to become more efficient (even if they do not have much fat). Boone claims that a monotonic indicator for competition is based on *relative* (variable) profit differences[37]. The intuition behind this indicator is that higher levels of efficiency

[36] Firms' conjectural variation is their expectations about the reaction of other firms to an increase in quantity (Bresnahan, 1989 p. 1026). The lower this parameter is, *"the more softly a firm expects its opponents to react to a rise in its output level. Hence the more aggressively (in the sense of higher output levels) the firm will behave (Boone, 2000 p. 9).*

[37] This relative profit differences as originally defined by Boone (2008) is: [P(n'')-P(n)]/[[P(n')-P(n)] where P denotes the level of profit of firm n (for the purpose of this presentation three firms are considered) and firms differ in their efficiency level, that is n''>n'>n. *"More precisely, in any model where a rise in competition reallocates output from less efficient to more efficient firms it is the case that more intense competition raises [P(n'')-P(n)]/[[P(n')-P(n)]. Since this output reallocation effect is a general feature of more intense competition, relative profit differences is a robust measure of competition from a theoretical point of view (p. 1246)."*

are mapped with higher relative profits and an inefficient firm is penalized by earning lower relative profits. This indicator reveals two effects of competition, the reallocation effect and the selection effect. The reallocation effect is that the *relative* (not the absolute) profits of the efficient firm (associated with lower marginal costs) increase compared to an inefficient firm as competition increases. For instance, if intensified competition leads to a reduction in profits, the reduction will be greater for the inefficient firm compared to the efficient firm. Hence, the market mechanism maps the cost differences among firms into profit differences. These effects are higher in more competitive markets than in less competitive markets. In other words, when competition increases, the output is reallocated from inefficient to efficient firms (which implies an increase in market share of an efficient firm given a fixed market size), since efficient firms can compete more aggressively due to cost advantages. In addition, if higher competition reduces (raises) firms' output levels, the fall (rise) in output is bigger (smaller) for less efficient firms. The two effects together reflect the selection effect of competition, which differentiates between "good" and "bad" firms due to cost advantages. When competition increases, the selection effect may result in "bad" firms exiting the market.

Van Leuvensteijn et al. (2011) are the first to apply the Boone approach to measure competition in the loan markets in five major EU countries (France, Germany, Italy, Netherlands and Spain) as well as, for comparison, in the UK, the US and Japan in the period 1994-2004, using *market share* as the dependent variable instead of *relative* profits. Hence, we use their model as the starting point of our theoretical framework and extend it as presented below. As these authors argue, the theoretical underpinnings of the Boone indicator is the efficiency hypothesis, as this hypothesis assigns higher relative profits to higher efficiency and not to monopoly power (Demsetz, 1973). On the basis of Boone's work and following the empirical model of Van Leuvensteijn et al. (2011), therefore, we argue that a bank's MS depends on its efficiency.

5.3.2 Market share and quality (Endogenous Sunk Cost Theory)

Next, based on the endogenous sunk cost theory (Sutton, 1991), we focus on relaxing two important assumptions of the Boone model: (i) homogenous bank products and (ii) exogenous entry costs. Van Leuvensteijn et al. (2011) assume that banks' products are similar over time, because all banks are forced to follow the innovative banks in order to remain competitive. However, the assumption that banks will follow those who innovate and carry out investment in quality is not plausible according to the endogenous sunk theory (Sutton, 1991, 2007). These investments (in quality, R&D and advertising) are primarily undertaken to increase entry barriers and to discourage new entrants, hence enabling the incumbent banks to gain higher market shares as market size increases. Furthermore, these investments provide products of higher quality which in turn enable banks to lure some of the customers of other banks. This theory produces the opposite result to Boone's argument that competition reduces if exogenous entry barriers are increased, because if entry barriers are increased due to endogenously determined sunk costs, competition does not necessarily soften, but the form of rivalry is changed from full price competition to price and non-price competition. Hence, it is important that investments in quality are included in the model, because they can contribute to gaining MS.

Sutton (1991, 2007) analyse the nature of entry barriers (exogenous or endogenous) and their effect on concentration levels. His work is based on the SCP paradigm, but with two important points of difference. The first point relates to difficulties arising from the chain of causation. The original SCP paradigm has been heavily criticized both by empirical researchers and game-theory scholars in the last couple of decades, especially in terms of its one-way causation. SCP did not take into consideration impact of the firms' conduct and performance on market structure. However, treating the firm's conduct only as a link between market structure and performance is challenged by the NEIO scholars. Both the game-theoretic literature and various empirical studies challenge this aspect of the SCP paradigm, emphasizing the possibility of a reverse link from conduct or performance to structure (Bresnahan, 1989; Panzar and Rosse, 1977). Sutton tackles this problem by looking to a reformulation of the basic theoretical model.

The second difference lies in Sutton's treatment of "barriers to entry". Bain (1956) considers entry barriers which are related to the presence of scale economies as exogenous (this assumption is used also in the study of the Van Leuvensteijn et al. (2011) discussed in the previous section). In the environment with exogenous entry (sunk) costs, as the size of the market grows (for instance, with growth in income or population), the incumbent firms are expected to expand in order to reach the minimum efficient scale. In addition, profits are also expected to increase, which will encourage new entrants to the market, if they can earn higher profits (higher than entry costs in equilibrium). Consequently, as the market size increases, the number of firms in the market increases and this in turn is expected to decrease each firm's market share and ultimately to reduce concentration. However, Sutton (1991) argues that industries with low levels of economies of scale (for example the soft drinks industry), have high levels of concentration. Hence, he suggests the presence of other "entry barriers" (such as advertising and R&D spending) which are *endogenously* determined as an outcome of the firm's choice prior to each period rather than exogenously given. Consequently, Sutton emphasizes that it is necessary to model levels of entry barriers as being determined jointly with the level of concentration as a part of an equilibrium outcome. This is a fundamental outcome of the modern game-theoretic literature. The treatment of entry barriers may be the reason why apparently high profits could be consistent with the absence of "explicit" entry barriers, or why high measured profit levels do not seem to stimulate new entry in certain industries.

These endogenous barriers are related to the *increase* in entry costs which could be in a form of investment in quality, R&D, advertising, etc. (for details see Sutton, 1991). This indicates that firms do not compete only on price, but also with other factors. Consequently, in order to "strengthen" these factors and to become more competitive, they may invest in quality to improve their products. The investment in quality will additionally increase the fixed entry cost. The term *"endogenous"* sunk costs refers to how the level of investment is determined in the firm's decision making process. Such investment has two effects: (i) it increases the fixed cost and possibly the marginal costs of production, since production of higher quality products may require higher cost and (ii) it retains the existing customers and attracts new customers. These two effects raise the entry barriers and discourage new entrants more than it would with exogenous sunk costs.

Furthermore, as the market size grows, the incumbents have an incentive to compete with each other in order to capture a part of the “new” market (MS may increase or remain unchanged) by investing further in quality. Hence, the entry costs continuously increase and further discourage new firms from entering the market. Consequently, the ultimate outcome is that although the market size grows, market concentration (which we interpret as market shares of leading firms) will not necessarily decrease – something which is opposite of the outcome of the exogenous sunk costs theory.

The theoretical underpinnings of Sutton’s theory suggest that this theory is applicable to industries where, in addition to price competition, non-price competition is important (Carlson and Mitchener, 2006). As Van Hoose (2010) argues, the banking industry is an industry in which non-price competition is important. The aim of non-price competition is to persuade the customers that a bank’s products and services are of high quality and either retain them or attract them from other banks. Such non-price competition in banking includes the branch network, number of ATMs, walk-in or drive-in services, advertising, number of employees per branch and more recently the availability of internet banking. However, because data on such variables, except for the number of branches, is unavailable for SEECs, this literature review is restricted only to the impact of branches on banking competition.

Hasan and Smith (1997) find that the number of branches may independently explain at least as much of profitability as the more traditional variables used in the extant literature. Calem and Nakamura’s (1998) results suggest higher competition and a decline in market power in U.S. banking due to an expansion in the branch network. Examining the effect of U.S. banking deregulation of the 1990s on branch banking, Dick (2006) finds that competition between banks relies on a significant expansion in the number of branches. This non-price competition, along with changes in regulation, increases the operating costs of banks significantly, but also boosts the earned revenues. Hirtle (2007) empirically investigates the impact of an increasing branch network on a set of indicators of bank performance in the U.S. His findings suggest that there is profit pressure on banks with a medium size branch network. In addition he finds a small amount of support for the impact of branch network size on the overall firm performance, possibly due to the optimization of the branch size network resulting from an increase in non-branch activities. The effect of branches is also prominent in studies on European banking. Cerasi et al. (2002) emphasize that a branch network was an essential strategic component and affects MS during the 1990s in Europe. Likewise, Kim and Vale (2001) point out that branching was important in Norwegian banking sector in the 1990s, with a positive effect on a bank's MS but not on the overall market size.

Higher branch density is expected to bring the services and products closer to the customers. If a bank has a branch in a neighbourhood, it is expected that local people and local companies will use the services in that branch, instead of going to another area for the same services. Thus, higher branch density is expected to increase the exposure of the bank and provide more convenient services to the customers. Often, the customers are served by the same employees in the branch, which may lead to higher confidence and satisfaction of the customer, since it is expected that employees will learn more about the customers in their branch and provide them a more personal service. In addition, by serving almost same customers frequently, it is expected that employees will obtain more information about the customers, which in turn may decrease information asymmetry, especially in the process of customer screening before, for example, granting a loan. Dick (2002), in a demand deposit study, finds evidence that branches are an important factor in a customer's choice of a bank. In another study, Dick (2007) emphasizes that banks open branches because they expect to shift the demand and therefore attracting new customers. Branches present mainly sunk costs, since building a branch costs approximately $1 million (Radecki et al., 1996). Only a small portion of this amount is used for equipment, which is expected to be sold easily or used to replace elsewhere.

Branches may also be considered also as a proxy for advertising (Dick, 2002 and Dick, 2007). She outlines that banks attempt to attract customers by their branches with stylish merchandising and customer service as well as by being more visible by, e.g., putting a clock outside the branch. Due to limited availability of advertising data there is a lack of studies using actual advertising expenses and their effect on a bank's performance, although the study of Örs (2003) is a rare exception. He analyses the role of advertising in commercial banking in the 2001–2002 period and finds supportive evidence of advertising increasing bank profitability and emphasizes that non-price competition through advertising is a vital factor in the banking industry. In a nutshell, so far two potential inside bank determinants of MS are identified, that is efficiency and investments in quality, such as branch offices.

5.3.3 Market share and risk taking

In this section we aim to relate a bank's risk-taking behaviour to possible effects on its MS. It is important to note that to our knowledge there are neither theoretical nor empirical studies that explicitly analyse the effect of risk-taking on banks' MS. Earlier studies usually consider the effect of MS on risk-taking as exogenous, but the most recent studies recognize potential endogeneity in the relationship between MS and the risk-taking. That such causation can exist is shown by Allen and Gale (2004) who demonstrate that banks may engage in excessive risk-taking because they expect a convex profit function in market share and bank size, since banks with a larger MS may exploit market power and increase profitability. Additionally, the same outcome may be expected in terms of profit and banks' size if larger banks have lower average costs due to economies of scale. Keeton (1999) explains that some authors maintain that banks reduce the loan price and ease credit standards to expand due to increased competition for loan customers and his findings suggest a two-way relation between loan growth and loan losses for the US. Recently, Foos et al. (2010) empirically examine the two way causation between loan growth and loan losses (in the context of this thesis, the former could be considered as action to maintain or increase a bank's MS and the latter as a realization of risk-taking) Specifically, their main research question is whether banks can grow without becoming riskier (the effect of past loan growth on current loan losses), but they subsequently examine if there is an intertemporal two-way linkage between loan growth and loan losses. The second possible relationship is supported by their argument that banks with high loan losses may be forced to reduce their loan growth because of shareholders' intervention, reputation, accounting policies, risk of bank runs, banking regulation, etc. Consequently, they estimate a modified two-equation vector autoregressive model (VAR) with changes in current loan losses and excessive loan growth as endogenous variables. Their VAR results support the two-way linkage between loan growth and loan losses, in particular the findings indicate that loan growth leads to higher loan losses and loan losses are associated with a decrease in loan growth. It is important that this study considers that both of the two relationships are realized with time lag, which emphasizes the importance of the realization of the undertaken project including the risk.

The excessive risk-taking behaviour in banking is usually explained by the risk-shifting paradigm. Boyd and De Nicolo (2005) analyse this paradigm in both the deposit and the loan markets and allow for competition in both markets. They build their model on the study by Allen and Gale (2000) who consider only the deposit market.[38] When the loan market is ignored, risk-taking behaviour is only related to banks; however, once the loan market is included in the analysis, the risk-taking depends on the borrowers' investments and activities financed by bank loans as well, which are determined by loan prices (risk is increasing in loan rates) and other terms of the loan contract. Boyd and De Nicolo (2005) show that in an environment with moral hazard and adverse selection problems, the loan market effects more than offset the deposit market effects and that increased concentration leads to higher bank risk (the concentration-fragility view). This paper also demonstrates that there exists a fundamental risk-incentive mechanism causing banks to become more risky as their markets become more concentrated. This mechanism exists on the asset side of the balance sheet and is not modelled in the widely cited studies that focus on deposit market competition. Ceteris paribus, as competition declines, banks earn more rents in their loan markets by charging higher loan rates. By themselves, higher loan rates would imply (weakly) higher bankruptcy risk for bank borrowers. This effect is further reinforced by moral hazard on the part of borrowers who, when confronted with higher interest costs, increase their own risk of failure.

[38] In the modified model which includes the existence of a loan market, banks face two additional problems to be solved: the portfolio problem (asset allocation, bonds and other trading securities for which prices and return distributions are given and there is no private information for banks); and the optimal contracting problem (banks allocate assets in loans besides other assets with borrowers' actions being unobservable or observable only at a cost, which leads to private information for banks).

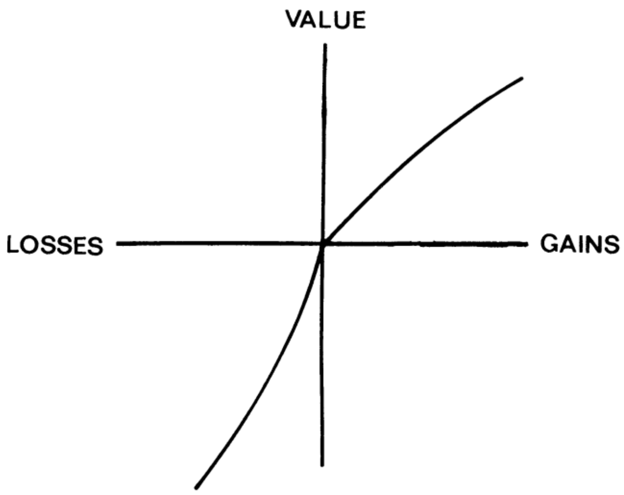
Following Boyd and De Nicolo that the risk-incentive mechanism and its effects are higher in the loan market relative to the deposit market, we further explain the effect of risk-taking on MS primarily using the loan market. The analysis is as follows: if a bank wants to increase its market share in order to enhance its profit later on, it implies that it should attract more borrowers and in doing this the bank lends to more risky customers. In order to demonstrate the role of risk-taking in the loan market, several strands of literature are consulted: (i) probability of failure in banking (Buchinsky and Yosha, 1995); (ii) prospect theory (Kahneman and Trevsky, 1979) and (iii) lending standards and screening (Dell'Ariccia and Marquez, 2006 and Ruckes, 2004).

Probability of Failure/Survival. Buchinsky and Yosha (1995) develop a dynamic model in which, in the absence of deposit insurance, the probability of failure of a bank is determined *endogenously* as a function of observable characteristics and bank-level *policy* variables (deposit interest rates, dividend payouts and risky investments) and, in the process, shed light on the effect of market discipline in identifying "bad" banks. The bank considers the effect of their optimal policy on the probability of failure, which affects its ability to collect deposits (necessary for undertaking projects). The optimal policy, as defined by Buchinsky and Yosha, is a result of the dynamic stochastic program solved for each bank in each period given an elastic supply of deposits. Hence, for every possible bank size there is an optimal policy which determines the probability of failure, which is taken into consideration by the depositors when they supply funds, which explains the existence of endogeneity in their model. The state of the dynamic programme in period *t* is characterized by: (i) a bank's size in period *t* (the monetary value of the portfolio) and (ii) the realized gross returns on investments undertaken in period *t-1* in securities (where the return on market portfolio is equal for each bank) and risky projects (the returns to the idiosyncratic investments in projects). As argued by the authors, at the end of each period, *"the size of the bank (conditional on survival) is determined by its initial size, the policy it chooses, and the realization of the returns from the risky investments" (p. 8)*. In the construction of their model they emphasize that the size of the bank is mainly determined by the actual returns on a bank's idiosyncratic investments in projects. In other words, the riskiness of the bank is entirely due to its activities on the asset side (the deposit supply is not stochastic: no liquidity shocks), where risky investments comprise of loans to new businesses, funding of R&D ventures, or the extension of mortgages where (gross) ex-post realizations differ, while the return on market portfolio of securities is the same for each bank.

Buchinsky and Yosha (1995) employ a simulation procedure to examine the effect of bank size (they use equity to proxy for bank size), the riskiness of investments and reserve requirements on the bank's optimal policy and probability of bankruptcy (determined endogenously within the system, as discussed earlier). Their focus is on the evolution of banks over time due to the idiosyncratic risk faced by banks as a result of their risky investments. In the first period of simulation banks (a total of 30) are identical in size and are allowed to select their optimal policies (they all choose the same optimal policy). However, from the next period they begin to differ both in size and the choice of optimal policies due to the different outcome of their undertaken projects. The study then examines the number of banks which survive and the size distribution of these banks over thirty periods of the simulation. Their results suggest that the shape of the size distribution becomes almost stationary and is skewed to the left with a small number of large banks. The main finding of the base case simulation is that the probability of survival becomes positively associated with a bank's size. Buchinsky and Yosha originally argue that small banks have three optional scenarios: (i) to raise no deposits at all and invest their capital in riskless securities, so the probability of survival is almost guaranteed, but they remain small; (ii) to offer a lower deposit interest rate and collect less deposit funds and invest those funds in projects with lower risk and by that increase their probability of survival; or (iii) to offer high deposit interest rates, which leads to higher risk premiums in order to collect more deposits, reflecting that some small banks want to "escape from poverty". In accordance with the simulation results, small banks choose the third option, implying that very small banks are involved in gambling activities by investing a large portion of their funds in risky projects. The incentives for small banks to adopt such a risky strategy are explained by their aim to become larger in the medium or long run although such strategies increase the probability of bankruptcy in the short run. Briefly, the higher the risk the higher the returns and thus growth in MS, if the undertaken projects are successfully completed.

<u>Prospect Theory.</u> The rationale for considering this theory is to further elaborate whether (excessive) risk-taking may be considered as a potential “inside” bank determinant of market share. Kahneman and Trevsky (1979) developed the prospect theory (behavioural decision theory under risk) as a critique of the well-established and commonly used expected utility theory for decision making under risk which assumes risk-averse individuals. They show that individuals typically make choices that are not in accordance with the expected utility theory when they face risky prospects. Individuals underweight merely probable outcomes compared to certain outcomes (the *certainty effect*), which implies risk-averse individuals in the case of gains and risk-seeking in the case of losses (the reflection effect). Additionally, individuals exhibit inconsistent preferences when the same choice is presented in different forms (the *isolation effect*). In prospect theory the choice decision relies on the value function (S-shaped), which is determined by two elements: a reference point (target or benchmark) for a choice decision (the asset’s value) and the changes in the preferences (the certainty and reflection effects) in the domain above/below the reference point (gains and losses). In particular, the function that describes the risk-taking behaviour of a decision maker of a below target return (benchmark or aspirational level) is commonly convex and steeper than the function that describes the domain of risk-averse individuals with above target returns, which is generally convex. The S-shaped function is steepest at the reference point, hence it the function is centred at the reference point (Figure 5.1).

Figure 5.1 Hypothetical value function



Source: Kahneman and Tversky (1979)

Having briefly presented the underpinnings of the prospect theory, we now discuss two rare studies on its application in the banking industry (Johnson, 1994 and Godlewski, 2007). Johnson (1994), motivated by the perception of increased riskiness of the banking industry in the US during the 1980s, tests the validity of the prospect theory over the period 1970 to 1989. Godlewski (2007) examines the validity of the prospect theory in the banking sectors in South East Asia and Latin America in the period 1996 to 2001. The testable hypothesis derived from Kahneman and Trevsky (1979) in terms of the risk-return relationship is positive for banks with above target returns and negative for banks with below target returns. As argued by Johnson (1994) riskier projects may provide a decision maker a better chance of achieving the desired target than less risky projects. Both studies employ profitability ratios (ROA and ROE) and the equity ratio as measures of return against which the target is determined. The target value is the median value of these measures in the industry. As a measure of risk both studies employ the so-called Fishburn's "redefined risk" as the integral of a function that is based on distance below target outcome (Johnson, 1994). These studies provide supportive evidence for the prospect theory. In particular, the findings suggest that banks performing below targeted performance behave as risk seekers, whereas the banks operating above targeted performance are risk-averse.

Given the findings above, the risk-taking behaviour of banks may affect their performance (ROA and ROE), but also affects their MS. Johnson (1994) explains that in order to increase its profitability on a longer time horizon, a bank can extend its loan portfolio through lending to high risk borrowers, the immediate effect being an increase in MS. For this category of loans the bank sets a higher interest rate as a compensation for the higher risk, which in turn leads to higher interest income per dollar invested and finally to higher profits, if the outcome is positive. This implies that the MS of the bank could be enhanced by undertaking higher risk. For a bank below its targeted MS (if the target is now a certain level of MS, instead of profitability), this may enable it to narrow the gap between its actual MS and targeted MS. However, the outcome of such activities is risky and the bank's MS may deteriorate further if the outcome is default on the risky loans. Indeed it may even lead to exit from the market. However, banks operating above their targeted MS may not be willing to apply such strategy.

Lending Standards and Screening. Dell'Ariccia and Marquez (2006) in their theoretical paper examine how the distribution of information regarding the borrowers in the loan markets is related to banks' strategic behaviour in determining lending standards, lending volume, and the aggregate allocation of credit. They present a model of a loan market where banks have private information regarding the quality of some, but not all, of the borrowers. For the "unknown" borrowers they may ask for collateral in order to differentiate between "good" and "bad" borrowers, or they may choose to approve loans without it. The screening of loan applicants is useful for reducing the asymmetric information in the loan market which leads to an adverse selection problem across banks and between banks and borrowers. Dell'Ariccia and Marquez show that in equilibrium banks will choose to screen the applicants more (less) if the proportion of unknown borrowers is low (high). The intuition behind this result is as follows: an unknown borrower who applies for a loan for a new project could be one of two types: (i) a first time applicant (ii) a borrower who has been already rejected by other banks. In a scenario, when the proportion of unknown borrowers and new projects in the market increases, each bank begins to receive an increased number of loan applications. Without screening banks are not capable of distinguishing between these two types of borrowers. However, when the proportion of new borrowers in the market significantly increases, the number of loan applications to each bank increases as well, hence banks find it more profitable in such circumstances to screen less (given that screening involves costs and those costs increase significantly when the proportion of unknown borrowers is becoming high), that is *"to reduce collateral requirements in an effort to undercut their competitors and increase their market share (p. 2512)."* Although Dell'Ariccia and Marquez primarily examine the effect of lending booms and lending standards on financial instability, they acknowledge that risk-taking may be a policy for some of the banks in order to increase their market share at least in the short run, whereas their long-run market share depends on the success of the granted loans. Given the above arguments that lending booms may result in higher riskiness and financial instability, undertaking higher risk may result in some banks gaining market share, suggesting a possible causality between the level of loans and risk-taking.

The variation in the lending standards and price competition among banks over different stages of the business cycle has also been examined by Ruckes (2004). He demonstrates that credit standards vary counter-cyclically, and banks screen less and use more lenient credit standards in expansion periods. This is the result of banks' rational decisions (not because they care less but because in periods of expansion the average quality of borrowers is higher, hence the probability of default is much lower) which enables profit maximization given intensified price competition. The rationale for intensified price competition is the increased willingness of all banks to grant a loan because the average quality of borrowers is high.

In periods of recession the average quality of borrowers is lower, hence in order to distinguish between borrowers, banks need more accurate information to forecast if it profitable to give loans to borrower. However, given that screening is costly and the low probability of a positive borrower assessment, conditional on the low average quality of borrowers, the marginal benefit from screening is small. Hence, Ruckes shows that, as in the expansion period, in recession also the optimal level of screening is superficial, but with the result that in recession banks resist lending. Once the share of good borrowers starts to increase above a certain benchmark level, the level of screening is intensified. The author further explains that in recession, price competition is lessened and the lending standards become stricter, because banks become reluctant to lend. Moreover, the gross profits in recession are lower than in expansion, given the decrease in the amount of lending, but the granted loans considered individually are more profitable in recession than in expansion because of the higher risk in the expansion period. Given the results from the Ruckes's model and the underpinnings of the prospect theory, during the recession period, the most risk loving banks, which may especially be those that are performing under their target MS, may increase their MS (at least in the short run) if they grant more loans.

Given the discussion above a definitive expectation of the direction of the relationship between risk taking and market share is not fully clear. However, it can be expected that in the short run taking higher risks will contribute to expansion of the loan portfolio of a bank, hence the bank to gain in MS. However, this would be sustainable on long run only if the undertaken risky projects are successfully realized.

5.3.4 Market share and capital

In this section we go beyond the study of Berger and Bouwman (2013) who empirically investigate the effect of capital on a bank's market share discussed in Section 5.2. Predictions of the relationship between capital and MS differ across different theories. Some studies suggest that banks with higher capital have a higher MS, because these banks are more competitive and have a competitive advantage (Holmstrom and Tirole, 1997; Allen and Gale, 2004; Boot and Marinc, 2008, Allen et al., 2011; Mehran and Thakor, 2011; Berger and Bouwman, 2013). Additionally, there is empirical evidence suggesting that better-capitalized banks may compete more effectively for deposits and loans (Calomiris and Powell, 2001; Calomiris and Mason, 2003; Calomiris and Wilson, 2004; Kim, Kristiansen, and Vale, 2005) and hence an increase in MS could be expected. On the other hand, some authors argue that in the case of highly-leveraged firms in the non-financial sectors, this positive relationship does not hold since such firms will be more aggressive in their market activities and strategies, resulting in a negative relationship between capital and market share. For example, in the banking sector, Stiroh and Strahan (2003) find that the equity to asset ratio has a negative impact on MS. They interpret this as the equity to asset ratio possibly picking up a size effect, since the large banks are inclined to be more leveraged. However, since the econometric model used in their analysis includes fixed effects, the authors provide a further explanation, namely that the equity to asset ratio may also control for the differences in the operational strategies across banks because aggressive banks tend to have both higher leverage and to expand more rapidly. Given the above arguments the effect of capital on MS is unclear.

5.3.5 Market share and regulation: "Outside" determinants

In his comprehensive review of SCP studies in banking, Gilbert (1984) argues that one of the serious drawbacks in those studies was the omission of the direct inclusion of regulation. Hence, the effects of changes in regulation on the market structure-performance relationship cannot be determined from these early studies. That regulation blunts the market mechanism and hinders the competitive process is evidenced by Stiroh and Strahan (2003), as discussed in Section 5.2. They find that a bank's relative performance and its subsequent MS growth strengthens significantly after deregulation as competitive reallocation effects lead to the transfer of assets to better performers (for example, more efficient) and a possible increase in concentration, unless the deregulation encourages new entry. In terms of regulation, this may imply that countries with stricter regulations (mainly to secure financial stability) could have a less concentrated banking sector not because of increased competition (Boone, 2000, 2008), but because regulation may serve as a protector of weak banks (Lyons and Zhu, 2012). However, if regulation restricts new banks from entering the market, then regulation may lead to more concentrated market. Hence, at first glance it seems that regulation in general and different types of regulation in particular may work in two directions, to contribute to more or less concentrated market.

However, to our best knowledge there is no coherent theoretical framework elaborating the effect of regulation on the competitive position of banks. Only Gonzalez (2009) examines this issue and acknowledges that his study is an empirical exercise as he does not provide any theoretical background for the effect of regulation on banks' MS. Recently, Lyons and Zhu (2012)[39] following the theoretical framework of Sutton (1991) empirically examine the relationship between competition, regulation and market structure (concentration) across European banks in the period 1997-2009. As with Gonzalez (2009), this study lacks a theoretical basis and does not discuss the expected effects of these regulatory and supervisory practices. Lyons and Zhu find that activity restrictions negatively affect concentration, while conglomerate restrictions are found to increase concentration. In addition, the authors examine the effect of entry restrictions, capital regulation and official supervision on concentration in banking, but these factors are found to be insignificant. They consider these results to be rather surprising, especially for the latter two, given that capital regulation and supervision have been revised and become stricter in the aftermath of last financial crisis. In terms of entry restrictions the insignificant results may be due to the lack of variation in this variable, or because entry requirements are offset by the incentives for entry.

The discussion above establishes a rationale for further investigation of regulation and supervision practices in terms of their effect on a bank's MS, hence in what follows we try to provide intuitive predictions regarding the effect of regulation on MS, hence prepare grounds for a better empirical investigation in Chapter 6. Before discussing the effect of regulation in banking in detail, we should highlight an important issue related to what we call the *country-level effect* and the *bank-level* effect of regulation on competitiveness in banking. This results from the fact that when one bank gains in MS, other bank(s) must lose a portion of their MS because the sum of all MSs equals to one. Hence, given that regulation is determined on a country level, it is not possible to observe a positive or negative effect of regulation on all individual bank's MS, since not all banks in one country can increase/decrease at the same time, unless the regulation encourages exit or entry. Consequently, the effect can be considered at the aggregate banking industry level as analogous to concentration and we name this as *the country-level effect*. In other words, this effect is whether the regulation is to favour a market with a few banks with a large

[39] This study is not included in the Section 5.2: Review of empirical studies investigating MS, because this study considers market concentration; however it is relevant in this section.

MS or a large number of banks with a small MS, i.e. a less/more concentrated market. On the other hand, it is reasonable to expect that regulation policies may affect an individual bank's MS through transmission channels such as individual bank specificities, for example a bank's performance (efficiency as in Gonzalez, 2009; and relative profitability as in Stiroh and Strahan, 2003), risk taking behaviour, size (for instance, as explained later in this section, big banks may influence regulators according to the interest group theory), etc. Given that in such case the effect of regulation on a bank's MS is through other factors (in the empirical model this would be interactions between regulation and the factors just mentioned above) we name this as *the bank-level effect*. These are elaborated below.

Although regulatory practices are mainly determined at the national level (such as activities restrictions and existence of explicit deposit insurance schemes), there is also a trend of establishing international regulatory practices such as Basel II[40]. This thesis focuses on both national and international regulatory and supervisory practices. However, the effects of these practices are difficult to establish clearly because there are several possible outcomes as suggested in the literature.

Consideration of the "capture" theory is relevant for understanding the potential reverse causality between regulation and MS. Specifically, from the standpoint of the "capture" theory, supervision and regulation may benefit larger banks by facilitating their expansion at the cost of medium and small banks because they can have more influence on the government policy and, hence, a positive association should be expected for big banks. These arguments raise the possibility that regulatory and supervisory processes may be endogenous. This point applies to all aspects discussed in the rest of this subsection.

CAPITAL REGULATION. Capital regulation is the main focus of government intervention and also of the Basel II Accord. Since capital serves as a buffer against potential losses and bank failures

[40] Basel II is the successor of Basel I, however the last financial crisis urgently requested changes in regulation, hence in 2010-11 new comprehensive set of reform measures are proposed by the Basel Committee on Banking Supervision, which implementation is expected 2013-2015. Hence, given that the period of analysis on this thesis is up to 2012, Basel II is considered when discussing the regulatory and supervisory practices.

and protects investors in the case of failure (Barth et al. 2004), its positive effect on a safe and sound banking system is quite clear (Dewatripont and Tirole, 1994). Berger and Bouwman (2013) argue that deposit insurance may mediate the effect of capital on MS, because deposit insurance increases the competition for deposits and the capital is essential for collecting uninsured deposits and subordinated debt. Kendall (1992) argues that indeed there may be increased risk-taking behaviour by individual banks occasionally, but this does not mean a riskier banking sector. The results of Barth et al. (2004a) suggest that more stringent capital requirements contribute to less non-performing loans, but it is not robustly associated with banking crises, bank development and efficiency when controlling for other supervisory–regulatory policies. Fernandez and Gonzalez (2005) provide results similar to Barth et al. (2004a). On the contrary, Koehn and Santomero (1980), Kim and Santomero (1988), Besanko and Kanatas (1996), and Blum (1999) emphasize that capital requirement may encourage risk-taking behaviour. Hence, given the above studies, capital regulation can be expected to affect risk-taking behaviour, which in turn can affect the size of the bank's loan portfolio.

Boot and Marinc (2006) present a set of theoretical models to assess how capital regulation interacts with the degree of competitiveness of the banking industry conditional on the level of screening which affect the profitability and riskiness of their lending operations (we assume higher screening reflects prudent bank behaviour). They distinguish two types of banks, "good" and "bad", where the "good" banks invest more in monitoring technologies, hence could be considered as less risky banks. Part of their findings can be summarized: (i) higher capital requirements enhance the screening incentives of both types of banks, because a higher level of capital requires means more risk is internalized and (ii) higher capital requirements always decrease the value of a bad bank, but enhances the value of a good bank when the competition is fierce enough and the banking industry is of significantly low quality. Since (i) seems to be clear, the (ii) is elaborated using two effects of capital regulation as explained by Boot and Marinc. In particular, their first effect results from the imposed higher cost on each bank since capital is more expensive than deposits, hence ceteris paribus, the value of each bank is reduced. Their second effect results from the deposit insurance subsidy. Specifically, the competitiveness of the low quality banks is strengthened due to the deposit insurance subsidy, but this is now reduced by the capital regulation, which enables good banks capture higher rents. Good banks can reduce the MS of the bad banks when the capital requirements are quite high, the competition is high and there are enough bad banks. On the other hand, they also show that high capital requirements may encourage entry due to the diminished competitive position of the lower quality banks compared to the high(er) quality banks.

These arguments provide ambiguous predictions in terms of the bank-level effect of capital requirements through risk-taking behaviour on MS, in particular if capital requirements are an incentive/disincentive for riskier investments, in line with the discussion in Section 5.3.3, it may improve/reduce the MS of those banks which opt for higher risk loans, at least in the short run. Beatty and Gron (2001) find that capital requirements are important for low-capital banks, because such banks are legally forced to always hold a certain threshold of capital for covering potential losses. According to this it may be expected that the effect of capital requirements systemically vary over different size-classes in terms of the competitive position of banks (MS), especially because big banks are able to better diversify and lower the overall riskiness of their undertaken projects than small banks. In terms of the country-level effect, in a country with stringent capital requirements a lower concentration in banking could be expected given that capital requirements act as a “brake” on lending activities. Specifically, instead of investing the capital in profitable projects, banks are obliged to hold “aside” a certain portion of their capital.

OFFICIAL SUPERVISORY PROCESS. The supervisory review process is the second pillar in Basel II. Given the prevalence of market imperfections in financial markets, official supervision is necessary to overcome them. Supervision becomes more important in countries with deposit insurance schemes, since banks have an incentive to engage in excessive risk-taking behaviour. Ogura (2006) emphasizes that more competitive banking systems require more stringent supervision because credit standards tend to be loosened either because of the lower duration of the customer-bank relationship or as a result of competition in the industry (as shown by Ruckes, 2004 and Dell’Ariccia and Marquez, 2006; Section 5.3.3). Therefore, during prosperous economic years, the number of approved loans increases rapidly, resulting in a lending boom which raises the need for closer supervision in order to restrict potential excessive risk taking. Additionally, Allen and Gale (2004) point out that the erosion of profits by long-term competition forces create an incentive for profit-seeking banks to invest in riskier assets, again requiring higher supervision to prevent excessive risk-taking. Barth et al. (2006) find that official supervisory power has a negative influence on bank development (using a country-level indicator: ratio of the banks' loans to private sector and GDP) which is line with Boot and Thakor (1993), Shleifer and Vishny (1998) and Djankov et al. (2002). However, they argue that this finding should be treated with caution because in a multivariate analysis this effect becomes insignificant, arguably due to the high correlation of official supervision with the other regulatory and supervisory practices. Gonzalez (2009) reports that greater private and official supervision reduces market concentration and a bank's MS. He finds that the negative influence of official supervisory power on market structure is interconnected with other factors than efficiency, indicating that the MS of more efficient banks are not negatively affected by official supervision.

Taking into consideration the above arguments and empirical findings, a number of intuitive predictions on the effect of official supervision on bank's competitive position can be put forward. First, clear-cut predictions in terms of the direct effect of the supervision cannot be established. However, if we add an assumption that big and complex banking institutions are difficult to monitor, it is reasonable to expect a negative association between supervision and MS at the country level, in other words supervision may promote a banking sector without (some) banks becoming "too big" to effectively monitor. Second, risk-taking and the size of a bank can be considered as the most relevant channels for analysing the bank-level effect of supervision on MS. If supervision is imposed to control the risk-taking behaviour of banks, then stricter supervision is expected to have a negative effect on the MS of banks which would otherwise be willing to embark on more risky lending in order to improve their MS, at least in the short run.

<u>PRIVATE MARKET MONITORING.</u> The private market monitoring is part of the third pillar in Basel II. In essence this will *"encourage market discipline by developing a set of disclosure requirements which will allow market participants to assess key pieces of information on the scope of application, capital, risk exposures, risk assessment procedures, and hence the capital adequacy* *of the institution" (BIS, 2006 p.226).* Very few studies have considered the effects of private monitoring in banking.

Van Hoose (2010) argues that private monitoring might help regulators in differentiating "bad banks" from "good banks" and force them to act appropriately in cases of possible failures. Similarly, Levine (2005) points out that private monitoring would improve a private bank's corporate governance thus will boost its functioning which may provide the potential for increased MS for "good banks". Van Hoose (2010) emphasizes that larger banks may comply with the process of information disclosure more easily and at less cost compared to smaller banks - and this is a negative outcome of market discipline. Furthermore, Duarte et al. (2008) maintain that private monitoring increases the bank's costs due to making additional informational disclosures and maintaining investor relations departments, which may have a negative impact on efficiency (Pasiouras et al., 2009). In the presence of economies of scale, this cost may be proportionately less for big banks than for small banks, thus it can be expected that the MS of small banks may be reduced.

Barth et al. (2006) explain that private monitoring is preferred because politicians and regulators would be forced to react promptly and accordingly regarding the market signals, instead of acting according to their own group and political interests, especially in countries with underdeveloped capital markets, accounting standards and legal systems (the case in SEECs as discussed in Section 1.4). Caprio and Honohan (2004) consider low-income countries with this regard and emphasize that these countries may be better off if they rely on market discipline despite the poor disclosure, accounting and legal system because: (i) market participants would be motivated to monitor, because even if the country has deposit insurance, it may not be appropriately provided because of the fiscal uncertainties of bank runs; (ii) the tendency for a large presence of foreign banks makes information disclosure more available; and (iii) a less complex banking environment. These arguments imply that private monitoring in SEECs may offset the selective positive effect of official supervision, especially for the big and influential banks, if regulators and supervisor act in line with the capture theory.

Barth et al. (2006) find a positive effect of private monitoring on bank development and emphasize the role of the third pillar, which prior to Basel II has been neglected. Barth et al. (2004), Levine (2005) and Delis et al. (2011) report that private monitoring has a positive impact on a bank's performance. Gonzalez (2009) finds that greater private supervision reduces market concentration and MS, similar to official supervision. However, his further findings support the expectation that private monitoring is a necessary condition for well-functioning markets, which in turn boosts efficiency and contributes to gains in MS (a significantly positive coefficient of the interaction term efficiency and private monitoring). Gonzalez explains that the negative association between MS and private monitoring as resulting from factors other than efficiency. From the discussion above, it is possible that one factor giving the negative effect on MS is the restriction of higher risk taken undertaken to enhance a bank's MS. This is a reasonable prediction, given that a significant portion of lending activities are financed by deposits of the customers, hence private monitoring is expected to reward banks with prudent behaviour and transparent disclosure practices and punish banks with opposite working practices. However, the country-level effect of private monitoring is not clear, as there are arguments which indicate both negative and positive effect of private monitoring on the average bank's MS.

RESTRICTIONS ON BANKS' ACTIVITIES. Another aspect of banking regulation is the range of activities that may be undertaken by banks (this regulation policy is country specific and is not part of the Basel pillars). In addition to the traditional banking activities other types of activities include securities, insurance and real estate. There is a debate on whether or not such restrictions should be imposed on banks. It has been argued that these restrictions would (i) help avoid conflicts of interest between different activities (Edwards, 1979 and Saunders, 1994); (ii) reduce the opportunities for riskier behaviour (Boyd et al., 1998); (iii) result in fewer big and complex financial institutions for monitoring; and (iv) limit the "too big to fail" phenomenon (Barth et al. 2004; Leaven and Levin, 2005). Moreover, Lyons and Zhu (2012) maintain that activity restrictions are expected to be associated with less concentrated markets, because banks do not have access to risky markets including securities, insurance and real estate, hence are less likely to substantially grow in MS. These arguments imply that activity restrictions hinder the expansion of a bank's MS and lead to a less concentrated banking sector (the country-level effect).

However, as Barth et al. (2006) have argued, there are reasonable theoretical grounds for permitting banks to engage in a broad range of activities since these may promote sound, stable and even more efficient banks. For example, involvement in different activities may allow the exploitation of economies of scale and scope (Classens and Klingebiel, 1999; Barth et al. 2000; Haubrich and Santos, 2005), which may facilitate the increase in the MS of the more efficient banks (although some banks may sacrifice efficiency and profits at least in the short run in order to expand MS). Moreover, having the opportunity to operate in different markets facilitates risk and income diversification which may enhance the stability, performance and the concentration in the banking sector, if such new opportunities result in remaining banks become even larger (the country-level effect). This is consistent with Gonzalez (2009) who finds that activity restrictions lead to increase in market concentration (Section5.3).

In terms of the bank-level effect, the engagement in new opportunities (projects and activities) and their transformation into MS of some banks depends on the ability of individual banks to penetrate these new markets and their willingness to extend the current product-mix. Hence, it is reasonable to expect that big banks and banks willing to undertake additional risk, which comes with the new unknown market, would benefit if there are no or fewer activity restrictions. On the other hand, Bonfim and Kim (2012) argue that banks may have a tendency to act like a herd (engaging in similar risk-taking and management strategies) and this increases the risk of failure if they believe that a bail out will take place in a case of severe financial distress (Acharya and Yorulmazer, 2007; and Brown and Dinc, 2011). Beck et al. (2013) argue that in more competitive environments herding behaviour may motivate banks to engage in more risky activities, hence the bank-level effect of activity restrictions on MS could be transmitted through the risk-taking behaviour of the individual bank. They refer to activity restrictions as a possibility that encourages herding behaviour and leads to negative outcomes. The rationale for herding behaviour is found in the limitation of banks' endeavour in new markets, when the core business is highly competitive. Consequently, due to activity restrictions some banks (some of them are leaders and some followers) can opt for herding behaviour increasing the risk taking of the respective banks in the lending market and it may also increase the overall risk taking of banks. Given that big banks are more likely to better diversify their portfolios in the existing markets, even in the case of herding they have a higher probability of success and growth in size, not only in the short run, but in the long run as well.

Barth et al. (2004) and Beck et al. (2006) find that restrictions on bank activities lead to a negative effect on bank performance and stability. Demirguc-Kunt et al. (2004) indicate a positive and significant relationship between net interest margins and restrictions on activities. This finding suggests that activity restrictions may affect MS positively if banks with a higher net interest margin have a predisposition to expand, because they can decrease the margin (and remain profitable) in order to reduce their rivals' MSs.

DEPOSIT INSURANCE SCHEMES. The arguments in favour of an explicit deposit scheme are that it protects the banking system and small customers from bank failures (Barth et al., 2004). However, others have argued that deposit insurance may decrease the level of monitoring by depositors (Barth et al., 2004a) and lead the banks to opt for higher risk since they can collect deposits without being obliged to pay a premium if something goes wrong and they also face failure (Merton, 1977; Bhattacharya and Thakor, 1993; Bhattacharya et al., 1998; Hendrickson and Nichols, 2001; Demirguc-Kunt and Kane, 2002).

Barth et al. (2004a) find a positive and robust relationship between deposit insurance generosity and probability of a crisis, but they maintain that the effect of deposit insurance depends on other factors such as bank-specific and/or other regulatory and supervisory practices. Some of these other factors are related to additional regulation policies and supervision processes which are expected to mitigate the moral hazard problem and hence affect the allocation of MS across banks. For example, prudent official supervision and enhanced private monitoring may decrease the extent and consequences of moral hazard discussed above. Risk-based deposit insurance premiums may be also considered as potential mechanism against moral hazard (Van Hoose, 2010). Moreover, some theories argue that deposit insurance strengthens deposit competition (Matutes and Vives, 1996; Hakenes and Schnabel, 2010). As Berger and Bouwman (2012, pp. 8-9) originally argued *"In such a setting, capital would still be of importance, however, especially for raising uninsured deposits and subordinated debt, both of which may affect the bank's MS."*

Gonzalez (2009) finds that deposit insurance schemes increase the average MS in the banking sector (the country-level effect). His results also indicate that deposit insurance reduces the validity of the efficiency-structure theory and the positive effect of deposit insurance on MS is for other reasons than those related to the efficiency hypothesis. Given that the purpose of regulation in banking is to ensure prudent behaviour amongst banks, it is reasonable to consider risk-taking as one of those other reasons for a positive effect of deposit insurance on a bank's MS, as discussed throughout this section. In fact, Boot and Marinc (2006)[41] show that *"deposit insurance effectively subsidizes low quality banks relative to high(er) quality banks. This makes low quality banks more competitive than they would otherwise have been, and makes it more difficult for good banks to gain market share at their expense, (p. 2)."* The low quality banks potentially undertake more risk (underinvest in monitoring of the borrowers) and, according to Boot and Marinc in the presence of a deposit insurance scheme it is expected that banks prone to risk-taking may increase their MS through expanding lending and deposits at least in the short run. In addition, the phenomenon of "too big to fail" allows big banks a favourable position and they may further increase their MS much easier than the smaller banks by undertaking riskier projects in the presence of deposit insurance. Eventually, the county-level effect of deposit insurance on MS can be expected to be positive (average MS in the sector is higher), while the bank-level effect on MS would depend on the size of the bank and its risk-taking behaviour. On the other hand, the long run effect depends on the realization of the undertaken projects (Buchinsky and Yosha, 1995).

[41] This study has been already presented in the section for the capital regulation.

The problem of moral hazard arising from a deposit insurance scheme may be mitigated if the regulators create a set of rules which limit the risk-taking behaviour of banks, which restricts the lenient lending and the MS expansion. Such measures can regulate: (i) who is the major contributor for deposit insurance; (ii) whether banks are charged risk-based deposit fees; and (iii) what proportion of deposits is insured by the scheme. Such measures could alleviate the moral hazard problem but may also limit the expansion of banks' MS, since is it is expected that banks would avoid excessive risk-taking.

5.4 CONCLUSION

The market structure in banking can have important implications for financial stability, firms' performance and growth, the well-being of the households and the banks' performance. The main purpose of this chapter is to identify the potential determinants of a bank's market share- which may also be considered as factors determining a bank's competitive position. However, as highlighted throughout this chapter, there are only a very limited number of theoretical and empirical studies analysing this topic and a comprehensive theoretical framework is still underdeveloped. Deriving a conceptual framework which reflects the potential determinants of a bank's market share presents a challenging task and requires an eclectic approach deriving from various strands of literature presented in Section 5.3. Recognizing that banking is a regulated industry, the range of determinants includes bank-specific factors (those under control of the management, or the "inside" bank determinants) and regulatory and supervisory practices (which are the control of the management, or the "outside" bank determinants).

The starting point for this theoretical discussion, and the empirical analysis in the next Chapter, is the study by Gonzalez (2009) which to our knowledge is the first empirical attempt investigating cost efficiency and regulation as determinants of MS. However, based on a detailed critical review of this study, it became clear that a number of important additional issues have to be taken in to account. First, his empirical study considers only one "inside" bank determinant, cost efficiency. In this chapter we go beyond this and identify other possible "inside" bank determinants, such as investments in quality, risk-taking behaviour and capital. Moreover, the inclusion of regulation in the study of Gonzalez is on ad hoc basis; hence we make an effort to develop theoretical predictions, at least intuitively, of the effect of regulation and supervision on a bank's competitive position. To this end, a "step by step" strategy and an eclectic approach are employed to identify a comprehensive set of determinants of a bank's MS (Section 5.4). In particular, various strands of economic literature tackling market structure from different perspectives are discussed. These include the literature on measuring competition (the Boone indicator), endogenous sunk cost theory, the literature on the role of capital in banking and the probability of survival in banking, prospect theory, and the literature on lending standards and screening.

Second, Gonzalez estimates bank's efficiency by a non-parametric approach, DEA, with a country-specific frontier, and then uses these estimates as a determinant of market structure in a cross-country panel study. However, as discussed in Section 5.2, the use of a country-specific frontier cannot provide efficiency estimates comparable between countries. Hence, we apply a parametric approach, Stochastic Frontier Analysis, using the Random Parameters Models in the context of a *common frontier*, in order to obtain comparable, time-varying efficiency estimates across countries (Chapter 4) and use these in the empirical estimation of market share in Chapter 6. Third, Gonzalez assumes that market structure and a bank's market share are of a static nature, an unrealistic and restrictive assumption. As supported by Stiroh and Strahan (2003), a bank's competitive position is a dynamic process, in other words the current level of bank's market share depends on past competitive levels as well as current factors (explored further in Chapter 6.2), which in turn requires use of a dynamic panel model (Section 6.4). Finally, although Gonzalez (2009) investigates determinants of market structure in 65 countries, his data set includes only two out of eight countries under consideration in this thesis, Croatia and Slovenia. The other six, Albania, BiH, Bulgaria, Macedonia, Montenegro and Serbia, are not included in his study.

After reviewing a broad range of literature, the following factors were identified as the "inside" bank determinants of market share: the level of efficiency, investments in quality (non-price competition), risk-taking behaviour and the capital ratio. The "outside" bank determinants identified include restrictions on activities of banks, the existence of explicit deposit insurance schemes, the level of capital requirements, the strength or effectiveness of official supervision and market discipline (the three pillars of the Basel II Accord). The identification of "outside" bank determinants and the potential testable hypotheses proved even more challenging than that of "inside" bank determinants. In particular, given that the sum of market shares of all banks has to add up to one, any regulatory policy cannot positively or negatively affect all banks. The analysis of the effect of regulation on MS at country level is analogous to the study of market concentration. Hence, our theoretical discussion focuses on both country level and bank-level effect of regulation on market share. The impact of any regulatory policy on an individual bank's MS depends on a bank's characteristics. It is known that the purpose of regulation in banking is to secure safe and sound banking system by influencing the incentives and behaviour of bank managers. In addition to efficiency, which was considered by Gonzalez (2009), risk-taking and the size of banks may be the channel for transmission of the effects of regulatory measures on an individual bank's MS.

An important issue that characterises the identified determinants is their potential endogeneity due to reverse causality with a bank's market share as discussed in Section 5.4, an issue that will be further considered in Chapter 6. The outcome of this chapter is a conceptual framework, which overcomes the identified limitations of Gonzalez (2009), that can be used as the basis for developing an empirical model to investigate the determinants of a bank's MS in selected SEECs in the period 2002-2012. This empirical analysis is presented in the next chapter.

CHAPTER 6

EMPIRICAL ANALYSIS: "INSIDE" AND "OUTSIDE" DETERMINANTS OF A BANK'S MARKET SHARE

6.1 INTRODUCTION

As discussed in Chapter 5, this thesis presents an attempt to identify the potential determinants of a bank's market share (which serves as a proxy for competitive position of the bank, thus the two terms are used interchangeably) by conducting an empirical investigation using a model developed by reviewing and extending different strands of the literature and a few already existing studies in the field. Therefore the aim is to provide initial empirical evidence that may lay the basis for further theoretical and empirical research on the determinants of MS in banking. As argued in Chapter 5, this area of investigation has policy relevance, given the importance of the banking industry for the economy and the fact that it has always been a regulated industry, with some aspects of regulation being directly concerned with MS concentration.

Therefore, this chapter aims to empirically investigate what determines a bank's MS. For that end, the "derived" theoretical framework in Chapter 5 regarding the possible determinants of a bank's MS is used as a ground for this empirical analysis. Specifically, this chapter considers two broad groups of variables (the "inside" bank and "outside" bank factors) discussed in Chapter 5. Furthermore, in line with the theoretical framework, as discussed in Chapter 5, additional testable hypotheses are defined which are related to the possibility of systematic variation across different risk-taking behaviour and size-classes of banks in terms of the effect of various determinants.

The structure of this chapter is as follows: Section 6.2 presents the baseline empirical model. Section 6.3 discusses the data employed in this analysis, and the research methodology used for this investigation is the subject of discussion in Section 6.4. The empirical findings of the baseline model are elaborated in Section 6.5, followed by the empirical findings from the alternative model specifications which check for possible systematic variation across different risk-taking behaviour and size-classes of banks. In addition, this section includes a robustness check of the empirical results using different specifications of efficiency and risk. Finally, Section 6.6 provides a summary of the findings and conclusion.

6.2 MODEL SPECIFICATION: THE BASELINE MODEL

This section develops an empirical model of the potential determinants of a bank's MS, drawing on the theoretical underpinnings and the literature review presented in Chapter 5. As discussed there, the potential determinants of MS are divided in two broad groups: "inside" and "outside". The "inside" bank determinants are those which are under a bank's control and decision, whereas the "outside" determinants are those beyond its control, that is factors determined by the regulatory and supervisory bodies in the country. At any given time a bank can actively improve its MS only by improving its "inside bank" determinants as the "outside bank" determinants are established for each country and, as discussed later in Section 6.3, they are pre-determined. The possibility that banks can affect these practices and influence regulators in the process of creating the regulation and supervision framework is excluded. In addition to the aforementioned groups of factors, there is another factor that is likely to play a role in determining a bank's competitive position, that is, the behaviour of the rivals. Although, it is difficult to account for competitors' actions, we endeavour to partially capture them as presented later in this section. It is important to note that the baseline model examines the country-level effect of regulation, while in Section 6.5 the alternative models are focused on the bank-level effect of regulation on MS.

6.2.1 "Inside" bank determinants

The "inside bank" determinants consist of the past MS of the bank (the lagged dependent variable) as well as other factors in the current period. According to the standard microeconomic theory in order for a firm to increase its MS, it needs to increase its size (its capital – its fixed assets) and to do so it needs to invest – but there is a delay in getting to the desired level because of costs of adjustment. The past level of MS gives the basis from which the bank needs to adjust its current level; hence the inclusion of the lagged dependent variable is necessary. Given the specificities of the banking industry, where collected deposits are as important as the capital for a further potential increase of the MS, as well as the cost of deposits (the interest rate), there are other costs associated with the expansion of deposits which result from asymmetric information and/or information sharing, switching costs and first mover advantage. It is expected that these kinds of costs are reflected in the partial adjustment process captured by the lagged dependent variable. For example, Kim et al. (2003, pp.51-52) find that: *"On average, 23.0% of the customer's added value is attributed to the lock-in phenomenon generated by switching costs. As much as 35% of the average bank's market share is due to its established bank–borrower relationship (on average 13.5 years)."* Furthermore, as discussed in Section 1.4, the banking industry in the countries under consideration have undergone substantial restructuring after the post-socialism era, which was a slow and long process characterised by various government interventions and imperfections in order for banks to accommodate to the new rules applied by the free market economy. The substantial inflow of foreign capital into this industry contributed to an asymmetrical distribution of knowledge and experience between banks about the functioning of the market economy and the required steps to remain active and/or to expand in the new environment, which can be considered as additional costs of adjustment. These arguments support the dynamic nature of a bank's MS [as well supported by Stiroh and Strahan (2003) as discussed in Section 5.2], which presents a development from the static model as specified by Gonzalez (2009) discussed in Section 5.2.

As discussed in Section 5.3, the "inside" bank determinants include efficiency, capital[42], risk (probability of default) and quality/advertising. The following discussion presents the choice of variables for the empirical analysis. As a measure for efficiency this thesis uses the cost efficiency of the bank. As discussed in Section 2.2 and 2.3.2 a bank's cost efficiency is defined as the ratio of the expenditures of the most cost-efficient bank (the minimum cost attainable in a given environment, accounting for random shocks) to observed total cost of any other bank. Thus, cost efficiency has a range of 0 to 1, where the further the bank is from 1 and closer to zero, the less efficient it is. It is expected that at least one bank has a score of 1 (produces at the lowest feasible cost level, that is no further reduction in the costs could maintain the same output level), representing the best-practice bank against which the other banks are compared with respect to cost efficiency. This definition is a relative measure of cost efficiency, hence it takes into account the behaviour of the most successful rival in the industry in terms of efficiency. It is important to note that in the empirical analysis of this chapter, for the sake of ease interpretation, we use cost efficiency multiplied by 100, that is a percentage, rather than as a ratio from 0 to 1. The cost efficiencies of the banks were estimated in Chapter 4 by conducting a SFA using a random parameters model (where loan impairment charges, loans and other earning assets were treated as random, that is the effect of each of these variables on total costs, hence implicitly on cost efficiency, is unique for each bank, given the presence of heterogeneity in these variables). An important property of these estimates is their variation across time within a bank on a yearly basis, which in turn is expected to provide more information about the effect of cost efficiency on

[42] As in Berger and Bouwman (2013) capital and capital ratio are used as synonyms, hence the both terms are interchangeably used throughout this chapter. In particular, in the theoretical discussion the term "capital" is used, while in the empirical analysis the term "capital ratio" is used, as it is widely used in the empirical literature to control for the size of banks and potential heteroscedasticity.

MS. As discussed in Section 5.3.1, cost efficiency is expected to be positively associated with a bank's MS

Another possible "inside" bank determinant is the effect of non-pricing/strategic competition on the competitive position of the bank. In the absence of other data representing this kind of competition, branch density (number of branches per 10,000km^2) is used as an indicator of non-pricing behaviour. This variable may serve as a proxy for quality (the endogenous sunk cost theory) and/or as a mean for advertising in banking as discussed in 5.3.2. A priori, branch density is expected to have a positive effect on a bank's competitive position, particularly because in the selected SEECs for the period of this study non-pricing competition was not a well-established mechanism, hence high initial yields from such form of competition may be expected.

The next potential "inside" determinant of a bank's MS is the capital, as discussed in Section 5.3.4. To investigate the effect of capital on the MS, this analysis considers the ratio of a bank's capital relative to its total assets. An appropriate indicator for capital is the risk adjusted capital (Tier 1 or Tier 2), since it represents more accurately the level of capital at the disposal of a bank in the case of losses, for example due to loan default. However, due to limited data on risks associated with each element of the bank's capital, the unadjusted capital ratio is employed. The theoretical literature that analyses the role of a bank's capital from different aspects (banking sector stability, optimal capital structure, franchise value of the bank) usually makes use of the terms *"holding more capital"* and *"more capitalized banks"* but rarely there is a defined benchmark against which this comparison is made. In some cases this benchmark may be the rate of capital requirements imposed by the regulators, but in most cases this is not explicit.

Accordingly, to capture "the more" issue, this empirical analysis defines the capital ratio relative to the median capital ratio (instead of mean to avoid the effect of the outliers) in each country for each year. In particular, a bank's capital ratio is defined as the difference between the bank's capital and the median banks' capital in each country in each year, hence the variable is negative (positive) if the bank's capital is below (above) the median bank's capital. Moreover, such definition of the capital ratio variable captures the rivals' behaviour in terms of capitalization. The literature suggests that being a more capitalized bank is associated with greater stability (more capital to be used as a "buffer" against losses) and higher MS (Section 5.2 and 5.3.3). However, a reverse relationship could be argued as well, if banks competing for MS are more aggressive hence highly leveraged, because holding more capital may imply less investments.

Section 5.3.3 presents the theoretical underpinnings along with empirical evidence on the relevance of including risk-taking as a potential determinant of MS. It is important to note that the database at our disposal does not provide any information regarding the ex-ante riskiness of individual investments and their ex-post realization; hence it does not allow a detailed empirical investigation regarding the effect of risk-taking on MS. The second best alternative is the Z-score, which captures the aggregate risk of insolvency, also known as the probability of default. This index is widely used in the literature as a measure of risk undertaken by a bank (Beck et al., 2013; Demirguc-Kunt and Huizinga, 2010; Houston et al., 2010; Giordana and Schumacher, 2012; De Nicolo, 2000; De Nicolo et al., 2004; Berger et al., 2009; Wolff and Papanikolaou, 2010). The Z-score measures the distance from insolvency (Roy, 1952) and is calculated as

$$Z_{i,t} = \frac{ROA_{i,t} + (E/A)_{i,t}}{\sigma(ROA)_{i,t}} \qquad \text{.... (6.1)}$$

where ROA is return on assets, E/A denotes the equity to asset ratio, σ(ROA) is the standard deviation of return on assets, *i* denotes the cross-section dimension (bank) and *t* stands for time. Boyd and Runkle (1993) interpret the Z-score as a number of standard deviations by which returns on assets need to fall from the mean to eradicate the bank's equity. A higher Z-score implies a lower probability of default, providing a more appealing measure of soundness compared to simple leverage measures.

In a similar vein as with capital, the literature with respect to risk-taking in banking is concerned with "the more" issue, but once again there is no clearly defined benchmark against which the undertaken risk of a bank is measured in order to become a "more" risk-taker. In this study the bank's Z-score index is defined as the difference between the Z-score of that bank and the median

Z-score in country *i* and time *t*. Accordingly, such definition of the Z-score accounts for the competitors' behaviour in term of risk-taking. If the estimated coefficient is negative it suggests that the higher the bank's solvency the lower the bank's MS, which implies that more-risk taking is associated with a higher MS. In terms of the expected sign of risk-taking, as discussed in Section 5.4.3, there are theoretical predictions and evidence that under some circumstances a positive relationship between risk-taking and MS is feasible, but in the medium and long run this effect mainly depends on the success (realization) of the undertaken projects and the bank's size. Hence, the general expectation with respect to the effect of risk-taking is ambiguous rather than positive.

Finally, ownership structure in banking is widely argued to affect a bank's performance in transition countries (Section 1.4 and Section 4.5). The relationship between market share and ownership structure can be considered as effected by different management goals. Aghion and Stein (2008) argue: *"If the firm's manager cares about the current stock price, she will favor the growth strategy when the market pays more attention to growth numbers. Conversely, it can be rational for the market to weight growth measures more heavily when it is known that the firm is following a growth strategy (p. 1025)."* If we assume that due to the higher expertise associated with foreign capital, the management of foreign-owned banks are more aware for the preferences of the investors compared to the management of the domestic-owned banks, then it is reasonable to expect that foreign banks aspire for a higher market share (a better competitive position). It is important that this empirical analysis does not follow the traditional definition for foreign bank, namely when more than 50 per cent of the capital is foreign. Instead, we include a dummy where 1 stands for banks with over 90 per cent foreign owned capital, and 0 otherwise, because we aim to investigate whether almost "fully" owned foreign banks have a higher market share compared to foreign banks with a substantial share of domestic capital and domestic banks. This definition of the ownership variable is used when estimating bank's cost efficiency in Chapter 4, where further discussion of this variable definition is provided (Section 4.3). The ownership variable can change over time which captures the ownership restructuring of the bank. It is expected that "fully" foreign owned bank will have a higher market share.

6.2.2 “Outside” bank determinants

The “outside” bank determinants can be divided in two groups of factors. The first group represents the macroeconomic environment in which banks operate, while the second group represent the regulatory and supervisory practices in the country, usually imposed by the respective central banks. Theoretical underpinnings and evidence with respect to the possible effect of regulation on MS are discussed in Section 5.3.5. So far, as discussed in Section 5.2, Gonzalez (2009) is the only author who investigates the effect of regulation and supervision on a bank’s MS and as he acknowledges his study is an empirical exercise without explicit theoretical grounds of the effect of regulation and supervision on MS, given that theories on this issue are still not developed. However, despite our effort to analyse the theory of banking regulation to derive testable hypotheses for the effect of different regulatory practices on a bank’s MS, it is important to note that this study does not provide a theoretical model in this regard (see Chapter 5). Therefore, for part of the regulatory practices there is no clear cut expectation of the effect on a bank’s MS.

The macroeconomic environment is represented by GDP per capita, population density and EU membership. GDP per capita is included to control for the differences in the levels of economic development across countries and over time. Population density is to control for the differences in the market size across countries and over time. A dummy variable for EU membership is included to distinguish between EU and non-EU countries, because EU countries compete in the single market.

The second group of “outside” determinants is of a special interest in this analysis given that banking is a significantly regulated industry. For that purpose the empirical model includes indices representing the regulatory and supervisory practices in the SEECs under investigation (the theoretical underpinnings for considering regulation and supervision as potential determinants of a bank’s MS is discussed in Section 5.3.5). In what follows in this section, we present only the indices employed in the empirical analysis; their detailed creation is presented in the following

Section 6.3 and the Appendix to Chapter 6, Section 6.1. For convenience we divide these indicators in three groups: (i) regulatory framework; (ii) supervisory framework and (iii) activity restrictions which can be related to bank herding (the last group is based on Beck et al., 2013).

Regulatory framework (Capital Requirements and Mitigation of Moral Hazard). This group of country-specific indicators represent regulatory measures that would prevent banks from risky behaviour when their charter value is eroded. They include *capital requirements* and *factors that mitigate moral hazard due to deposit insurance*. As discussed in Section 5.3.5, the reviewed literature gives ambiguous predictions for the effect of capital regulation on a bank's competitive position. In particular, a country with stringent capital requirements could be expected to have a less concentrated banking sector, that is banks with a lower MS on average, because capital requirements could be considered as a "brake" on lending activities, since instead of investing the capital in profitable projects, banks are obliged to put "aside" a certain portion of their capital. To empirically examine the country-level effect of capital regulation the *Capital Regulatory Index* is included in the model, which exhibits whether explicit (even risk-based) requirements exist regarding the amount and source of capital that banks are supposed to hold.

Another issue is to investigate the effect of deposit insurance schemes on the competitive position of a bank. Beck et al. (2013) use deposit insurance coverage to investigate the stability-competition relationship. However, due to lack of such data for the SEECs, it is not possible to directly control for the effect of deposit insurance on MS, where too generous deposit insurance schemes may enhance a bank's incentives for risk-taking in more competitive markets, as discussed in Section 5.4.5. In order to control for the prevention of moral hazard and excessive risk-taking due to introduction of insurance deposit schemes and to investigate the effect of such actions on a bank's competitive position, the Mitigating Moral Hazard Index is included in the model. The country-level effect of moral hazard mitigation is not clear, because these factors are supposed to provide fair, transparent and risk-tolerant competitive environment.

Supervisory framework (Official Supervision and Private Monitoring). More effective supervision is expected to limit the risk taking behaviour of a bank, which in turn can lessen the influence of competition on risk taking (Section 5.3.5). In this analysis the *Official Supervisory Power Index* is included to examine the effect of official supervision on a bank's competitive position. According to the discussion in Section 5.3.5 the expected country-level effect on bank's MS is not clear and straightforward, but a negative country-level effect could be expected if supervisors have difficulties in monitoring big and complex banking institutions.

Banking supervision may be supplemented by private (market) monitoring which serves the same purpose, as discussed in Section 5.4.5. Barth et al. (2006) advocate that many economists consider the private monitoring more reliable than the official supervision. That private monitoring is becoming an important aspect of banking regulation and maintaining the market discipline is why it has been introduced as a third pillar in Basel II; it was not a part of Basel I. However, the effect of the private monitoring is not clear cut in the literature; hence there is no clear priori expectation with respect to the sign. As discussed in Section 5.4.5, based on the arguments in Section 5.1, firms face problems with access to finance in highly concentrated markets, while households feel less likely to be credit constrained in areas where banks have greater market power (Bergstresser, 2005). This leads to opposite predictions of the customer preferences regarding the concentration in banking, hence the country-level effect is ambiguous. To examine the effect of private monitoring on a bank's competitive position, this empirical analysis includes the *Private Monitoring Index*. This index aims to capture the ability of the private market forces to affect a bank's behaviour.

Activity Restrictions. This group of "outside" bank determinants is motivated by Beck et al. (2013), but includes different variables from their study as discussed below. The country-level effect of activity restrictions is ambiguous. Specifically, these restrictions can be negatively associated with the concentration in banking, because by limiting the activities and markets, banks' growths are restricted, while on the other hand concentration may increase if some banks grow and become to dominate the current market. The *Activity Restrictions index* included in this empirical analysis measures the degree to which banks are allowed/prohibited from engaging in the business of securities (underwriting, brokering, dealing, and all aspects of the mutual fund industry), insurance (underwriting and selling) and real estate (investment, development and management); hence the degree to which banks are allowed to diversify away from traditional banking activities.

Given the above discussion the baseline model specification considers the inside-bank determinants and the outside-bank determinants, where for the latter we consider the country-level effect of regulatory and supervisory practices. The model is:

$$MS_{it}=f(MS_{it-1}, IBD_{it}, OBD_{ct}) \quad \text{... (6.2)}$$

Where MS_{it} stands for the market share of bank *i* in time *t*, IBD_{it} denotes a range of inside determinants for bank i in time t; OBD_{ct} represents a range of outside bank determinants for country c in time t. However as it is discussed in Section 6.3, data on regulation and supervision indicators are available only for two periods in time, since the survey used for creation of these indices is not conducted on yearly basis. Description of the variables included in the model is presented in Table 6.1.

6.3 DATA

As in Chapter 4, this empirical analysis investigates the determinants of a bank's MS in eight selected SEECs (Albania, BiH, Bulgaria, Croatia, Macedonia, Montenegro, Serbia and Slovenia). The period covered is 2002-2012 this is slightly different than in Chapter 4 where the analysed period was 2000-2012; more on this issue later in this section. For the purpose of this empirical analysis several data sources are exploited to obtain the required data. Hence, this section presents a comprehensive overview of the datasets employed as well as their descriptive statistics. We first focus on the related sources for bank-specific variables and then we discuss the data sources for the country-specific variables (regulation and supervision practices and macroeconomic environment). The exception is the main variable of interest, the cost efficiency, which is not collected from secondary data sources but estimated using Stochastic Frontier Analysis and Random Parameters Models (in Chapter 4).

The rest of the bank-specific variables of interest to this thesis are calculated using data obtained initially from Bankscope. However, as it is discussed in Section 4.3.2, the Bankscope database has substantial missing data for the countries under investigation in this thesis. In order to increase the representativeness of the dataset and to reduce the problem of missing data, the Bankscope data is supplemented by data from individual financial bank's reports available on their websites, as in the case of the cost efficiency estimation (details on the data augmentation process has already been discussed in Section 4.3.2). Especially relevant for this particular empirical analysis is the extension of the data regarding the number of bank's branches, because Bankscope provides very limited information on this variable, which is one of the main variables of interest. Specifically, the number of observations available from Bankscope with respect to the number of branches is 489, but in the final dataset after consulting the financial reports of each bank individually, this number is increased to 1912, which can be considered an important addition to our analysis.

Table 6.1 Description of variables used for estimation of the model in STATA 12

Variables and their abbreviation	Description
<u>Dependent variable</u>	
Market Share (LMSA)	Natural logarithm of percentage share of a bank's total assets relative to the total assets in the industry.
<u>Independent variables</u>	
Inside Banks (IBV)	
Efficiency (LEFF)	Natural logarithm of percentage efficiency estimates obtained using SFA and RPMs (Table 4.6: column TRE3T)
Branch density (BDEN10)	Number of branches per 10,000 km^2
Risk (DZS)	Relative Z-Score index calculated as the difference between each bank's Z-score and the median Z-score in the corresponding country and year. Z-score is calculated as a ratio of: the sum of return on assets and capital ratio over the standard deviation of return on assets

Capital (DEQ)	Relative capital ratio calculated as the difference between each bank's capital ratio and the median capital ratio in the corresponding country and year. Total capital ratio is calculated as total capital over total assets
Foreign Ownership (FOREIGN9)	A dummy for foreign ownership, taking the value of 1 when the share of foreign owners is over 90% of a bank's equity, 0 otherwise
Outside Bank (OBV)	
Regulation and Supervision	
Capital Regulation* (CRINDEX)	Index which may take values from 0 to 10, where higher values indicate greater capital stringency
Moral Hazard Mitigation* (MORALH)	Index which may take values from 0 to 3, where higher values indicate greater mitigation of moral hazard
Official Supervisory Power* (OSPOWER)	Index which may take values from 0 to 12, where higher values indicate greater supervisory power
Private Monitoring* (PMINDEX)	Index which may take values from 0 to 11, where higher values indicate more private monitoring
Activity Restrictiveness* (OAR)	Index which may take values from 0 to 12, where higher values indicate greater activities restrictiveness
Macroeconomic Environment	
Population density (LPOP)	Natural logarithm of inhabitants per km^2
EU/Non-EU country (EU)	Dummy variable 1 for the year before EU accession, 0 otherwise
Economic development (LGDPC)	Natural logarithm of GDP per capita in constant 2005prices

Source: The author
*Note: * See the text below and Appendix to Chapter 6, Section 6.1 for the calculation of these indices*

A further drawback of the Bankscope dataset is the lack of accuracy and consistency in the representation of the number of branches. During the process of data augmentation it was realized that the figures on branches do not always reflect a unique definition of a bank's branches, instead in many occasions they only represented major branch units, while in others they include also other representative offices, outlets, etc. in addition. Such inconsistent data can easily lead to misleading empirical findings. In order to correct for this inconsistency, we use a broad definition of branch, namely all network units a bank utilizes to serve its customers are defined as a branch. However, despite the effort to correct the inconsistency, the problem is not completely solved, given that not all banks report the number of all different network units, for example outlets.

Turning to the data required for the "outside" bank determinants two data sources are used. For the purpose of the environmental variables (GDP per capita and population density) the World

Bank Database is used and there is no issue with this data that requires additional discussion. However, for this empirical analysis the data for regulatory and supervisory practices requires more explanation, given that in the creation of these variables we make use of the special surveys sponsored by the World Bank, designed and implemented by a group of researchers (Barth, Caprio and Levine 2001, 2004, 2008). This particular survey was conducted in several waves in 2001, 2003 and 2007. The original survey (Survey 1) as of 2001 is conducted in 117 countries in the period 1998 and 2000. In 2003 the first update of the survey is conducted (Survey 2) in 152 countries, which reflects the regulatory situation in 2001-2002, while the Survey 3 is conducted in 2007 covering 142 countries (Barth et al., 2006, 2008). For the purpose of this analysis we make use of the Survey 2 and Survey 3, mainly because the questions in these two surveys differ from Survey 1, hence a comparable indices with respect to regulatory and supervisory practices in each country cannot be created that include the earlier survey. Moreover, if the length of the time component of the panel was important for estimation of time-varying cost efficiency (Section 4.2.2), this is not the case for dynamic panel models using GMM (Section 6.4), in other words dynamic panel models are designed for short T (time series dimension) and wide N (cross-section dimension). Additionally, in the first two years of the dataset (2000 and 2001) the number of banks included in the analysis for some of the countries is small. Accordingly, considering these arguments the time span covered in this analysis is from 2002 to 2012, the years 2000 and 2001 are excluded.

Survey 2 and Survey 3 are used for creation of the indices which reflect the regulatory and supervisory practices in each country for the periods 2002-2007 and 2008-2012, respectively. The rationale for such split of the time span is to avoid the problem of potential simultaneity bias in the relationship between regulators/supervisors and banks' managers, given the contrasting views of grabbing or helping hand of the government, as discussed in Section 5.4.5. Specifically, given that Survey 2 reflects the regulation in each country in the period 2001-2002, we use the indices created from this survey from 2002, because the accounting data as used for this analysis reflects the bank's position as of the end of year 2002. Survey 3 is conducted in 2007, hence the indices created from this survey are used from 2008 until 2012. Another option to control for endogeneity is to use instrumental variables in line with Gonzalez (2009) who uses a number of instruments for the observed values of the variables reflecting the regulation and supervision practices. In particular, he follows Barth et al. (2004) and uses the following instruments: legal origin dummy variables (English, French, German, Scandinavian, and Socialist), latitudinal distance from the equator, and religious composition dummy variables (the percentage of population in each country that is Roman Catholic, Protestant, Muslim, or other). The study of Gonzalez investigates market structure determinants on a sample of 69 countries, hence this choice of instruments could be considered as reasonable, because the sample is comprised of countries worldwide. However, our analysis includes selected SEECs which are neighbouring countries, thus the differences in the latitudinal distance from the equator are negligible and moreover they share very similar characteristics in terms of legal origin and religion. Consequently, Barth's instruments are inappropriate for our analysis. As discussed in the next section for the purpose of this analysis we employ dynamic panel model estimated by General Methods of Moments (GMM) technique which allows lagged values of the variable itself and/or its lagged differences to be used as instruments. Nevertheless, such instrumentalization is problematic for these variables, given their limited variation across years. Therefore, it seems that our approach is the most appropriate to control for potential causality bias, that is one year lagged indices.

It is important to note that Albania, Serbia and Montenegro are included in the Survey 2, but not in Survey 3. In addition, Serbia and Montenegro are considered together as one country in Survey 2, because at that time Montenegro was not an independent country. Hence, the same indices are used for both countries. Given that Albania, Serbia and Montenegro are only included in the Survey 2, these countries are included only for the period 2002-2007.

The regulation and supervision indices are created following Barth et al. (2006). In what follows, we present the generation of only two indices while in Appendix to Chapter 6, Section 6.1 the generation of other indices is presented. For the purpose of demonstration we choose the index for Overall Activity Restrictions and the index for Factors Mitigating Moral Hazard. The rationale for choosing these two indices is the difference in the offered answers for the questions included in the corresponding index. In particular, the former index is based on multiple choice questions, where only one answer can be chosen and each choice has a different score value (from 1 to 4). On the other hand, the latter index is based on YES/NO questions (as majority of the other indices), where the answer has a value 1 for YES and 0 for NO. However, one of the questions included in this index is a multiple choice question, with one answer to be chosen as presented below. The value of the index is a simple sum of the answer values from each question, which gives an equal weight of all questions included in the corresponding index.

The Overall Activity Restrictions Index is consisted of three questions regarding the regulation banks to be involved in activities related to securities, insurance and real estate market (as originally defined in the Survey, Barth et al., 2006):

- Securities: What is the level of regulatory restrictiveness for bank participation in securities activities (the ability of banks to engage in the business of securities underwriting, brokering, dealing, and all aspects of the mutual fund industry)?
- Insurance: What is the level of regulatory restrictiveness for bank participation in insurance activities (the ability of banks to engage in insurance underwriting and selling)?
- Real Estate: What is the level of regulatory restrictiveness for bank participation in real estate activities (the ability of banks to engage in real estate investment, development, and management)?

There are four identical answers (as originally defined in the Survey, Barth et al., 2006) offered to the three questions such as:

- Unrestricted (a full range of activities in the given category can be conducted directly in the bank). This answer has a value of 1.
- Permitted (a full range of activities can be conducted, but all or some must be conducted in subsidiaries). This answer has a value of 2.
- Restricted (less than a full range of activities can be conducted in the bank or subsidiaries). This answer has a value of 3.
- Prohibited (the activity cannot be conducted in either the bank or subsidiaries). This answer has a value of 4.

Given the values of each answer by summing them up (only one answer chosen) the index range can vary from 3 to 12. The higher the index value, the higher the restrictions for non-banking activities.

The index for Moral Hazard Mitigation includes three questions related to the possible measures that can be undertaken in order to reduce banks' activities which lead to moral hazard problems. The existence of such measures is reflected by the following questions, as originally defined in the Survey of Barth et al. (2006) are:

1. Is explicit deposit insurance protection system funded by (check one): the government, the banks, or both? The value is 1 if the answer is "banks", otherwise 0
2. Do deposit insurance fees charged to banks vary based on some assessment of risk? The value is 1 if YES, 0 if NO
3. Is there formal coinsurance, that is, are depositors explicitly insured for less than 100% of their deposits? The value is 1 if YES, 0 if NO

Likewise, the previous index each answer values are summed up to obtain the country index value. Hence, the value of this index may vary from 0 to 3. The higher the index, the more activities are undertaken for mitigating moral hazard.

As presented the creation of indices is fairly straightforward and there is no need for further elaboration. However, the regulatory and supervisory indices are not without problems in terms of statistical and theoretical perspectives. As presented earlier the creation of the indices is based on simple summing up of the answer values for the questions included in each index, which in turn complicates the interpretation of the estimated coefficients. In particular, given the method of creating these indices sheds light on their type of data and interpretation, because these indices neither represent continuous data nor ordinal data. In other words, while the interpretation of the continuous regressors is almost straightforward, it is not the case for the ordinal data, because the difference between the assigned values within each index is not measurable and may not be consistent, although the assigned values provide additional information of the rank order for the assigned values. For example, if we recall the index for activity restrictiveness the offered answers for each question are: 1=unrestricted; 2=permitted; 3=restricted and 4=prohibited, which raises the question of whether the difference between "unrestricted" to "permitted" is really the same as the difference between "permitted" to "restricted". This issue is transmitted to the indices themselves; hence a traditional interpretation (one unit increase in the corresponding index) is inappropriate. There are two possible approaches in order this problem to be overcome. The first approach is to investigate the effect of each regulation and supervision measure/policy separately as binary variables (yes/no with arbitrary labels 0 and 1). However, the rationale for excluding this approach is fourfold: (i) the aim of this thesis is to investigate the effect of the three Basel II pillars (capital regulation, supervision and market discipline) and the effect of some regulation strategic policies such as activity restrictions and measures that allow for mitigation of moral hazard on competitiveness in banking sector, rather than investigating each policy individually; (ii) there is no explicitly defined theory for the effect of the major regulation and supervision concepts on competitive position, hence less expected is that the theory provides any guidelines for individual regulation policies; (iii) given the size of the data it is not feasible to include a binary variable for each regulation and supervisory policy as defined in the Survey; (iv) there is a very high correlation between the responses which reflect the individual regulation policies. The second approach includes modification in the interpretation, in other words, only the sign (positive or negative) of the estimated coefficients of the indices to be interpreted, while the size of those coefficients to be ignored (Section 6.5).

Another relevant issue to be discussed related to the interpretation of the estimated effects with respect to the regulatory and supervisory practices is the "level of aggregation" against which these effects are interpreted. As discussed in Section 5.3.5 and Section 6.2, and also in Berger and Bouwman (2013), the battle for market share is a zero-sum game (one bank may gain market share at the cost of other bank, hence the sum of all shares equals to 1), hence it cannot be expected that on average, ceteris paribus, change in regulation can contribute to the increase (decrease) of each bank's MS (it should be noted that although for banks in the market at a particular time it is not a zero sum game if there is exit from and entry into the industry; some exit and entry did occur in the countries investigated as show in Table 6.3). As discussed in Section 5.3.5 and Section 6.2 the effect of regulation on a bank's MS is expected to depend on "inside" bank specificities, which suggest that the differential impact of regulation on a particular bank's MS depends on bank specific determinants. Hence, we distinguish between country-level and bank-level effects of regulation on a bank's MS. The country-level effect is interpreted as to whether a particular regulation leads to a lower or higher concentration, that is, a banking sector where, on average, individual banks have lower or higher MS, respectively. The bank-level effect, as discussed in Section 5.3.5, is captured by inclusion of interaction terms of regulatory and supervisory practices, and bank-specific variables and in this context the effect is interpreted as giving variation in the effect at bank level.

However, given the size of the cross-sectional dimension of our dataset, the possible simultaneity between "inside" bank's factors and the MS in addition to the GMM dynamic model estimation procedure (Section 6.4), it is not possible to include all interaction terms between each regulatory and supervisory practices and each "inside" bank determinants at the same time. The reason is the significant loss of degrees of freedom and the problem of providing sufficient instruments for all the endogenous variables (since all the interacted terms include endogenous variables, hence instruments need to be used for their estimation as discussed in Section 6.4). Consequently, we consider two transmission channels of regulation on MS, size of the bank and risk-taking, which are presented in Section 6.5.2 as alternative models, in addition in the baseline model specification which examines the country-level effect of regulation. It is important to note that besides the challenges from theoretical and empirical perspectives this thesis aims to provide empirical findings for first time in terms of the impact of regulation and supervision on competitive position in banking and to lay ground for further theoretical and empirical studies in this area. Table 6.2 presents the calculated indices for the regulatory and supervisory practices across countries based on the Survey 2 and Survey 3 and they signal variations across countries and surveys.

Table 6.2 Indices for regulatory and supervisory practices across countries and surveys

		Overall Activities Restrictiveness	Capital Regulatory Index	Official Supervisory Power	Private Monitoring Index	Factors Mitigating Moral Hazard
Survey 3	***Country***					
	BiH	8	7	12	4	1
	Bulgaria	7	7	11	6	1
	Croatia	6	5	10	6	1
	Macedonia	6	4	12	6	0
	Slovenia	8	7	13	7	1
Survey 2	***Country***					
	Albania	6	5	12	5	0
	BiH	8	6	14	6	2
	Bulgaria	7	8	11	6	1
	Croatia	6	5	12	7	2
	Macedonia	6	4	12	5	1
	Serbia & Montenegro	6	7	5.5	6	2
	Slovenia	8	10	12	7	2

Source: Author's calculation based on Barth et al. (2006)

The values of the indices indicate that regulation and supervision are subject to changes over short period of time, except OAR, which indicate that regulators aim to adopt and adjust the new international regulations (for example Basel 2 and Basel 3, since in the period when these surveys are conducted, the countries under investigation has not yet fully adopted these practices). Table 6.3 presents the number of banks across countries through time included in the empirical analysis.

Table 6.3 Number of banks included in the dataset across counties and years

Year/Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total
Albania	8	9	10	9	8	9						53
BiH	23	24	22	23	23	24	23	23	21	21	21	248
Bulgaria	14	19	22	24	24	23	23	23	21	21	20	234
Croatia	24	27	27	28	28	28	28	27	25	25	25	292
Macedonia	9	9	12	12	13	13	13	13	12	12	11	129
Montenegro		5	6	9	9	9						38
Serbia	7	18	25	26	28	28						132
Slovenia	16	17	17	17	17	17	17	17	17	17	17	186
Total												1912

Source: Author's calculation based on various publications by the national banks of the countries under consideration

Table 6.4 presents descriptive statistics of the data used for estimation of the baseline model.[43]

Table 6.4 Descriptive statistics of the variables used in estimation of the baseline model

Variable (based on 1069 observations)	Mean	Min	Max
Market Share as a % of Assets	2.41	0.04	49.06
Lagged Market Share	2.32	0.04	54.06
"Inside" bank determinants			
Cost efficiency (%)	88.32	40.17	99.58
Branch density per 10,000km^2	9.85	0.09	84.41
Z-Score (relative to industry median)[a]	6.79	-32.03	544.64
Capital Ratio (relative to industry median)[a]	2.46	-20.06	70.31
Foreign capital (>90%)		0	1
"Outside" bank determinants			
Macroeconomic environment			
Population density (population on km^2)	80.75	45.70	118.27
GDP per capita (in $)	5,721.58	2,314.62	20,702.30
EU membership		0	1
Regulation and Supervision			
Activity Restriction Index	6.87	6	8
Official Supervisory Power	11.14	5.5	14
Capital Regulatory Index	6.36	4	10
Mitigating Moral Hazard	1.30	0	2
Private Monitoring Index	5.97	4	7

Note: a) the values of the median z-score across countries and time are presented in Appendix to Chapter 6, Section 6.2.1.

6.4. METHODOLOGY

This section aims to identify a suitable estimator for the specified model in Section 6.2 (Eq. 6.2) given that the dataset is a panel. As a departing point we consider the specificities embraced in the model developed in Section 6.2 (Eq. 6.2). The inside bank determinants raise serious econometric issues due to the presence of the lagged dependent variable (market share) and potential endogeneity due to simultaneity between market share and inside bank determinants

[43] These descriptive statistics are calculated after the estimation of the baseline model, i.e. using the command "estat summarize" after estimating the model with xtabond2. However, given that many of the variables are expressed in natural logarithm, in Table 6.4 the values are converted in original values in order to be easily readable. Appendix to Chapter 6, Section 6.2.2 presents the unique descriptive statistics corresponding to the estimated model.

and bank-specific heterogeneity. In addition, part of the variables of interest (the outside bank determinants) are mainly time-invariant indices (see Section 6.3), hence the choice of a panel model is also based on ability of the model to allow for estimation of coefficients of time-invariant variables. Hence, the focus is turned on dynamic panel models.

Dynamic panel models induce serious complications in terms of estimation, since the basic assumptions of the linear regression are violated. In particular, given that the dependent variable is a function of the unobserved individual specific effect, it follows that the lagged dependent variable is as well function of the same unobserved individual specific effect. Therefore, the lagged dependent variable is correlated with the error term (Baltagi, 2005, p.147). However, the random-effects model assumes that the independent variables are independent of the error term (Baltagi, 2005, p. 17), thus the GLS estimator is biased (Baltagi, 2005, p.148). In a similar vein, the fixed-effect model estimated by OLS is biased and inconsistent, although this model does not assume that independent variables are independent from the unobservable individual specific effect, even if the remainder disturbances are not serially correlated (more details on these Baltagi, 2005, p. 147). Consequently, dynamic panel models cannot be accurately estimated by conventional panel econometric techniques.

The current knowledge regarding the estimation of dynamic panel models suggests a use of approach introduced by Arellano and Bond (1991) and Arellano and Bover (1995) which relies on General Methods of Moments (GMM) estimator. Prior to the discussion of this approach, which requires large cross-section (N) and short-time series (T), we briefly present the GMM estimator. GMM *"refers to a class of estimators which are constructed from exploiting the sample moment counterparts of population moment conditions (some-times known as orthogonality conditions) of the data generating model*", (Hansen, 2007, p. 1). GMM estimator embraces other familiar estimators, including least squares (linear and nonlinear), instrumental variables, and maximum likelihood, (Greene, 2002, p. 540) and *"permits the disturbances implicitly used in the orthogonality conditions to be both conditionally heteroskedastic and serially correlated"* (Hansen, 1982 p. 1030).

In the presence of endogenous variables in the model, the covariance between the error term and (some of) the independent variables differs from zero, $Cov[\varepsilon_i, \boldsymbol{x}_i \neq 0]$, the estimates of the coefficients of interest are likely to be biased and inconsistent. A remedy for this problem is found in the instrumental variables, a vector of variables, $\boldsymbol{w}_i$, such that $\boldsymbol{w}_i$ is uncorrelated ε_i, but correlated with the endogenous variables, a set of orthogonality conditions $E[\boldsymbol{w}_i \varepsilon_i | \boldsymbol{x}_i]$ (Greene, 2002, p. 545). Given that the number of instruments is not limited, implies that there may be more than one set of moments which can be employed for estimating the parameters. Exactly this feature gives preference to GMM in estimation of the dynamic panel models.

The orthogonality conditions that exist between the lagged values of the dependent variable and the disturbances can produce additional instruments in dynamic panel data model (Arellano and Bond, 1991). This seminal idea initiated a development of two types of dynamic estimators– a difference GMM estimator (Arellano and Bond, 1991) and a system GMM estimator (Arellano and Bover, 1995; Blundell and Bond, 1998).

Consider a simple autoregressive model without independent variables:

$$y_{it} = \beta y_{it-1} + \varepsilon_{it}, \quad i = 1, \ldots, N; \quad t = 1, \ldots, T; \ |\beta < 1| \qquad \ldots (6.3)$$

where $\varepsilon_{it} = \mu_i + v_{it}$, $\mu_i \sim IID(0, \sigma_\mu^2)$ denotes unobservable time-invariant individual specific effect and $v_{it} \sim IID(0, \sigma_v^2)$ stands for time variant disturbance; μ_i and v_{it} are assumed to be uncorrelated with each other and among each other. In this model $Cov[\varepsilon_{it}, y_{it-1} \neq 0]$ because μ_i and y_{it-1} are correlated. Consistent estimate of β can be obtained if the time-invariant specific effects are eliminated. This problem is solved by differencing the model:

$$y_{it} - y_{it-1} = \beta(y_{it-1} - y_{it-2}) + (v_{it} - v_{it-1}) \qquad \ldots (6.4)$$

However, endogeneity is still a problem, since the differenced lagged dependent variable and disturbance are correlated because $y_{it-1}$and v_{it-1} are correlated (Greene, 2012; p.537). However, this can be overcome by employing the lagged difference $y_{it-2} - y_{it-3}$ or lagged levels y_{it-2} and y_{it-3} as instruments for $y_{it-1} - y_{it-2}$, when T=3. Accordingly, the number of valid instruments increases for each forward period, hence for period T, the number of valid instruments would be $(y_{i1}, y_{i2}, \dots, y_{iT-2})$, (Baltagi, 2005, p. 149). However, the strength of the instruments is of importance in parameter estimation and it is expected that strength will diminish the further back in time the instrument is from.

Blundell and Bond (1998) show that in case of dependent variable with random walk, $\beta \rightarrow 1$ and as ${\sigma_\mu^2}/{\sigma_v^2}$ increases the Arellano and Bond (1991) difference estimator performs poorly as first-differenced instruments become weak (Baltagi, 2005, Pugh, 2008; Roodman, 2009a). Blundell and Bond show that in the presence of a random walk, the "system" GMM estimator (Arellano and Bover, 1995; Blundell and Bond, 1998) is considerably more efficient than the difference GMM. The "system" GMM is an extension of the difference GMM and embraces two equations, original level equation in addition to the difference equation. System GMM employs lagged differences of y_{it} as instruments for equations in levels, in addition to lagged levels of y_{it} as instruments for equations in first differences.[44] The rationale for inclusion of the levels equation in the model is found in the argument of Roodman (2009a, p. 114): *"For random walk–like variables, past changes may indeed be more predictive of current levels than past levels are of current changes so that the new instruments are more relevant."* The "system" estimator unlike the difference estimator has the ability to estimate time-invariant variables. Given that some of the variables of interest in our empirical analysis are time-invariant (Section 6.3), system GMM is preferred over difference GMM.

However, the "system" GMM is not free of drawbacks. The most known and emphasized problems are: the "too many instruments" and the assumption of the "steady state". Both the Sargan and Hansen tests are used to test the validity of the instruments, but the Sargan test

[44] Consequently, the dataset is now compiled with twice the observations, each observation for the levels equation and the differenced equation.

requires errors to be homoskedastic (which is rarely the case) and Hansen is robust to heteroskedasticity, hence Hansen is the preferred test for testing the validity of the instruments (Roodman, 2005b). Roodman emphasizes that the conventional levels of 5 and 10 per cent used to reject the null hypothesis of instrument validity could not be considered as an acceptable threshold for instrument validity. Instead, he proposes a p-value of 0.25 as possible threshold for rejection of the null hypothesis. However, the Hansen test (as well as the Sargan test) is weakened by too many instruments and may mean that it is unable to reject the null hypothesis of instrument validity. In this case the p-value estimated is close to 1. However, the literature does not provide clear "guidance" in terms of the optimal number of instruments. It is required that the number of instruments should at least be smaller than the number of groups (cross-sectional units) used in estimation. Regarding the "steady-state" assumption, Mangan et al. (2005) argue that two conditions are necessary for this condition to hold: (i) the absolute value of the estimated coefficient on the lagged dependent variable must be less than 1 in order the process to be convergent and (ii) the convergence process must be independent from the unobservable time-invariant individual specific effects, otherwise changes in the dependent variable would not depend on the error term.

One-step and two-step procedures can be employed to estimate the GMM estimators. In the one-step procedure the GMM estimator assumes that the variance of the errors is homoscedastic in the weighting matrix, an arbitrary assumption. The two-step procedure provides a robust estimator as in the second step the residuals from the first step are used to construct a proxy for the optimal weighting matrix which is then embodied in the feasible GMM estimator, which is robust to the modelled patterns of heteroskedasticity and cross-correlation (Roodman, 2009a, p. 9). A drawback of the two-step procedure is the downward bias of the standard errors in the case of large number of instruments; however Windmeijer (2005) proposes corrections for the two-step standard errors. These corrected standard errors as proposed by Windmeijer are superior to the cluster-robust one-step standard errors (Roodman, 2009a, p. 12). Consequently, this empirical analysis uses the two-step system GMM and the standard error correction procedure by Windmeijer (2005).

Another issue related to the treatment of standard errors also deserves discussion. Specifically, the bank efficiency variable (one of the “inside” bank determinants as discussed in Section 6.2.1) presents the estimated level of each bank’s cost efficiency. Cost efficiency was estimated for each bank and each year as presented in Chapter 4, and these estimates are used as an independent variable in the model in this chapter. According to basic econometrics, it is expected that these cost efficiency estimates include an error element, which is reflected in the standard errors of that estimate. As a result, when an estimated variable is introduced as an independent variable in the empirical model (as in our case), it may be expected that an appropriate adjustment may become necessary to take account of the error involved in its earlier estimation. Such a procedure should be applied regardless of whether the estimates used in the second stage (in our case in the empirical analysis of this chapter) are estimates of a dependent variable or error term in the first stage. In our case the cost efficiency estimates are derived from the composed error term, which implies that the standard errors of the estimated cost efficiency variable obtained in the next section should be adjusted. However, it is important to note that the cost efficiency estimates obtained in Chapter 4 do not provide a variance for the individual efficiency estimates (this is considered as a limitation of the SFA), hence there is nothing that can be used for correction. Alternatively, the problem can be viewed as measurement error, for which the standard econometric approach is to use IV estimation. However, we are not aware of any adjustment that provides a treatment for this problem in GMM estimation, nor is it clear how a separate model for the measurement error can be developed that could be used to construct an external IV.[45] Thus, given the lack of an appropriate procedure, no adjustment is made for this problem in the analysis that follows.

The inclusion of lagged dependent variable introduces a different interpretation of the equation Greene (2012, p. 536). In a static model the set of independent variables denotes the full set of information which produce the observed dependent variable. When the lagged dependent variable is included in the model it implies that the entire history of the independent variables is

[45] I am indebted to Professor William Greene for explaining these points to me in emails dated the 17th of July 2012 and 31st of March 2015.

now included in the model, hence any measured influence of the independent variables is conditioned on this history. Accordingly, the estimated effect of the independent variables embodies the effect of new information, which presents the so-called short-run effect. On the other hand, the long-run effect is obtained as a product of the estimated coefficient (for all independent variables except the lagged dependent variable) and the long-run multiplier $^{1}/_{1-\beta}$ (where β is the estimated coefficient on the lagged dependent variable), (Greene, 2002, p.568).[46]

6.5 EMPIRICAL FINDINGS

This section discusses the empirical findings obtained from the baseline model (Eq. 6.2) and from the alternative models which examine whether the determinants differently affect, in terms of sign and magnitude, the market share of the big banks and the other banks. According to the theoretical framework discussed in Chapter 5 followed by the discussion of specification of the baseline empirical model in Section 6.2 and the methodology in Section 6.4, the following form of the model is specified:

$$LMSA_{it} = c + \alpha LMSA_{it-1} + \boldsymbol{X_{it}\beta} + \boldsymbol{Z_{it}\gamma} + v_i + u_{it} \qquad \text{… (6.5)}$$

[46] The standard error and the corresponding t-statistic for the long-run effects are calculated using the delta-method (Greene, 2002, p. 569). The validity of the long-run coefficient is conditioned on the stability of the system (no structural breaks over time).

where $LMSA_{it}$ stands for the banks' competitive position (the natural logarithm of the bank's market share based on total assets) for bank *i* in time *t*, X and Z include "inside" and "outside" bank determinants, respectively as defined in Section 6.2, while v_i denotes time-invariant unobservable individual specific effect and u_{it} stands for the remainder disturbance.

The full specification of the baseline model, with the constituent variables in X and Z, is:

$$LMSA_{it} = c + \alpha LMSA_{it-1} + \beta_1 LEFF_{it} + \beta_2 BDEN10_{it} + \beta_3 DZS_{it} + \beta_4 DEQ_{it} + \beta_5 FOREIGN9_{it} + \gamma_1 LPOP_{it} + \gamma_2 LGDPC_{it} + \gamma_3 EU_{i(t)} + \gamma_4 OAR_{i(t)} + \gamma_5 OSPOWER_{i(t)} + \gamma_6 CRINDEX_{i(t)} + \gamma_7 MORALH_{i(t)} + \gamma_8 PMINDEX_{i(t)} + \theta_1 D_t + v_i + u_{it} \quad \text{... (6.6)}$$

The full names of the variables included in equation 6.6 are presented in Table 6.1. Given that some of the variables are characterized by limited variation over time we use **(t)** to distinguish these variables from the continuous variables. In order to control for cross-sectional dependence the model includes time dummies (D_t from 2003 to 2012, where 2002 is excluded to avoid perfect multicolinearity). Such dependence is likely to occur due to universal time-shocks which in turn affect all units of analysis (Roodman, 2009a).

STATA 12 econometric software is used to estimate these models. The lagged dependent variable and all "inside" bank determinants (cost efficiency, branch density, relative capital ratio and relative risk) are treated as endogenous (Section 5.5). The decision regarding the "rank" and "depth" of instruments, that is the specified combination of lags used as instruments is made in accordance to the principle that all necessary model diagnostics are satisfied. When several alternative sets of instruments give satisfactory diagnostics the choice of final results is made on two grounds: (i) smaller number of instruments exploited and (ii) the estimates make more economic sense. Given that the dataset available for this empirical analysis is unbalanced all the models are estimated using the forward orthogonal deviations transform instead of first differencing, as this preserves sample size in panels with gaps (STATA 12 Manual). To keep the focus on the variables of interest, the results on the year dummy variables are presented only for the baseline model in section on the diagnostics of models. The original estimation printouts for all estimated models along with the syntax for each of them are enclosed in the respective appendices.

6.5.1 Baseline model

The diagnostics of the model are given in Table 6.5 along with the estimated coefficients of the year dummies (the original printouts related to the baseline model are presented in Appendix to Chapter 6, Section 6.3). One of the most important issues in the dynamic panel estimation technique is the choice of instruments, given that the technique exploits instruments are derived within the system (Section 6.3). As discussed in Section 6.4 “too many instruments” can lead to reduced power of the instrument validity test (Sargan/Hansen). The baseline model is estimated by using 36 instruments comparing to the number of groups 148 and total of 1069 observations (Table 6.5). Thus the number of groups is four times higher than the employed number of instruments (Roodman’s, 2007 minimally arbitrary rule of thumb is that the former should be at least equal to the latter). The p-value of the Hansen test in the baseline model is 0.68 (Table 6.5) suggesting that the employed instruments are valid.

Table 6.5 Diagnostic Statistics of the baseline model

Test Statistics	p value	Hypothesis
Serial correlation		
AR(1)	0.000	H_0: no first-order autocorrelation
AR(2)	0.555	H_0: no second-order autocorrelation in the error term of the first-differenced equation
Instrument validity		
Hansen test	0.680	H_0: the overidentifying restrictions are valid
Steady state assumption		
Difference-in-Hansen	0.846	H_0: Instruments for levels equation are valid
Cross-sectional dependence		
Sarafidis test: Difference-in-Hansen Market Share collapse lag(3 3)	0.526	H_0: Instruments on lagged dependent variable is valid
Difference-in-Hansen tests of exogeneity of instrument subsets:		

Efficiency: collapse lag(2 2)			0.827	H_0: Instruments are valid
Branch density: collapse lag(2 2)			0.307	H_0: Instruments are valid
Z-Score relative to industry median in year *t*: collapse (4 .)			0.385	H_0: Instruments are valid
Capital ratio relative to industry median in year t: collapse (2 2)			0.393	H_0: Instruments are valid
Wald test for joint significance of the independent variables			0.000	H_0:Coefficients are jointly equal to zero
Time dummies/coefficient/(Std. error)/(p-value)				
Year 2004	0.0145	(0.0217)	0.503	
Year 2005	0.0018	(0.0261)	0.946	
Year 2006	-0.0360	(0.0281)	0.201	
Year 2007	-0.0591	(0.0316)	0.061	
Year 2008	-0.1483	(0.0737)	0.044	
Year 2009	-0.1721	(0.0746)	0.021	
Year 2010	-0.1484	(0.0725)	0.041	
Year 2011	-0.1766	(0.0714)	0.013	
Year 2012	-0.1886	(0.0713)	0.008	
Observations	**1,069**			
Number of id	**148**			
No. of Instruments	**36**			

Source: The author

The Arellano-Bond test checks for autocorrelation of first and second order, hence it is also known as the m1/m2 test. The null hypothesis of this test is that there is *no second-order autocorrelation in the error term of the first-differenced equation*. In particular, it is expected that first differences of errors are serially correlated, but there should be no second-order serial correlation. If these conditions are satisfied then second and higher lags of potentially endogenous variables are valid instruments. The p-value of 0.000 for the first-order autocorrelation means the null hypothesis of no autocorrelation of first order is rejected while the p-value of 0.555 for no second-order of serial correlation indicates there is insufficient evidence to reject the null hypothesis of no autocorrelation of second order in differences of errors (Table 6.5).

Next important check is related to the assumption of steady-state, hence the difference-in-Hansen test for levels equation is used. This test suggests that there is insufficient evidence to reject the null hypothesis of valid instruments for levels indicating that the assumption of steady-state holds, which in turn gives support to the system estimator over the difference estimator. The majority of the individual year dummies (from 2007 to 2012) are significant and they are also jointly significant at all conventional levels, suggesting universal time-related shocks. Given that the analysis covers the period of the last financial crisis it is expected that the banking sectors in all of the countries under investigation are affected by this universal shock in part of the period under investigation. However, Sarafidis et al. (2009, p.2) argue that cross-sectional dependence may still be present although year dummies are included in the model and for that they propose additional testing procedure which is related to the validity of the instruments used for the lagged dependent variable. The difference-in-Hansen test statistic for the over-identifying restrictions after excluding the instruments on the lagged dependent variable suggests insufficient evidence to reject the null hypothesis that the instruments on lagged dependent variable are valid, thus no evidence is found that there may be cross-section dependence in the error term.

The econometrics literature shows that OLS estimation biases upwards the coefficient on the lagged dependent variable, whereas the fixed effects estimation of this coefficient gives a downward bias (Roodman, 2009a). Consequently, the estimated coefficient of the lagged dependent by a true dynamic estimator is expected to be within the range of the estimates obtained by fixed effects (the lowest bound) and OLS (the highest bound). As presented in Table 6.6 the obtained coefficient of the lagged dependent variable lies between the estimated coefficient with OLS and fixed effects method (Appendix to Chapter 6, Section 6.3). The test for joint significance of the independent variables included in the model suggests that the variables have jointly explanatory power. Thus overall the diagnostic statistics suggest that the baseline model is well specified.

Table 6.6 Comparison of coefficients on lagged dependent variable obtained with OLS, dynamic panel system GMM and fixed effects estimation techniques for baseline specification

Model	Coefficient	Std.Error	Probability
Fixed Effects	0.667	0.020	0.000
System GMM	0.864	0.041	0.000
Ordinary Least Square (OLS)	0.954	0.006	0.000

Source: The Author

In the baseline model specification in Table 6.7, the coefficient on the lagged dependent variable (market share) is positive and highly significant supporting the hypothesis of dynamics in the competitive position of a bank, that is there is a presence of partial adjustment in a bank's market share towards their desired position. A one per cent increase in the lagged dependent variable leads to a 0.87 per cent increase in the current market share. This implies that the value of past determinants has strong persistence and their effects are important for the bank's competitive position in the current period as discussed in Section 6.2.

The inside bank determinants are considered first. Cost efficiency, which is the initial concern in this thesis, is insignificant, although the coefficient is positive as expected. The finding that market share is not determined by cost efficiency allows for an alternative interpretation, related to the debate of efficiency versus market power hypothesis (Section 5.3.2), that banks may gain market share due to market power, however, as discussed in Section 6.2 the model specification as such does not directly investigate this issue. It is possible that neither efficiency nor market power are important determinants of a bank's market share in SEECs, but other factors such as non-pricing behaviour (quality), risk-taking, the level of capitalization or regulation and supervision are the principal determinants of a bank's market share, and these are discussed in what follows.

Table 6.7 Determinants of the bank's competitive position (natural logarithm of market share) in SEECs 2002-12 (baseline model specification)

Dependent Variable	Short run	Long run
Natural logarithm of Market Share (Assets)		
Lagged dependent variable	0.865***	-
	(0.0406)	
"Inside" bank determinants		
Cost efficiency (natural log.)	0.3038	2.2552
	(0.5470)	(4.0894)
Branch density per 10,000km^2	0.0182**	0.1350**
	(0.0073)	(0.0609)
Z-Score (relative to industry median)	-0.0015***	-0.0108**
	(0.0005)	(0.0054)
Capital Ratio (relative to industry median)	-0.0092***	-0.0684**
	(0.0029)	(0.0280)
Foreign capital (>90%)	0.0315	0.2336

	(0.0628)	(0.4256)
"Outside" bank determinants		
Macroeconomic environment		
Population density (natural log.)	0.0758	0.5625
	(0.0929)	(0.7442)
GDP per capita (natural log.)	-0.0626	-0.4643
	(0.0507)	(0.3966)
EU membership	0.0419	0.3112
	(0.0353)	(0.2589)
Regulation and Supervision		
Activity Restriction Index	0.0952**	0.7066**
	(0.0430)	(0.3104)
Official Supervisory Power	-0.0252**	-0.1866**
	(0.0121)	(0.0829)
Capital Regulatory Index	-0.0378**	-0.2805**
	(0.0149)	(0.1148)
Mitigating Moral Hazard	-0.0270	-0.2001
	(0.0567)	(0.3871)
Private Monitoring Index	-0.0342*	-0.2536
	(0.0195)	(0.1819)
Constant term	-0.9782	-
	(2.3756)	

*Note: The values in brackets are the corrected robust standard errors (Windmeeijer's). All models include year dummies. ***, ** and * denote statistical significance of variables at 1%, 5% and 10% level of significance respectively.*

The relationship between market share and investments in the quality of services (branch density) is positive and statistically significant (5%). An increase in investment in quality by one branch office per 10,000km^2 leads to increase in the bank's market share of 1.8 per cent in the short run and 13.5 per cent in the long run, suggesting that non-price competition is important determinant of a bank's competitive position in SEECs. Accordingly, this finding gives support to Sutton's endogenous sunk cost theory (Section 5.3.2), that market concentration may not be reduced as the market increases in size, given that quality investments positively affect market share and incumbent banks not only sustain their market share, but such investments contribute to strengthening the market position by expanding the market share. The estimated high effect of branch density suggests that in the SEECs customers still value the access to "bricks-and-mortar" branch offices, despite technological progress and innovations (e-banking, the proliferation of automatic teller machines-ATMs and the increasing reliance on centralized call centres) that might have been expected to reduce the need of easy accessible branch offices. An alternative interpretation of the positively significant effect of branch network is that advertising (in line with Sutton it is one way for investments in quality) in banking as well may be important for the enhancement of the competitive position in banking.

In terms of risk as a determinant of bank's market share, the empirical findings suggest that a one standard deviation (Z-score is expressed in standard deviations by definition) increase in the Z-score of a bank above the median is associated with a drop in the market share of 0.15 percent in the short run and one percent in long run (results are significant at 1 and 5 per cent respectively). Consequently, there is evidence that more risk-taking relative to the industry median facilitates a bank's market share expansion. This finding is consistent with Ruckes (2004) and Dell'Ariccia and Marquez (2006) (Section 5.3.3) who show that banks may reduce collateral requirements (which is considered as undertaking more risk) in an effort to undercut their competitors and increase their market share. Additionally, microeconomic evidence from large international banks suggest that loan growth is an important driver of risk (Laeven and Majnoni, 2003; Foos et al., 2010; Keeton, 1999), but given the simultaneity in this relationship, our results further suggest that in order to expand the loan portfolio (and by that the market share) may involve more risk-taking. Moreover, this finding may be in line with prospect theory, since riskier projects may provide a decision maker a better chance of achieving the desired target than less risky projects, however, this thesis does not directly test the validity of the prospect theory.

More capitalized banks relative to the median in the industry in the same country in year t are estimated to be associated with a decline in the market share, that is a decline in the bank's market share of 0.9 per cent in the short-run and 6.8 per cent in the long run if the bank's capital ratio is increased by one percentage point above the median capital ratio. This finding is consistent with the argument that overcapitalized banks lose market share, because the possessed capital is not used for undertaking new investments. According to Berger and Mester (1997) the level of capitalization may as well reflect the risk preference, with risk-averse banks holding more capital, which additionally supports the importance of risk-taking behaviour as a determinant for bank's market share. However, the correlation between the capital ratio and the Z-score is moderate at 0.36. It is possible that overcapitalization is partially due to the bank being forced to hold "buffer" capital (especially after the last financial crisis and the introduction of Basel III) based on the riskiness level of currently "active" projects. On the other hand, Berger and

Bouwman (2013) find it puzzling in their empirical results that banks with higher capital ratios are likely to lose market share after market crises, in normal times. Finally, the effect of ownership structure on a bank's market position is insignificant.

According to the empirical findings "outside" bank determinants play an important role in the distribution of the market share across banks. Here, the model gives results at a country-level. In terms of the impact of activity restrictions, the empirical results suggest a positive and significant country-level effect, that is a higher average MS and this finding is consistent with Gonzalez (2009), whilst the theoretical expectations are ambiguous. Greater official supervisory power and private monitoring (the former significant at 5 per cent, but the latter only significant at 10 per cent and insignificant in the long run) are associated with a smaller bank's MS on average, as a priori expected. Considering the effect of capital regulation, the results are consistent with the a priori expectations, with more stringent (risk-based) capital regulation leading to a reduction in a bank's MS on average, that is a less concentrated banking sector. For the undertaken actions for mitigating moral hazard, although the sign is also in line with the theory, i.e. associated with smaller average MS, but the results are statistically insignificant. Similarly, macroeconomic development, EU membership and the market size are not significant, although the estimated coefficients are in line with the expectations.

6.5.2 Alternative Model Specifications and Further Empirical Findings

This section goes beyond the baseline model specification examines the country-level effect and specifies alternative models which allow for the estimation of possible bank-level effects of regulation as discussed in Section 5.3.5. Gonzalez (2009) empirically examines the bank-level effects of regulatory and supervisory practices using the cost efficiency of banks (Section 5.2), but as he emphasizes other channels (bank-specific factors) apart from efficiency may be useful for explaining the effect of regulation on an individual bank's MS. As discussed in 5.3.5 the bank-level effect of regulation on bank's MS could be different for the big banks compared to the rest of the banks in the sector. Additionally, the main purpose for imposing regulation is to secure safe and sound banking system (Section 5.3.5), which usually refers to the interaction of regulation, risk taking and financial stability, hence risk-taking is considered as another channel for examining the effect of regulation on bank-level MS.

Is there systematic variation in determinants across different size-classes?

The following empirical analysis focuses on possible variations in the effects of determinants of market share of the big banks and that of all the other banks in the industry (medium and small). The rationale for this investigation is found in the theoretical framework discussed in Chapter 5. In terms of cost efficiency, for example, the empirical findings of Berger and Humphrey (1994) regarding scale economies suggest that (i) large and small banks are less scale efficient than medium banks; (ii) measured scale economies are relatively small, and only small banks are likely to gain scale efficiency by growing; and (iii) growing in size beyond the one of the largest banks will not contribute to higher scale economies. This implies that the effect of cost efficiency on market share may vary systematically across different size-classes. In addition, it is argued that cost structure and efficiency may be seriously affected by an extensive branch network, since branches are considered to be expensive channel for delivering retail financial services, especially deposit-based services (Hirtle, 2007).

Turning to the endogenous sunk cost theory (Section 5.3.2) the incumbent banks endogenously determine the level of quality investments (branch density) in order to increase the entry cost for the potential entrants and secure their competitive position on the market - to absorb the share of the “new” market. The level of such investment presumably depends on the performance and the competitive position of the bank. Hence, it is expected that big banks may benefit more than the other banks from these investments in terms of maintaining or even expanding their market shares. Another underpinning for conducting this analysis is the study of Berger and Bowman (2013) (Section 5.2), who find a different effect of capital ratios across different groups of banks in terms of size. Therefore, this hypothesis is tested as a part of this further investigation. In the context of risk, as discussed in Section 5.3.3, specifically Buchinsky and Yosha (1995) find that small banks, especially those that have nearly failed, are prone to undertake riskier investments, because by doing that they increasing the probability of “hitting the jackpot” and remaining in the market- they have almost nothing to lose. Prospect theory (Section 5.3.3) additionally gives support for excessive risk-taking when the bank performs under the targeted objective, in this context the targeted market share. On the other hand, big banks may undertake individual projects with higher risk, given their ability to better diversify. Consequently, the a priori expectation regarding the effect of risk-taking on market share of big banks and that of the other banks is not clear.

Regulation and supervision may also differently affect the competitive position with the size of the bank. As discussed in Section 5.3.5, given that theory on the effect of regulation on market share is not developed, the arguments for possible systematic variations in the effects of regulation across size-classes can be supported by the role of government, given the opposing public and private interest views. For the purpose of this study, the theory of interest groups is relevant, because this theory argues that regulatory bodies are captured by the interest of the big and powerful banks usually using politicians as intermediaries for achieving their interests. If the proposition holds that interest groups determine regulation direction, then the choice of regulation will depend of the power of the interest groups through time, meaning that the change of power among groups (government and banks) will dictate regulation choices. Given the arguments above, it seems relevant to examine for possible systematic variations in the effect of regulation on market share across different size-classes, that is the bank-level effect of regulation on the competitive position of different sizes of bank.

Next, we briefly discuss the expected effect of regulation across different bank size-classes, based on the framework for analysis discussed in Section 5.3.5:

Capital regulation. Capital requirements can be expected to be more detrimental to the competitive position of smaller banks, because big banks have more possibilities for funding than smaller banks.

Mitigating moral hazard. It is reasonable to expect that factors mitigating moral hazard would restrict the small banks from expanding on the basis of higher risk activities (Buchinsky and Yosha, 1995).

Official supervision. In line with the "capture" theory, supervision may facilitate the expansion of the big banks at the cost of the medium and small banks, hence a positive association is expected between supervision and the MS of big banks.

Private monitoring. Private monitoring may be expected to enhance the MS of big banks simply because these banks have already established units for relations with investors which provide various information on regular basis for the activities of the bank. Such work practices bring the customers closer to the bank and creates a positive impression for the public.

Activity restrictions. To analyse the bank-level effect of activity restrictions on bank's MS, activity restrictions in this study are considered as an incentive for herding, where herding reflects the covariation of banks' behaviour. In case of herding if the assumption that big banks are the leaders and the rest of the banks are followers holds then we could expect that big banks have a predisposition towards success and to further grow in size, at least in the short run.

For the purpose of this additional analysis big banks are considered the four biggest banks in each country. Due to a limited number of banks (although majority of the banks in each countries are included in the data set) and the considered estimation technique which requires large N, it is not feasible to divide the dataset in two sub-sets, big banks and all others and conduct the proposed analysis. Therefore, the second best is inclusion of interaction terms of the considered determinants and a dummy variable denoting 1 for the biggest four banks in each country (C4), otherwise 0. The strategy regarding these additional model specifications is as follows: the first model, in addition to the baseline model, includes interaction terms with C4 for all the "inside" bank determinants, except ownership; the second, in addition to the baseline model, includes interaction terms with C4 for all the regulatory and supervisory practices.

The full model specification of the alternative models is:

$$LMSA_{it} = c + \alpha LMSA_{it-1} + \beta_1 LEFF_{it} + \beta_2 C4_i * LEFF_{it} + \beta_3 BDEN10_{it} + \beta_4 C4 * BDEN10_{it} + \beta_5 DZS_{it} + \beta_6 C4_i * DZS_{it} + \beta_7 DEQ_{it} + C4_i * \beta_8 DEQ_{it} + \beta_9 FOREIGN9_{it} + \gamma_1 LPOP_{it} + \gamma_2 LGDPC_{it} + \gamma_3 EU_{i(t)} + \gamma_4 OAR_{i(t)} + \gamma_5 OSPOWER_{i(t)} + \gamma_6 CRINDEX_{i(t)} + \gamma_7 MORALH_{i(t)} + \gamma_8 PMINDEX_{i(t)} + \theta_1 D_t + v_i + u_{it}$$

… (6.7)

$$LMSA_{it} = c + \alpha LMSA_{it-1} + \beta_1 LEFF_{it} + \beta_2 BDEN10_{it} + \beta_3 DZS_{it} + \beta_3 DEQ_{it} + \beta_4 FOREIGN9_{it} + \gamma_1 LPOP_{it} + \gamma_2 LGDPC_{it} + \gamma_3 EU_{i(t)} + \gamma_4 OAR_{i(t)} + \gamma_5 C4_i * OAR_{i(t)} + \gamma_6 OSPOWER_{i(t)} + \gamma_7 C4_i * OSPOWER_{i(t)} + \gamma_8 CRINDEX_{i(t)} + \gamma_9 C4_i * CRINDEX_{i(t)} + \gamma_{10} MORALH_{i(t)} + \gamma_{11} C4_i * MORALH_{i(t)} + \gamma_{12} PMINDEX_{i(t)} + \gamma_{13} C4_i * PMINDEX_{i(t)} + \theta_1 D_t + v_i + u_{it}$$ … (6.8)

The estimation technique is the same used for estimating the baseline model (the original printouts regarding these models are presented in Appendix to Chapter 6, Section 6.4). As in the previous section, the diagnostics of the models are initially discussed. There is not sufficient evidence to reject the null hypothesis of the validity of overidentifying restrictions and the p-values of Hansen test in the two models are above the most conservative threshold of 0.25 (Table 6.8). In all estimations the null hypothesis of no first order autocorrelation was rejected and there is insufficient evidence to reject the null hypothesis of no second order autocorrelation in differences of residuals.

Table 6.8 Diagnostic statistics for the alternative model specifications

Models/Tests Dependent Variable (LMSA)	**C4*"Inside" Bank Determinants**	**C4*Regulatory and Supervisory Indices**
Test Statistics		
Observations	1,068	1,069
Number of id	148	148
No. of Instruments	68	41
AR(1)	0.000	0.000

AR(2)	0.469	0.554
Hansen Test	0.782	0.710

Source: The Author

Additionally, the number of instruments is relatively low in comparison to number of groups of cross-sectional observations. As a starting point when estimating these additional models the same structure of instruments is employed as in the baseline model. However, when necessary in order to satisfy the required diagnostic statistics, slight changes in the instruments are made. The number of instruments is considerably higher when estimating the Eq. 6.7 compared to Eq. 6.8 because in the former model the endogenous variables are doubled (all bank-specific variables, except ownership structure are treated as endogenous as discussed in Section 5.5). The difference-in-Hansen test for levels supports the choice of the system over the difference estimator. In all specifications, the coefficient on lagged dependent variable is lower than the one obtained with OLS but higher than the one from fixed effects estimation (Appendix to Chapter 6, Section 6.4). Finally, the Wald test for joint explanatory power of coefficients rejects the null that all coefficients are jointly equal to zero.

Table 6.9 Determinants of the bank's competitive position (natural logarithm of market share) in SEECs 2002-12 (baseline and alternative model specifications)

VARIABLES/ Models	Baseline model	C4*"Inside" Bank Determinants	C4*Regulatory and Supervisory Indices
Lagged dependent variable	0.865***	0.889***	0.827***
	(0.041)	(0.040)	(0.051)
Cost efficiency	0.304	**0.667**	0.327
	(0.547)	**(0.641)**	(0.586)
Cost efficiency*C4		**-2.427****	
		(1.039)	
Branch density	0.018**	**0.018****	0.017**
	(0.007)	**(0.009)**	(0.007)
Branch density*C4		**-0.005**	
		(0.009)	
Z-Score (solvency)	-0.002***	**-0.002****	-0.002***
	(0.001)	**(0.001)**	(0.001)
Z-Score*C4		**0.004**	
		(0.003)	
Capital Ratio	-0.009***	**-0.006***	-0.007**
	(0.003)	**(0.003)**	(0.003)
Capital Ratio*C4		**-0.019****	
		(0.008)	
Activity Restriction	0.095**	0.080**	**0.112****
	(0.043)	(0.040)	**(0.045)**
Activity Restriction*C4			**-0.084**
			(0.079)
Official Supervisory Power	-0.025**	-0.024**	**-0.027****
	(0.012)	(0.012)	**(0.013)**

Official Supervision*C4			**0.006**
			(0.022)
Capital Regulation Index	-0.038**	-0.026	**-0.026**
	(0.015)	(0.017)	**(0.018)**
Capital Regulation*C4			**-0.035**
			(0.032)
Mitigating Moral Hazard	-0.027	-0.039	**-0.071**
	(0.057)	(0.039)	**(0.050)**
Mitigating Moral Hazard*C4			**0.080**
			(0.066)
Private Monitoring Index	-0.034*	-0.032	**-0.021**
	(0.020)	(0.020)	**(0.025)**
Private Monitoring Index*C4			**-0.017**
			(0.056)
Foreign capital (>90%)	0.032	0.023	0.072*
	(0.063)	(0.035)	(0.042)
Population density	0.076	0.157*	0.062
	(0.093)	(0.095)	(0.098)
GDP per capita	-0.063	-0.053	-0.061
	(0.051)	(0.039)	(0.047)
EU Membership	0.042	0.033	0.049
	(0.035)	(0.030)	(0.036)
C4		10.79**	0.739
		(4.635)	(0.698)
Constant	-0.978	-3.041	-1.209
	(2.376)	(2.812)	(2.549)

Note: The values in brackets are the corrected robust standard errors (Windmeeijer's).
****, ** and * denote statistical significance of variables at 1%, 5% and 10% level of significance respectively.*
All models include year dummies.

In the last two columns of Table 6.9 the results from the alternative models (Eq. 6.7 and Eq. 6.8) are presented, while the second column presents the results from the baseline model (Eq. 6.6 and Table 6.7) for comparison purposes. The results from the three models are consistent in terms of sign, size and significance of the estimated coefficients, which in turn suggest that the results from the baseline model are robust (checks for robustness are further discussed in Section 6.5.3). Detailed interpretation of the results from the alternative models is not provided, given that the main interest is to examine possible systematic variation across different bank size-classes.

The first step is to learn whether there is a significant difference among the C4 banks and all the other banks in terms of the effect of “inside” and “outside” determinants on their market share. This is indicated by the significance of the interaction terms as provided in Table 6.9. According to the findings in Table 6.9 there is systematic variation across different bank size-classes only for cost efficiency and relative capital ratio, in other words these two “inside” bank determinants are found to affect the market share differently of the C4 banks compared to the other banks. The empirical findings suggest no statistical difference in the effects of regulation and supervision on competitive position of big banks and the other banks.

Where there is statistical significance of the interaction term, the overall impact on MS of these variables for the C4 banks is considered. A test for joint significance (lincom test in STATA) of the two variables is conducted, given that the coefficient of the interaction term presented in Table 6.9 reflects the additional effect of the particular variable on the market share of the C4 banks over the one estimated for the corresponding variable (the base effect). The results of the test for joint significance are presented in Table 6.10 and the original printouts can be found in Appendix to Chapter 6, Section 6.4.

Table 6.10 The effect of selected variables on the market share of the biggest four banks

The effect on market share of selected variables for the biggest four banks (C4) and its significance (lincom test in STATA)	C4*"Inside" Bank Determinants	C4*Regulatory and Supervisory Indices
Efficiency+ Efficiency*C4=0	-1.760**	
	(0.870)	
Capital ratio+Capital ratio*C4=0	-0.0251***	
	0.0072	

Source: The author

Unexpected finding is related to cost efficiency, which is found to be significantly and negatively associated with the market size for the C4 banks. Specifically, an increase of 1 per cent in cost efficiency reduces the market share of the C4 banks by 1.76 per cent (0.67-2.43 from Table 6.9). Hence, this result suggests that cost efficiency is detrimental in terms of the competitive position of the C4 banks, which is opposite of the theoretical underpinnings (Boone, 2000, 2004).

Turning to the holding excess capital (over the median capital of the industry), the results suggest a higher negative effect on MS of the C4 banks compared to the other banks, with a decline of 2.5 per cent if they increase their capital ratio by one percentage point above the median capital ratio in the same country in year t. These findings are not consistent with Berger and Bouwman (2013), who find that large banks with a higher capital ratio improve their market share during banking crises and they are able to maintain the improved MS after such crises. However, this finding is consistent with the arguments in Section 5.3.4 that bigger banks are more leveraged and hold less capital while expanding their lending.

Is there systematic variation in regulatory and supervisory practices across different risk-taking behaviour (the bank-level effect)?

As discussed in 5.3.5 the main purpose for imposing regulation is to secure safe and sound banking system. Moreover, given that the main concern of the economic literature on banking regulation is the interaction of regulation, risk taking and financial stability, the channel that is considered in this thesis for examining the effect of regulation is risk-taking.

Next, we briefly discuss the expected interaction effect of risk-taking and regulation on banks, based on the framework for analysis discussed in Section 5.3.4 and Section 5.3.5:

Capital regulation. Increased capital requirements could be considered as either an incentive or disincentive for riskier investments and it may increase/decrease, at least in the short run, the market share of those banks which opt for higher risk.

Mitigating moral hazard. Given that these measures aim to restrict the risk-taking of banks which arise due to a deposit insurance scheme, the bank-level effect is expected to be negatively associated with the competitive position of high-risk banks.

Official supervision. A negative bank-level effect of supervision is expected for banks which opt for risk-taking behaviour in order gain market share, at least in the short run.

Private monitoring. It is expected that more risky banks will have to reduce their lending by a greater amount than less risky banks, giving a negative bank-level interaction effect, especially because a significant portion of the lending activities are financed by deposits of the customers (as discussed on Section 5.3.5).

Activity restrictions. As discussed in Section 5.3.5 due to activity restrictions most banks may opt for herding behaviour (with leaders and followers), which in turn may increase the risk taking of some banks (the followers, presumably the small banks, given that big banks have more opportunities to diversify), hence some of them may gain MS based on risk-taking at least in the short run, where the long run outcome depends on the realization of the undertaken projects.

In order to conduct this empirical analysis, the baseline model (Eq. 6.6) is augmented by the interaction terms between each regulatory and supervisory practice and the Z-score relative to the industry median (Eq. 6.9). The full model specification is:

$$LMSA_{it} = c + \alpha LMSA_{it-1} + \beta_1 LEFF_{it} + \beta_2 BDEN10_{it} + \beta_3 DZS_{it} + \beta_3 DEQ_{it} + \beta_4 FOREIGN9_{it} + \gamma_1 LPOP_{it} + \gamma_2 LGDPC_{it} + \gamma_3 EU_{i(t)} + \gamma_4 OAR_{i(t)} + \gamma_5 RISK_{it} * OAR_{i(t)} + \gamma_6 OSPOWER_{i(t)} + \gamma_7 RISK_{it} * OSPOWER_{i(t)} + \gamma_8 CRINDEX_{i(t)} + \gamma_9 RISK_{it} * CRINDEX_{i(t)} + \gamma_{10} MORALH_{i(t)} + \gamma_{11} RISK_{it} * MORALH_{i(t)} + \gamma_{12} PMINDEX_{i(t)} + \gamma_{13} RISK_{it} * PMINDEX_{i(t)} + \theta_1 D_t + v_i + u_{it}$$

… (6.9)

The estimation technique is the same used for estimating the previous models in this chapter. Initially, the diagnostics of the models are briefly discussed (Table 6.11) and these are satisfactory (the original printouts related to this model are presented in Appendix to Chapter 6, Section 6.5). There is not sufficient evidence to reject the null hypothesis for validity of overidentifying restrictions. In all estimations the null hypothesis of no first order autocorrelation was rejected and there is insufficient evidence to reject the null hypothesis of no second order autocorrelation in differences of residuals.

Table 6.11 Diagnostic statistics for the alternative model specification

Models/Tests Dependent Variable (LMSA)	**RISK*Regulatory and Supervisory Indices**
Test Statistics	
Observations	1,069
Number of id	148
No. of Instruments	60
AR(1)	0.001
AR(2)	0.475
Hansen Test	0.720

Source: The Author

The number of instruments is relatively low in comparison to number of groups of cross-sectional observations. As with the previous model specifications, we tried to keep the same structure of the instruments, to avoid results manipulation due to the choice of instruments. The number of instruments is considerably higher compared to the baseline model (Eq. 6.6) because all the interaction terms are treated as endogenous. The difference-in-Hansen test for levels supports the choice of the system estimator over difference one. In all specifications, the coefficient on lagged dependent variable is lower than the one obtained with OLS but higher than the one from fixed effects estimation (Appendix to Chapter 6, Section 6.5). Finally the Wald test for joint explanatory power of coefficients rejects the null that all coefficients are jointly equal to zero.

In the last column of Table 6.12 the results from the alternative model (Eq. 6.9) are presented, while the second column presents the results from the baseline model (Eq. 6.6 and Table 6.7) for comparison purposes. The results from both models are consistent in terms of sign, size and significance of the estimated coefficients and again the results of the baseline model are found to be robust. Detailed interpretation of the results from the alternative models is not provided, given that the main interest is to examine possible systematic variation across different risk-taking behaviour. The empirical findings indicate that there is a systematic variation in the effect of regulatory and supervisory practices across different risk-taking behaviour. Specifically, except for the private monitoring, all the other regulatory and supervisory practices are found to vary in their affect the MS of banks depending on risk-taking behaviour.

Table 6.12 Determinants of the bank's competitive position (natural logarithm of market share) in SEECs 2002-12 (baseline and alternative model specification)

VARIABLES/ Models	Baseline model	Z-score*Regulatory and Supervisory Indices
Lagged dependent variable (LN)	0.865***	0.876***
	(0.041)	(0.038)
Cost efficiency (LN)	0.304	0.145
	(0.547)	(0.636)
Branch density	0.018**	0.019***
	(0.007)	(0.007)
Z-Score (solvency)	-0.002***	0.025

	(0.001)	(0.020)
Capital Ratio	-0.009***	-0.009***
	(0.003)	(0.003)
Activity Restriction	0.095**	0.057
	(0.043)	(0.062)
Activity Restriction*Z-score		**0.004***
		(0.002)
Official Supervisory Power	-0.025**	-0.009
	(0.012)	(0.019)
Official Supervision*Z-score		**-0.003*****
		(0.001)
Capital Regulation Index	-0.038**	-0.028
	(0.015)	(0.024)
Capital Regulation*Z-score		**-0.003****
		(0.001)
Mitigating Moral Hazard	-0.027	-0.014
	(0.057)	(0.051)
Mitigating Moral Hazard*Z-score		**0.008****
		(0.004)
Private Monitoring Index	-0.034*	-0.041**
	(0.020)	(0.020)
Private Monitoring Index*Z-score		-0.002
		(0.002)
Foreign capital (>90%)	0.032	0.069
	(0.063)	(0.043)
Population density	0.076	0.153
	(0.093)	(0.203)
GDP per capita	-0.063	-0.058
	(0.051)	(0.052)
EU Membership	0.042	0.048
	(0.035)	(0.030)
Constant	-0.978	-0.650
	(2.376)	(2.748)

Note: The values in brackets are the corrected robust standard errors (Windmeeijer's).
****, ** and * denote statistical significance of variables at 1%, 5% and 10% level of significance respectively.*
All models include year dummies.

In order to interpret the empirical results in this regard, the marginal effects are estimated for Z-score (dzs) and each of the following practices, activity restrictions (oar), factors mitigating moral hazard (moralh), official supervision (ospower) and capital regulation (crindex) and the estimates are presented in Figure 6.1, 6.2, 6.3 and 6.4, respectively.[47]

[47] The estimation of the marginal effects are presented in Appendix to Chapter 6, Section 6.4.

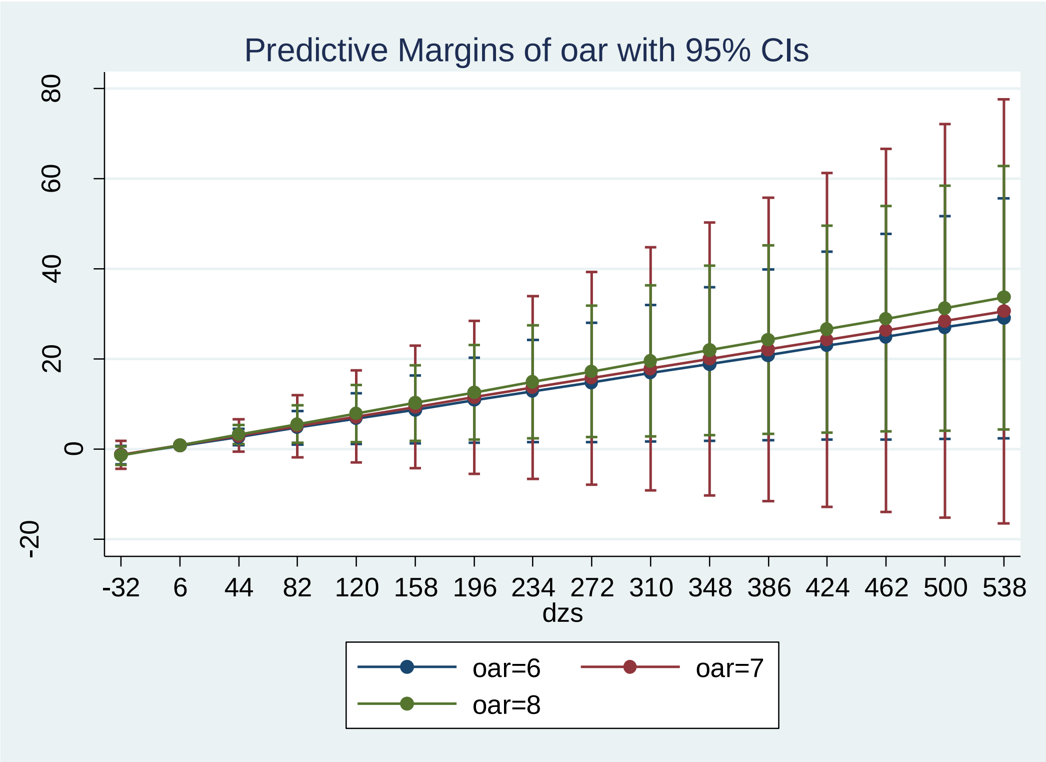


Figure 6.1 Marginal effects of activity restrictions and Z-score

We found that less risky banks (higher z-score) gain in MS with activity restrictions. As the level of OAR becomes higher this gain becomes slightly higher and significant at all levels (Figure 6.1). Similarly, the less risky banks are found to gain in MS with activities for mitigation of moral hazard (Figure 6.2). As the level of MORALH becomes higher this gain becomes higher, with the effect significant at the 10 per cent level.

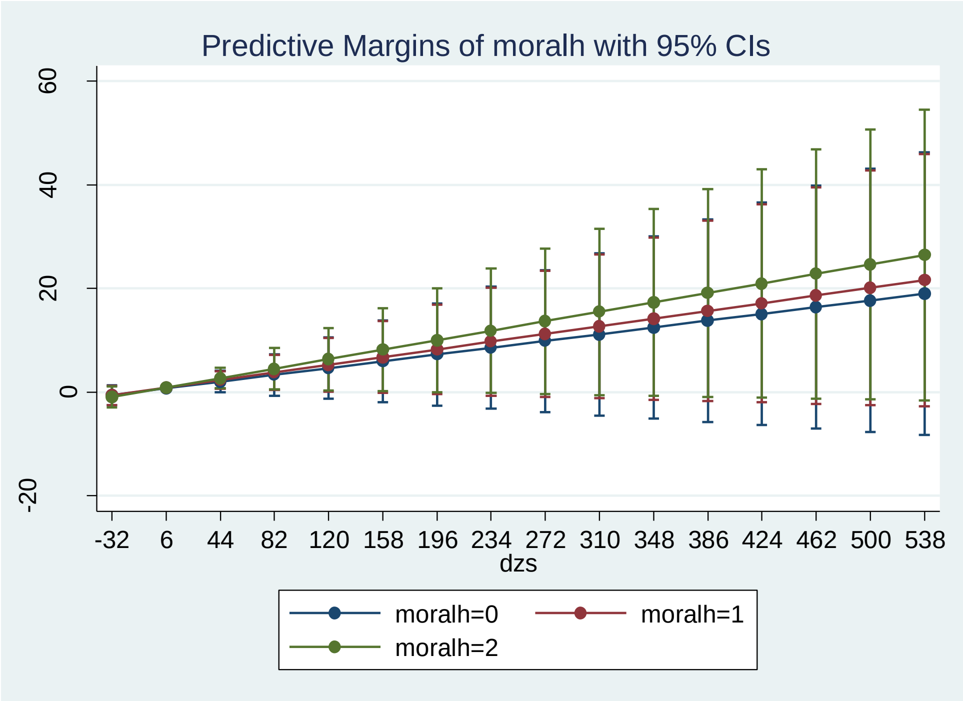


Figure 6.2 Marginal effects of mitigating moral hazard and Z-score

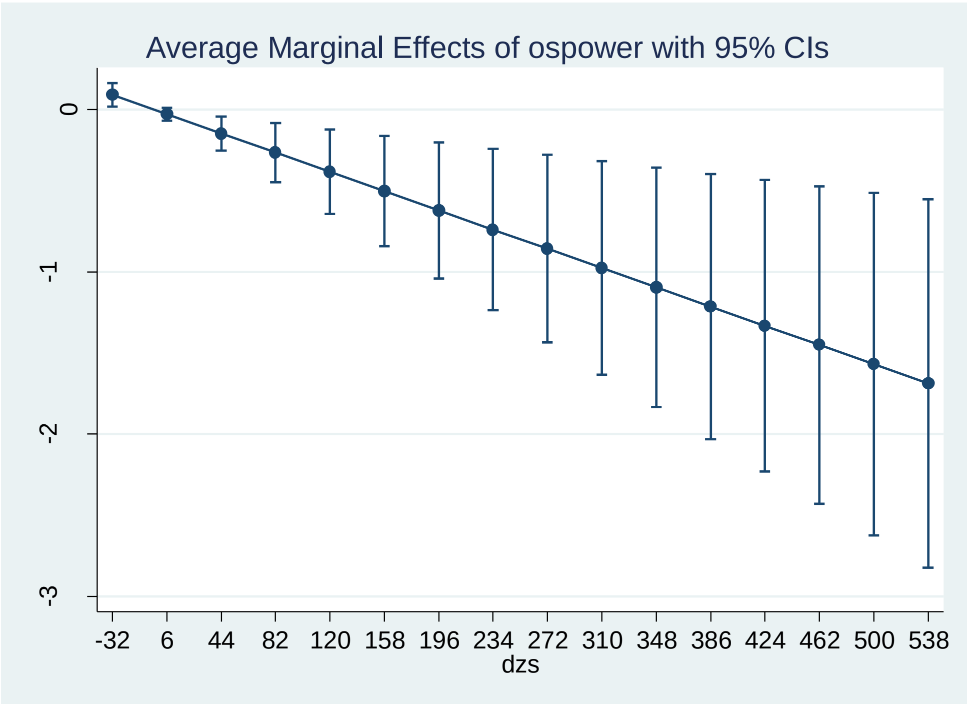


Figure 6.3 Marginal effects of official supervision and z-score

The empirical findings suggest that the less risky banks are found to experience a decline in their MS as official supervision increases, which again indicates that official supervision does not contribute in preventing the banks undertaking higher risk from further growing in relative size (Figure 6.3). Similarly, the less risky banks are associated with a lower MS with increase is the capital regulation, indicating that higher capital regulation is detrimental for the "good" banks (Figure 6.4).

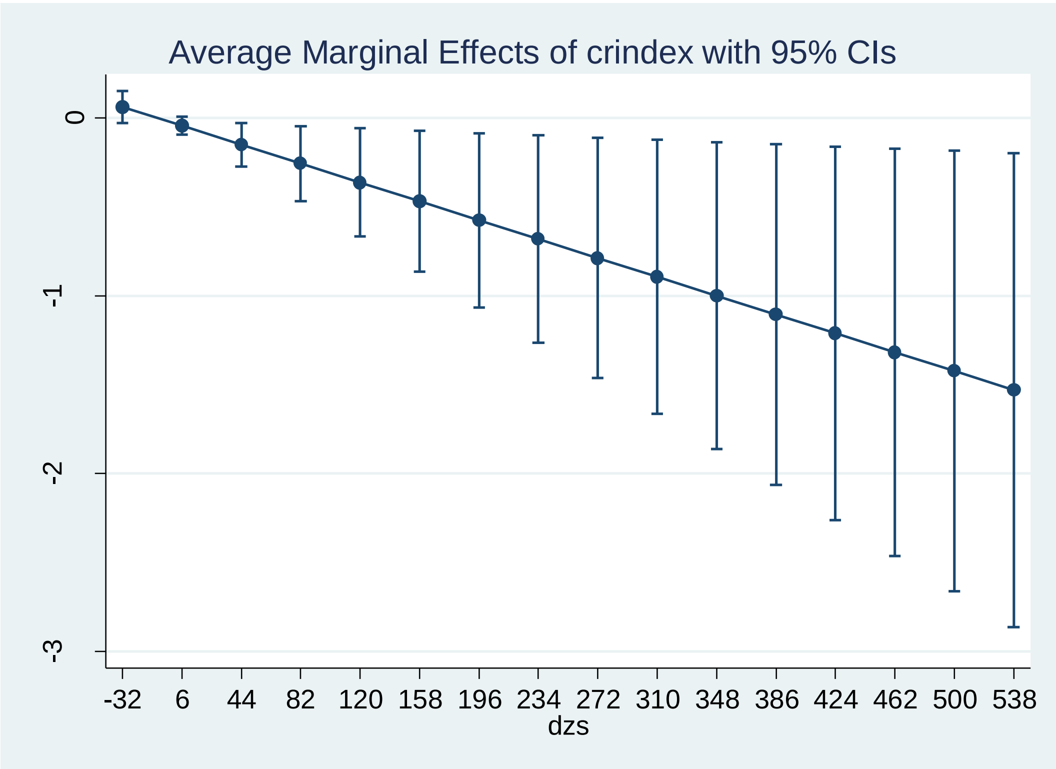


Figure 6.4 Marginal effects of capital regulation and z-score

6.5.3 CHECK FOR ROBUSTNESS

This section presents further alternative model specifications which serve as a check for robustness by considering alternative specifications of important variables, namely those for cost efficiency and risk. The original specification includes cost efficiency as estimated by Random Parameters Models, whereas in this robustness check two different cost efficiency measures are employed. In particular, efficiency estimates obtained from the "true" random-effects model of Greene and time trend (Section 4.5.1, Table 4.6, the model named ETR2T) and efficiency estimates obtained from the Battese and Coelli model with time trend where the bank-specific variables enter in the underlying mean of the inefficiency component (Section 4.5.1, Table 4.4, the model named EBC2T). Employing cost efficiency obtained from different empirical models and econometric techniques, would not only be a check for robustness for the empirical findings of this particular analysis, but would also provide indications of possible serious distortions of the results due to misspecification and inadequate techniques when estimating cost efficiency. In addition, a specification is included that uses a different measure of risk-taking instead of Z-score index employing the ratio of loan impairment charges and the net loans.

Table 6.13 presents the results of these specifications in column 2, 3 and 4 respectively, and the results from the baseline specification (Eq. 6.6) are presented in the first column for comparison. The diagnostic statistics of the three new models are satisfactory (Appendix to Chapter 6, Section 6.6). In terms of the specifications with different cost efficiency estimates (columns 2 and 3), the empirical results are fully consistent compared to those obtained from the baseline model. Most of the estimated coefficients have the same sign, similar size and statistical significance when compared with the coefficients from the baseline model (column 1). The only exceptions are the coefficients of the capital regulatory index and private monitoring index which are insignificant when EBC2T is included as a measure for efficiency, although the size of the coefficients is almost the same compared to the other two models (column 1 and column 2).

Table 6.13 Determinants of the bank's competitive position (natural logarithm of market share) in SEECs 2002-12 (baseline and alternative model specifications)

VARIABLES/Model	Baseline	Efficiency:	Efficiency:	Risk-taking:

Dependent: Market Share (Assets)		(1)	(2)	(3)
Lagged dependent variable	0.865***	0.864***	0.870***	0.845***
	(0.041)	(0.041)	(0.044)	(0.045)
"Inside" bank determinants				
Cost efficiency (ETR3T)	0.304			0.080
	(0.547)			(0.638)
Cost efficiency (ETR2T)		0.138		
		(0.527)		
Cost efficiency (EBC2T)			0.260	
			(1.368)	
Z-Score (relative to industry mean)	-0.002***	-0.001***	-0.001**	
	(0.001)	(0.001)	(0.001)	
DLICL (relative to industry mean)				0.002
				(0.003)
Branch density per 10,000km^2	0.018**	0.018**	0.018**	0.017**
	(0.007)	(0.007)	(0.009)	(0.008)
Capital Ratio (relative to industry mean)	-0.009***	-0.009***	-0.010***	-0.013***
	(0.003)	(0.003)	(0.003)	(0.003)
Foreign capital (>90%)	0.032	0.035	0.027	0.071
	(0.063)	(0.064)	(0.095)	(0.045)
"Outside" bank determinants				
Macroeconomic environment				
Population density	0.076	0.073	0.097	0.102
	(0.093)	(0.092)	(0.123)	(0.084)
GDP per capita	-0.063	-0.057	-0.058	-0.091**
	(0.051)	(0.050)	(0.084)	(0.045)
EU membership	0.042	0.041	0.038	0.062**
	(0.036)	(0.037)	(0.041)	(0.031)
Regulation and Supervision				
Activity Restriction Index	0.095**	0.101**	0.098**	0.087**
	(0.043)	(0.042)	(0.050)	(0.044)
Official Supervisory Power	-0.025**	-0.026**	-0.027*	-0.024*
	(0.012)	(0.013)	(0.016)	(0.013)
Capital Regulatory Index	-0.038**	-0.040***	-0.038	-0.036**
	(0.015)	(0.015)	(0.024)	(0.017)
Mitigating Moral Hazard	-0.027	-0.030	-0.029	-0.043
	(0.057)	(0.057)	(0.0610)	(0.050)
Private Monitoring Index	-0.034*	-0.034*	-0.033	-0.021
	(0.020)	(0.020)	(0.028)	(0.021)
Constant	-0.978	-0.278	-0.896	0.108
	(2.376)	(2.294)	(5.855)	(2.735)
Observations	1,069	1,069	1,069	1,070
Number of id	148	148	148	148
No. of Instruments	36	36	36	37
AR(1)	0.000	0.000	0.000	0.000
AR(2)	0.555	0.511	0.531	0.565
Hansen Test	0.680	0.633	0.677	0.398

Note: The values in brackets are the corrected robust standard errors (Windmeeijer's). All models include year dummies.

****, ** and * denote statistical significance of variables at 1%, 5% and 10% level of significance respectively.*

In the case when LIC are used as a measure for risk-taking instead of Z–score, the empirical results again give support for the robustness of the results obtained from the baseline model specification, given that the majority of the coefficients have the same sign, size and significance as those obtained from the baseline model. However, the risk-taking measure (LIC) although it is found to be positively associated with the bank's market share, the higher the risk the higher the market share, it is not significant, while in the baseline model Z-score is significant. In addition, in the revised specification the effect of GDP per capita estimated to be considerably larger and significant (5 per cent). Specifically, the findings of this model suggest that more developed countries are characterized by banks with a lower market share. The final difference is with the EU membership dummy which is significant in this model. It suggests that being a bank in an EU member country favours a higher market share compared to being in a non-EU country. However, given that the last two discussed variables are not of main interest in this analysis, we do not consider this as a signal for major inconsistency in the results. In a nutshell, the performed check for robustness indicates that the empirical results produced in this analysis are robust.

Another possible approach to check the robustness of the results often used in studies is estimation of the baseline model on a reduced sample cleaned from outliers using winsorizing or a trimming procedure. In the former case the outliers are not excluded, but they are transformed, in particular after specifying a certain threshold (percentile) of the data which is considered as outliers, then the values of all data below (above) that percentile are transformed to the lowest (highest) value of that percentile. In the latter case, the threshold percentile of the data considered to be outliers are completely excluded from the dataset. However, given the specificities of this analysis, it is inappropriate to undertake these common procedures to perform a robustness check. For instance, if such procedures are performed on the dependent variable (market share) it means that the largest banks, which are the major players in every banking sector, would be excluded from the dataset, thus we could expect misleading results. In the case of risk-taking (independent variable) such data cleaning may also produce misleading results if the riskiest banks are excluded, given that the domino effect is present in banking. Therefore, such approach for checking the robustness of the results is not appropriate here and is not carried out.

6.6 CONCLUSION

This chapter empirically investigated the potential determinants of a bank's competitive position (market share) in eight selected SEECs for the period 2002-2012, based on the theoretical framework discussed in Chapter 5. Two broad categories of potential determinants were considered, in particular factors under control of the bank's managers ("inside" bank determinants) and factors beyond their control ("outside" bank determinants). The bank's competitive position was treated as a dynamic process; hence a dynamic panel model was specified and estimated by the two-step General Methods of Moments.

The empirical findings supported the hypothesis of the dynamic nature of a bank's MS. In addition the results provided support for some of the "inside" bank determinants and regulatory and supervisory practices effecting MS, but not the macroeconomic environment. Initially, the evidence did not support the view that one of the main variables of interest, cost efficiency, was a determinant of the bank's competitive position. Furthermore, increased risk-taking was found to affect a bank's competitive position, which could be a detrimental for the stability of the banking system in the long run if banks undertake excessive risk in order to achieve a strategic target to enhancing their competitive position. Likewise, banks holding higher capital (compared to the median) had a lower market share, arguably due to underinvesting which hinders market share expansion. Non-price competition reflected in investments in quality, in particular the number of branches, was also found to be an important for determining a bank's competitive position.

Besides the bank-specific factors, regulation and supervision affect the MS of the bank, which could be considered as a "side-effect", since their main role is to a secure safe and sound banking sector. As discussed in Section 6.5 the effect of regulation is analysed from two aspects, the country-level and bank-level. First, the analysis of the country-level effect of regulation on MS is analogous to the study of market concentration. Second, the bank-level effect of any regulatory policy on an individual bank's MS depends on a bank's. Initially, we provide a summary of the empirical findings of the country-level analysis. Higher activity restrictions resulted in more concentrated banking sectors. On the other hand, the findings suggested the more stringent capital requirements are the less concentrated the banking market. Similarly, turning to the supervision, official and private, the empirical results suggest that higher supervision and monitoring negatively affect the concentration in banking.

The bank-level effect of regulation and supervision on a bank's MS was investigated in a separate empirical model, using the risk-taking determinant as a channel through which regulation effect is transmitted to a bank's MS. We found that less risky banks gain in MS when the level of activity restrictions are higher and when more action is undertaken to mitigate moral hazard. The empirical findings suggested that the less risky banks are found to experience a decline in their MS in the case of greater official supervision, which again indicates that official supervision does not contribute in preventing the banks undertaking higher risk from further growing in relative size. Similarly, the less risky banks are associated with a lower MS the more stringent is the capital regulation, indicating that higher capital regulation may be detrimental for the "good" banks.

Also we investigated whether there is a variation in determinants across different size-classes (this analysis again investigated the bank-level effect of regulation on a bank's MS). The empirical findings suggested variation in the effect of cost efficiency and the relative capital ratio across different bank size-classes. In particular, an increase in cost efficiency negatively affects the market share of the four biggest banks, which is not the case for the other banks. In terms of relative capital ratio, holding of more capital has higher negative effect on the market share of the four biggest banks, while for the other banks the estimated negative effect is lower. Regulatory and supervisory practices are not found to have different effect on different bank size-classes.

In a nutshell, the empirical results indicated several important findings. First, a bank's competitive position is a dynamic process. Second, a bank's MS is not a result of higher cost efficiency; arguably market power could potentially be a determinant of MS, but this was not investigated in this thesis. Third, relatively high (above the country's median at a particular year) risk-taking and capital, and non-price competition are significant "inside" bank determinants. Fourth, regulatory and supervisory practices (activity restrictions, capital regulation, official supervision and private monitoring) were also important factors for the degree of concentration in the banking sector. Fifth, variation in regulatory and supervisory practices across different risk-taking behaviour was found for activity restrictions, official supervision, capital regulation and factors for mitigating moral hazard. Sixth, variation was found for cost efficiency and the relative capital ratio, while regulation was not found to have different effect on different bank size-classes. Finally, the performed checks for robustness of the results with different variable specifications did not suggest any inconsistency.

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CHAPTER 7

CONCLUSIONS

7.1 INTRODUCTION

In the 1990s South East European Countries (Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Macedonia, Montenegro, Serbia and Slovenia) embarked on the process of transition from centrally planned economies towards free market economies. Their financial sectors, dominated by banks (as capital markets are still underdeveloped), play a crucial role in macroeconomic stability and development, and have undergone extensive reforms and restructuring in terms of size, ownership structure, technological progress and regulatory framework during this period. It has been a period of intense competition in the sector mainly due to the substantial inflow of foreign capital, which in turn has changed the structure of the industry in most transition economies. These changes have been associated with the reallocation of market share (MS) across banks and changes in the competitive position of banks. During the period of analysis all SEECs aspired to join the EU, but only Slovenia and Bulgaria became EU member states, with the rest still striving to fulfil the required conditions of accession (Croatia joined the EU in July 2013). Joining the single EU market involves more severe competition in the banking industry, hence their survival depends on their ability to compete; and this is initially influenced by their cost efficiency. Given the aspiration of SEECs to join the EU and the importance of the banking sector for their development, the main focus of this thesis is twofold: the estimation of banks' cost efficiency and the identification and empirical analysis of determinants of the banks' competitive position (based on their market shares).

In terms of cost efficiency in banking in SEECs several interrelated specific questions are investigated. What is the most appropriate method for investigation of cost efficiency? What is the level of cost efficiency of banks in the SEECs and has there been any improvement in the cost efficiencies in these countries over time? Is there any technological progress that reduces the total costs of banks, hence improving their efficiency? What is the role of ownership structure, the EU accession and the last financial crisis on the cost efficiency of banks in SEECs?

The analysis of potential determinants of banks' MS in SEECs also provides answers to several interrelated specific research questions. Does cost efficiency matter for banks' MS in SEECs? Are there other potential determinants of banks' MS, in particular factors which are under the control of banks' managers (quality investments, risk-taking behaviour and capital) and beyond the control of banks' managers (regulation and supervision)? Is there a systematic variation in determinants of MS across different bank size-classes? Is there a systematic variation in the effect of regulatory and supervisory practices across different risk-taking behaviour on banks' MS?

This chapter summarises the results of the investigation of the research questions related to the two focal points of the thesis, formulates policy recommendations for enhancing cost efficiency in banking in SEECs and provides a basis for better understanding of what determines market structure in banking in SEECs, specially the competitiveness of a bank reflected in its market share. The chapter is structured as follows. Section 7.2 summarises the main findings of the thesis. The contributions to knowledge of this thesis are presented in Section 7.3. Policy recommendations are developed in Section 7.4. The limitations of the thesis are identified in Section 7.5. Finally, Section 7.6 provides suggestions for further research.

7.2 MAIN FINDINGS

Given that this thesis focuses on two main research questions, as discussed above, initially the main findings with respect to cost efficiency of banks in SEECs are presented, followed by the findings associated to the determinants of banks' competitive position (market share, MS). Although, the investigation of the two main research issues implies that this thesis is comprised of two parts, they are closely related. In particular, cost efficiency is identified as a potential determinant of banks' MS, hence the cost efficiency estimates are used in the empirical investigation of the determinants of banks' MS.

7.2.1 Cost efficiency of banks in SEECs

The concept of efficiency is well established in the economic literature, and among several definitions for this concept, this thesis uses the one proposed by Farrell (1957). In particular, he considers that a producer is inefficient either by producing less than the maximum output obtainable from a given bundle of inputs (technically inefficient) or by not employing the best mix of inputs given their prices and marginal productivities (allocatively inefficient). Although this concept is theoretically established, efficiency itself is not observable, in other words it is not a simple reflection of any of the data usually recorded by banks or other firms, but instead efficiency levels are empirically estimated.

The literature on the estimation of efficiency in the banking sector begins in the late 1980s. There were a remarkably large number of studies conducted for the U.S. banks compared to the developed European countries' banking sectors, particularly in the early stages. The first paper to examine the banks' efficiency in transition economies dates back to 1998 by Kraft and Tirtiroglu. From then onwards, the literature on transition economies has been expanding, but it is still limited, especially for SEECs (Chapter 3). This was the main motivation for analysing banks' cost efficiency and, for the same token the thesis contributes to a better understanding of banks' cost efficiency in SEECs which is also reflected in the ability of banks to compete.

To estimate banks' cost efficiency in SEECs we presented a critical review of the literature on efficiency estimation and the various approaches with regard to this issue (Chapter 2). We argued that Stochastic Frontier Analysis (Section 2.3.1) was the appropriate method for the estimation of banks' cost efficiency. Given the substantial reforms in SEECs since the beginning of the transition process, it was important that we estimated time-varying efficiency, because changes in efficiency were expected to happen at a fast pace. However, one issue that was neglected for a long time was the problem of potential heterogeneity due to observed and unobserved differences across countries and banks (Section 2.3.3). Given that efficiency estimates are derived from the error term of the regression analysis, it implies that efficiency and heterogeneity have been confounded. The remedy for the observed heterogeneity usually used in the empirical studies was the introduction of adequate control variables in addition to the production technology parameters. These account for the differences that both are under control and beyond the control of the banks' managers, where the former group included bank-specific variables, while the latter included environmental and industry-specific variables. Greene (2005a, 2005b) proposes a set of models able to control for the unobserved heterogeneity, in particular, the Random Parameters Model (including the so-called true random effects model where the only random parameter is the constant term) (Section 2.3.2). Consequently, this set of models was considered for cost efficiency estimation in this thesis. However, given the popularity of the Battese and Coelli (1992, 1995) models as discussed in Section 3.3, these models were also estimated, primarily for comparative purposes.

The average estimated banks' cost efficiency in SEECs for the observed period is 87.5 per cent, with a range by country of 81.5 to 90 per cent (Section 4.5.4). The Slovenian banking sector is the most cost efficient with an average of 90 per cent in the period of analysis, while the Serbian banking sector is the least cost efficient with an average of 81.5 per cent. The banking sectors in Croatia, Macedonia and BiH are characterized by a similar average cost efficiency of around 89 per cent, while the banking sectors in Montenegro, Bulgaria and Albania are by two percentage points less efficient. The largest improvement in terms of banks' CE is found in the banking sector of Albania, where the positive trend has been briefly interrupted only during the years of financial crisis. Although there is a gap or room for improvement of the banks' CE in SEECs of between 10 and 18.5 per cent, it seems that the banking sectors in these countries are highly efficient. The average banks' cost efficiency in SEECs is the highest at the beginning of the investigated period, 2000, at 88.8 per cent, while the lowest average efficiency is at the final year of analysis, 2012, at 86.2 per cent. The recent financial crisis has had a slight negative impact on the efficiency levels of banks in all SEECs and this effect is the highest in the EU member states (Slovenia and Bulgaria), which is to be expected because the recession was more severe in the EU than in SEECs.

Given that there are other studies which analyse some of the countries included in this study, we used this opportunity to compare the CE of those studies, reviewed in Chapter 3 and Section 4.5.5, with the CE obtained in this thesis (Section 4.5.4). It can be noted that our CE estimates are generally higher than the CE from the reviewed studies. This can arguably be because of: firstly a different period of time is investigated, as we consider the later stage of transition (2000-2012) which includes the recent financial crisis and the evolution in CE could be expected; secondly, and, possibly more importantly, the use of different panel models. Specifically, the majority of the reviewed studies rely on BC models, which although provide time-variant CE estimates, do not control for unobserved heterogeneity, whereas our preferred models, RPMs, do. Only, Kosak & Zoric (2011) use the true random effects model by Greene (2005b) and their result for cost efficiency in the banking sector in Slovenia of 87 per cent is similar to our CE estimates for Slovenia of 86-89 per cent obtained from the three RPMs considered in this thesis.

In terms of technical change, the empirical results suggest an average effect for all SEECs of a 1.8 per cent decrease in total cost due to technical change during 2000–2012 (Section 4.5.3). This technical progress ranges from 1.4 per cent (Bulgaria) to 2.2 per cent (BiH), which suggests fairly similar technological progress across this group of countries. It is interesting to find that in the 2000-2009 period there is a cost reduction due to technical change but this effect decreases during these years.

7.2.2 Determinants of bank's market share in SEECs

After an extensive search of the literature we found that the theoretical basis for the determinants of market share (MS) is underdeveloped. Therefore, we applied a "step by step" strategy and an eclectic approach to identify the potential determinants of MS (Chapter 5). Recognizing that banking is a regulated industry, the considered determinants included bank-specific factors (those under control of the management, or the "inside" bank determinants, Section 5.3.1, 5.3.2 and 5.3.3) and regulatory and supervisory practices (beyond the control of the management, or the "outside" bank determinants, Section 5.3.4). The starting point for developing the theoretical discussion and the empirical analysis was Gonzalez (2009) which, to our knowledge, was the first empirical attempt investigating cost efficiency and regulation as determinants of MS. We built on his framework by identifying other potential determinants in addition to cost efficiency. In particular, a number of strands of economic literature, which treat market structure from different perspectives, were considered and discussed. First, the literature on measuring competition (the Boone indicator, Section 5.3.1) was discussed to further support the view of cost efficiency as a determinant of banks' MS. Second, the endogenous sunk cost theory (Sutton, 1991, 2000) was useful as it establishes that investment in quality, in particular a branch network, is relevant for the banking industry, and that it could be considered as a determinant of banks' competitive position (Section 5.3.2). Third, Berger and Bouwman (2013) directed our attention to the effect of bank total capital on MS. Their study along with other studies (Section 5.3.4) suggested that capital should be considered as another determinant of banks' MS. Finally, given that risk-taking behaviour plays a key role in banking stability, we aimed to understand if it could also affect the banks' MS. To that end we reviewed several arguments which associate risk taking and banks' MS, in particular the probability of survival in banking, prospect theory, and the literature on lending standards and screening (Section 5.3.3). Briefly, cost efficiency, investments in quality, capital and risk-taking behaviour are identified as potential "inside" bank determinants.

In addition, similar to Gonzalez (2009), we considered the potential impact of regulation and supervision in banking on banks' MS. However, given that regulation and supervision in banking is primarily introduced to secure prudent behaviour by banks, which is necessary for financial stability, the literature on the relationship between regulation and banks' MS is generally scarce. Arguably this is the reason why the study by Gonzalez was conducted on an ad hoc basis in terms of the effect of regulation and supervision on banks' MS. Therefore, we made an effort to develop some theoretical predictions, at least intuitively, of the effect of regulation and supervision on a bank's competitive position and market structure (Section 5.3.5). The identified "outside" bank determinants included restrictions on activities of banks, the existence of an explicit deposit insurance schemes (developed at national level), the level of capital requirements, the strength of official supervision and market discipline (the three pillars of the Basel II Accord).

The identification of "outside" bank determinants and the potential testable hypotheses proved even more challenging than that of "inside" bank determinants (Section 5.3.5). In particular, given that banks are competing for market share a change in any regulatory policy may not positively or negatively affect all banks. Hence, our theoretical discussion focused on both country-level and bank-level effect of regulation on MS. The country-level effect is analogous to the study of market concentration; in other words, the country-level effect is whether the effect of regulation is to favour a market with a few banks with a large MS or a large number of banks with smaller MS, that is a less/more concentrated market. The bank-level effect of any regulatory policy on an individual bank's MS is expected to depend on a bank's characteristics. It is known that the purpose of regulation in banking is to secure safe and sound banking system by influencing the incentives and behaviour of bank managers. In addition to efficiency, which was considered by

Gonzalez (2009), risk-taking and the size of banks were also considered to be potential channels for the transmission of the effects of regulatory measures on an individual bank's MS.

Another important issue which resulted from the process of developing the framework for analysis is the potential endogeneity due to reverse causality between the identified determinants and banks' MS. In summary, the outcome of Chapter 5 was a framework for analysis and a model for the determinants of banks' MS.

The empirical analysis of the determinants of banks' MS was the subject of analysis in Chapter 6. Gonzalez's static model was extended to a dynamic model. To assume that bank's MS is static, is an unrealistic and restrictive assumption because, as Kim et al. (2003, pp. 51-52) have pointed out, "a*s much as 35% of the average bank's market share is due to its established bank–borrower relationship (on average 13.5 years)."* Therefore, we allowed the banks' MS to be dynamic by including the lagged value of the bank's MS in the empirical model- and the system GMM dynamic panel technique was found to be the most appropriate for this empirical analysis (Chapter 6.4). The empirical results supported the hypothesis of a dynamic relationship. This implies that the past value of a determinant has persistence and impacts on the bank's competitive position in the current period. In terms of the "inside" bank determinants, interesting findings emerged from the empirical analysis. In particular, cost efficiency, which was the initial concern of this thesis and for which theoretical underpinnings suggested a positive association with banks' MS, was found not to be a significant determinant of banks' MS in SEECs (Section 6.5.1). This finding allows for an alternative interpretation, that banks may gain MS by exercising their market power instead of improving their efficiency. However, our empirical analysis did not directly investigate this issue.

The empirical findings supported other factors, such as non-price competition (quality), risk-taking, the level of capitalization or regulation and supervision to be important and significant determinants of a bank's MS (Section 6.5.1). Specifically, the results suggested a positive and significant effect of investments in the quality of services (branch density) which implies that that non-price competition is an important determinant of a bank’s competitive position in SEECs, providing support for Sutton’s endogenous sunk cost theory. In addition this finding suggests that, in the SEECs, customers still value the access to “bricks-and-mortar” branch offices, despite technological progress and innovations (e-banking, the proliferation of automatic teller machines-ATMs, and the increasing reliance on centralized call centres) that might have been expected to reduce the need for easily accessible branch offices. An alternative interpretation of the positive and significant effect of branch network on a bank’s MS is that the additional advertising achieved by branching may be important for the enhancement of the competitive position of a bank.

In terms of risk taking as a determinant of bank’s MS, we found that excessive risk-taking facilitates a bank’s MS expansion. This is consistent with the reviewed literature on lending standards that argued banks may reduce collateral requirements (i.e., undertake more risk) in an effort to undercut their competitors and increase their MS (Section 5.3.3). Moreover, the relevance of risk taking as a determinant of banks’ MS is arguably in line with the prospect theory in which riskier projects may provide a decision maker a better chance of achieving the desired target than less risky projects, especially if they operate under a defined target. In essence, according to the prospect theory the individual underweights merely probable outcomes compared to certain outcomes, which implies an individual is risk-averse in the case of gains and risk-seeking in the case of losses (the reflection effect) (Section 5.3.3). However, this thesis did not directly test the validity of prospect theory. More capitalized banks were found to be associated with a decline in the MS and this finding is consistent with the argument that overcapitalized banks lose MS because they do not use their capital to undertake new investments. In addition, this is consistent with Berger and Bouwman (2013) who found it puzzling that banks with higher capital ratios are likely to lose MS after market crises and in normal times. Finally, ownership structure was not found to be a determinant of a bank’s competitive position.

According to the empirical findings “outside” bank determinants play an important role in the distribution of the MS across banks at a country level. Activity restrictions were found to positively affect the average MS in banking and this is in line with Gonzalez’s (2009) findings. Greater official supervisory power and private monitoring were found to reduce the average MS as expected and this is again consistent with the findings of Gonzalez (2009). Considering the effect of capital regulation, the results are consistent with the a priori expectation that a more stringent (risk-based) capital regulation leads to a reduction in the market concentration. Actions undertaken to mitigate moral hazard were found not to have a significant effect on the concentration level in banking (the average MS of banks). Similarly, macroeconomic development, EU membership and the market size were found not to be of significance in determination of a bank's competitive position (Section 6.5.1).

We also investigated whether there was a systematic variation across different size-classes of banks which allowed for the estimation of bank-level effects of regulation on market share, using the size of the bank, in particular the four largest banks, as a transmission channel of the effect of regulation on a bank's MS (Section 6.5.2). According to the findings there is a systematic variation across different bank size-classes only for cost efficiency and excess capital; in other words, these two "inside" bank determinants were found to affect the market share of the four largest banks differently compared to the other banks. An unexpected finding was related to cost efficiency, which was found to have a negative effect on the competitive position of the four largest banks in the market and this is the opposite of the theoretical expectation (Boone, 2000, 2004). In terms of holding excess capital the results suggested a higher negative effect on the MS of the four biggest banks compared to the other banks. These findings are not consistent with Berger and Bouwman (2013), because they find that large banks with a higher capital ratio improve their market share during banking crises and they are able to maintain their improved market share after such crises. However, such a finding is consistent with the arguments that bigger banks are more leveraged and hold less capital, while expanding their lending (Section 5.3.4). In terms of regulation and supervision, the empirical findings suggest no statistical difference in the effects of regulation and supervision on competitive position of big banks and the other banks, which contrary to capture theory.

Finally, we investigated whether there was a systematic variation in regulatory and supervisory practices across different risk-taking behaviour of banks, in other words we investigated the bank-level effect of regulation and supervision transmitted through the banks' risk-taking behaviour (Section 6.5.2). The empirical findings suggested that the less risky banks are associated with a lower market share the more stringent is the capital regulation, indicating that higher capital regulation is detrimental for the "good" banks. Similarly, the less risky banks are found to experience a decline in their MS in the case of greater official supervision, which again indicates that official supervision does not contribute in preventing the banks undertaking higher risk from further growing in relative size. On the other hand, we found that less risky banks gain in MS when the level of activity restrictions is higher and when more action is undertaken to mitigate moral hazard.

7.3 CONTRIBUTIONS TO KNOWLEDGE

7.3.1 Cost efficiency of banks in SEECs

The empirical analysis of cost efficiency has made several contributions to knowledge of banks' cost efficiency in transition economies, in particular SEECs. So far, the empirical contributions on cost efficiency focusing on transition countries have dealt almost exclusively with the countries that recently joined the EU (including Slovenia and Bulgaria) and to the best of our knowledge, there is only one empirical study evaluating cost efficiency in the banking sector for the SEECs conducted by Staikouras et al. (2008) (Section 3.3.5). Although Croatia has been the subject of analysis in the studies focusing on the more advanced transition economies (the new EU member states), and Macedonia and Bulgaria have been rarely included in any empirical study to date, the other successor states of former Yugoslavia (Serbia, Montenegro and BiH) and Albania have not been examined at all before this study (Chapter 3). Consequently, our study contributes originally by investigating the cost efficiency of banks for a unique set of countries which have not been the subject of analysis previously.

Moreover, the dataset collated for the empirical analysis of this study presents an additional contribution to knowledge (Section 4.3). Specifically, as the database Bankscope has a lot of missing information on certain important variables for the countries of interest in the period 2000-2009, we endeavoured to find the missing data from other sources such as the Annual Reports of individual banks and the Central Banks' and other agencies' reports to augment the Bankscope data. During this process we have also cross-checked the Bankscope data with those from other sources and any major inconsistencies were resolved. As a result, we increased the sample size with the data from other sources that were not available in Bankscope, making it a unique dataset, larger and more representative than what has been used in this literature before.

Another contribution to knowledge of this thesis is related to the method employed in the estimation of cost efficiency. We use Random Parameters Models (including the true random effects model introduced by Greene, 2005b where the only random parameter is the constant term) in the context of Stochastic Frontier Analysis. We identified only one other application in the literature (Section 3.3.5), that of Kosak and Zoric (2011), but they employ only the Greene's true random effects model. However we argue that this study also contains a flaw in model specification - an inappropriate way of including time trend in a translog functional form. The advantage of RPMs models is not only their ability to control for the unobserved heterogeneity which is usually confounded with the efficiency itself, but they also allow for control of cross-sectional heterogeneity in the parameters of the cost function. Hence, it is reasonable to expect that cost efficiency estimates obtained from these models would be higher compared to the estimates obtained from the commonly used models such as Battese and Coelli (1992, 1995) because, by using the former models, the part of the unobserved heterogeneity would be disentangled from the error term component representing the efficiency estimate (Section 2.3.3). This could be arguably considered as a reason for the higher efficiency estimates obtained in our study compared to results from other studies. Therefore, another contribution of the thesis to the current literature is the finding that before this study banks' cost efficiency was possibly underestimated.

Given the wide use of Battese and Coelli (1992, 1995) models among other SFA researchers we also estimated cost efficiency using these models for comparative purposes. However, we encountered problems during the estimation procedure (the iteration of the likelihood function could not converge properly), implying that this set of models does not adequately fit our dataset which is larger and more representative that other datasets used in previous studies – something which had already been highlighted as a possibility by Greene (2011). However, none of the studies reviewed in Chapter 3 acknowledge such problem. Thus, our findings with respect to Battese and Coelli models may be considered as a sign of possible publication bias, hence a contribution to knowledge.

Finally, our empirical study on cost efficiency presents a first attempt to investigate the effect of technical change on banks' total costs and implicitly on banks' efficiency in SEECs. Moreover, so far none of the empirical studies on cost efficiency in transition economies investigated the effect of joining the EU or the effect of the last financial crisis on cost efficiency.

7.3.2 Determinants of bank's market share in SEECs

The analysis in this thesis has several contributions to the existing theoretical and empirical knowledge on determinants of banks' MS. First and foremost, by studying the potential determinants of banks' MS, we learnt that neither the theoretical nor the empirical literature on this topic is comprehensively developed. Therefore, we applied a "step by step" strategy and an eclectic approach to identify the potential determinants of MS (Chapter 5). In order to develop the framework for the empirical analysis various strands of economic literature dealing with market structure from different perspectives were considered and discussed. These included the literature on measuring competition (the Boone indicator) and the endogenous sunk cost theory, the literature on the role of capital and the probability of survival in banking, prospect theory, and the literature on lending standards and screening. We made an effort to develop theoretical predictions, at least intuitively, of the effect of regulation and supervision on a bank's competitive position and market structure. Hence, the framework for analysis of the determinants of a bank's

MS in Chapter 5 presents a contribution to knowledge, because it lays the basis for further development of this topic.

The contribution to knowledge is also reflected in the empirical analysis of determinants of banks' MS, in particular the extensions of Gonzalez (2009), which is the only study examining determinants of banks' MS from similar perspective. First, his empirical study considers only one "inside" bank determinant, while we went beyond that and identified the potential impact of investment in quality, risk-taking behaviour and capital on a bank's MS. Second, Gonzalez estimates a bank's efficiency by a non-parametric approach, DEA, using a country-specific frontier; however the use of a country-specific frontier cannot provide efficiency estimates comparable between countries. Hence, we applied a parametric approach, SFA, and Random Parameters Models in the context of a *common frontier* and used comparable efficiency estimates across countries in the empirical analysis. Third, Gonzalez assumes the market structure and a bank's market share to have a static relationship. However our empirical findings supported the prediction that market share is of a dynamic nature. Finally, although Gonzalez (2009) investigates determinants of market structure in 65 countries, his data set includes only two out of eight countries subject to analysis in this study, Croatia and Slovenia. Albania, BiH, Bulgaria, Macedonia, Montenegro and Serbia were not included in his study. Hence, this is the first empirical attempt for identification of the determinants of a bank's competitive position in SEECs.

7.4 POLICY IMPLICATIONS

Prior to the discussion on possible policy implications deriving from this thesis, it is important to note that this research was not initially motivated by the needs of policy makers, but by a desire to understand the determinants of efficiency and market share in banking. However, during the process of conducting this research relevant policy implications emerged, which are discussed in Sections 7.4.1 and 7.4.2.

7.4.1 Policy implications of the cost efficiency of banks in SEECs

Berger and Humphrey (1997, p. 21) asserted that research on the efficiency of financial institution was to improve managerial performance and to inform government policy usually determined by the central banks. In general, cost efficiency analysis could be used as a guideline by managers to improve their performance. In particular, the significant time trend used to control for technical change in the empirical analysis may be the result of technological progress. If this is the case then managers are likely to improve their cost efficiency due to technological progress which could be in the form of R&D which could result in new products and services similar to ATMs, debit/credit cards and on-line banking which have been introduced since recently in SEECs; or financial innovations primarily encouraged by technological changes in telecommunications and data processing (using software and hardware for client credit scoring, risk management, automated clearing house, etc.).

Another issue which seems to be of relevance for achieving higher cost efficiency levels and depends on the manager's decision is product differentiation and the choice of a suitable product-mix (the assortment of products and services that bank offers to their customers). This argument is supported by the results from the Random Parameters Models used for estimation of cost efficiency (Section 4.5.2, Section 4.5.3 and Section 4.5.4). In particular, the estimated effects of these two outputs on the total costs were found to substantially vary across banks, suggesting that the structure of loans and other earning assets are of relevance with respect to bank's total costs, hence its efficiency. However, given the data limitations with respect to disaggregated data (further discussed in Section 7.5) this research was constrained to use only broad definition of outputs, therefore we cannot provide any recommendation which product-mix could improve a bank's efficiency. Finally, managers of banks with higher capital at their disposal need to be aware that although it may serve to signal higher stability, it is found to have a detrimental effect on cost efficiency which probably could be due to the high cost of ownership equity and/or high opportunity cost of holding "idle" capital.

This study provides some useful findings for government policy, in particular for competition policy and for the central banks which are in charge of setting the rules for regulation and supervision in banking. It is important for these institutions to learn that the banking sectors in SEECs could be considered as highly competitive with cost efficiency about 90 per cent, except for the Serbian banking sector with cost efficiency as of about 80 per cent (Section 4.5.4). Moreover, efficiency in banking was found to depend on the environmental conditions. In other words, stable and expansionary macroeconomic environments are beneficial for banks' cost efficiency. In addition, we found that being an EU member state is associated with a more cost efficient banking sector (Section 4.5.3). Hence, it is useful to be learnt that banking cost efficiency possibly could be another benefit of joining the single EU market.

Finally, in terms of the competition policy, we found that the more concentrated market structure in SEECs is associated with higher total costs, hence lower average cost efficiency (Section 4.5.3). In addition to this and contrary to the theoretical predictions, we found that cost efficiency is not a significant determinant of MS in SEECs (Section 6.5.1). These findings arguably imply that the SCP paradigm, in particular the market power hypothesis, may to some extent explain the market structure in the banking sector in SEECs. Therefore, this may be considered as a call for revising the competition policies in these countries, if they exist, and to regulate the concentration level of the banking sector.

7.3.2 Policy implications of determinants of market share in SEECs

The analysis of determinants of banks' MS also provided relevant information for managers and governmental institutions. For managers it is useful to learn what determines the bank's competitive position, hence what they needed to change if interested in enhancing this. It was a somewhat surprising finding that being a more cost efficient bank is not necessarily the way to improve their competitive position (Section 6.5.1). Moreover, big banks were found to lose MS if they improve their cost efficiency (Section 6.5.2) and this suggests that the managers may prefer an increase in costs which would lower cost efficiency if the higher costs were in the form of higher interest paid or additional services provided (Berger and Humphrey, 1997). Consequently, the competitive position of a bank depends on factors beyond costs, implying that managers should seriously consider non-price competition as a way of enhancing the bank's competitive position (Section 6.5.1). One sort of non-price competition that could be used as a strategy to increase the bank's MS is expansion of the branch network. Another strategy that can be used by mangers is undertaking higher risks, however this strategy could be detrimental to the bank's stability in the long run. Holding more capital seems to negatively affect the competitive position, hence managers need to invest the excess capital at their disposal (above the requirement levels) in order to gain market share.

The findings from this part of the thesis seem to be of much relevance to for the regulatory and supervisory practices defined by the central banks, especially because more risk-taking was found to be a significant determinant of MS (Section 6.5.1). Moreover, the effects of regulatory and supervisory practices on MS were found to differ according to the risk taking of banks (Section 6.5.2). Given our findings, central banks need to impose higher activity restrictions and introduce more activities preventing moral hazard in order to allow less risky banks to enhance their MS. On the other hand, more stringent capital regulation and greater official supervision were found to have a negative impact on the competitive position of the more solvent banks, hence these restrictions need to be relaxed.

7.5 LIMITATIONS OF RESEARCH

Although this thesis has made several contributions to the existing body of knowledge on cost efficiency and determinants of market share in banking, we encountered several constraints in the course of this research which may be considered as potential limitations of this thesis. Most of these limitations have resulted from the lack of data and its quality (Section 4.3). First, the definition of the outputs in banking sector could not be defined precisely because the disaggregated data for loans made by banks in SEECs (such as loans to other banks, companies and households) is not available (Section 4.3). Hence the outputs in banking had to be defined broadly, although we believe the use of Random Parameters Models and treating the bank's outputs as random parameters was a remedy against potential misspecification (Section 4.4). Second, the data for the years before 2000 is very limited (Section 4.3). Therefore, it was not possible to make any comparison between the two stages of transition (early and late) for SEECs. Although this did not affect our findings for the period under consideration, it certainly limited the scope of our research.

Third, another data-related problem was availability of appropriate indicators on the nature of regulation and supervision in the banking sector (Section 6.3). In particular, for regulatory and supervisory practices we used the special surveys sponsored by the World Bank, designed and implemented by a group of researchers (Barth, Caprio and Levine, 2001, 2004, 2008). This particular survey was conducted in several waves in 2001, 2003 and 2007, which means that we did not have the data on a yearly basis for these variables. Moreover, given that the Survey conducted in 2001 was not comparable with the next surveys, we had to exclude the years 2000 and 2001 from the empirical analysis on the determinants of a bank's MS. Furthermore, Albania, Serbia and Montenegro were included in Survey 2 (2003) but not in Survey 3 (2007). Therefore, in the analysis of the determinants of MS covers these countries only for the period 2002-2007 (and not the entire period). In addition, Serbia and Montenegro were considered together as one country in Survey 2. Hence, the same indices are used for both countries. As we used system the GMM dynamic panel technique (Section 6.4), which does not requires large time dimension for a panel dataset, we believe the shorter time dimension did not affect our empirical results. However, because of the limited and irregular data on regulatory and supervisory practices (Section 6.3) it was not able to control for the effect of regulation and supervision on cost efficiency, given that the estimation of time-varying efficiency requires a long data series (Section 4.2.2). Hence, in this case efficiency estimation could be affected. However given the use of models that control for unobserved heterogeneity we have adjusted for this lack of data as much as possible so that cost efficiency estimates are not significantly affected. Next, there is a problem of measuring the ex-ante risk of a project and the corresponding realization. As the most widely used variable in the literature is the Z-score and it represents a solvency and distance to default (Section 6.2.1), but there was no better variable available to us to proxy risk. However, we had to use this as a time invariant variable in order to include Albania, Serbia and Montenegro in the analysis.

Fourth, another potential limitation was the possible endogeneity which may result from the causality between cost efficiency and bank-specific variables, such as loan impairment charges (Berger and Humphrey, 1997). However, there have not been any developments yet in terms of SFA models that could account and control for endogeneity (Greene, 2011). Finally, the framework for analysis of the potential determinants of bank's MS is intuitive than theoretical; hence it only represents a step in the development of theory in this area.

7.6 DIRECTIONS FOR FUTURE RESEARCH

Research does not only provide answers to specific research questions, it also raises new challenges and areas for research. As one of the first quantitative analyses of cost efficiency in banking in SEECs and of the determinants of MS in banking, we address several research questions worth considering for future research and to fill the gaps in this literature. These research questions, along with the limitations discussed in the previous section, are presented in what follows.

7.6.1 Cost efficiency of banks in SEECs

The current literature on efficiency demonstrated that banks are less than fully efficient and there is a room for improvements (Section 3.3.4 and 4.5.4). Nevertheless, although some initial attempts have been undertaken in terms of the significance of the estimated efficiency levels, still procedures for testing the significance of these estimates are underdeveloped (Section 4.5.X). Hence, it is important that future research is focused on developing this issue. SFA imposes functional forms that restrict the shape of the frontier and specifying more globally flexible functional forms, such as Fourier-Flexible functional form, would allow the shape of the frontier to be more freely determined (Section 2.4). Such a specification of the frontier may allow the data to provide more accurate efficiency estimates. However, this is conditioned on the data at the researcher's disposal. Other limitations with respect to the methods of estimation efficiency that deserve attention for future research is developing approaches that would allow the choice among the various models to be based on more clearly determined process.

In terms of the steps needed to build on and extend this study there are several important issues that deserve attention though the realization of which mainly depends on data availability. First, it would be of interest to investigate the effect of regulation and supervision on banks' efficiency. Second, it would be useful, especially for banks' managers, to learn the effect of investments in quality, such as a branch network on banks' cost efficiency. Third, it would be beneficial to investigate the effect of the organizational structure of the bank on cost efficiency, which could provide evidence on whether any restructuring could enhance cost efficiency. Finally, given the increased process of consolidation in SEECs, the analysis of the effect of bank consolidation on profit and cost efficiency would be a related empirical analysis to go on the agenda of researchers (similar work has already been undertaken for other countries).[48]

7.6.2 Determinants of bank's market share in SEECs

Our analysis of the determinants of a bank's MS, which to some extent present a pioneering work in this field, hence it opens many questions that deserve further consideration and present an opportunity for future research. First and foremost, our framework for analysis of the determinants helped in deriving testable hypotheses, but it is intuitive and eclectic (Section 5.1). However, it lays the basis for developing a comprehensive theoretical framework which could provide further testable hypotheses for empirical research.

[48] For example, Montgomery et al. (2015) explore the impact of bank mergers on profit and efficiency in Japanese banks.

Next, it would be useful to work on a definition of a more representative variable indicating the riskiness of projects. Moreover, an interesting issue that arose during this research was "the more" risk and capital, which is commonly used in the theoretical literature. However, this concept is not discussed in terms of applied empirical research, namely how we are supposed to measure "the more" in this context. This thesis provided empirical evidence for the potential determinants of a bank's MS (Sections 6.5.1 and 6.5.2), however this research could be extended form various perspectives. One of them is to investigate whether there is a particular capital threshold above which the effect of holding more capital is negatively associated with a bank's MS. Such investigation could also apply for the risk-taking behaviour. Next, we can examine whether changes in regulation (Basel I, Basel II and Basel III) differently affect a bank's competitive position.

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APPENDICES

APPENDIX TO CHAPTER 1

1.1 EXTENT AND EFFECTIVENESS OF FINANCIAL LAWS AND REGULATIONS IN SEECs

Table A1.1 Extent and effectiveness of financial laws and regulations in SEECs, 1998

Country	Extensiveness	Effectiveness
Albania	2+	2
BiH	3	2
Bulgaria	4	4-
Croatia	3	3
Macedonia	3	3-
Slovenia	4	3

Explanation of the scores as proposed by EBRD in Transition Report (1998):

Extensiveness:

Score 2: Legal rules governing banking and securities are somewhat limited in scope. Although regulations in banking have been amended to accord with core principles, at least one important area of regulation remains deficient – for example, capital adequacy, use of international accounting standards, use of consolidated comprehensive supervision;

Score 3: Legislation for banking and securities activities is reasonably comprehensive but would benefit from further refinement in some areas. Banking regulations generally conform to the Basle Committee's Core Principles, although regulations concerning bank insolvency and deposit protection may not have been adopted;

Score 4: Comprehensive regulation exists with respect to banking and securities activities that conforms generally to minimum international standards. But refinement is still needed in at least one important aspect of either banking or securities regulation. For example, many countries in this category still need to enact rules concerning money laundering (including "know your customer" provisions), or bank insolvency. Legislation concerning shareholder depositories and registries is either non-existent or is in its early stages of implementation.

The effectiveness of legal rules on banking:

Score 1: Legal rules governing financial institutions and markets are usually very unclear and often contradictory. The regulatory support of the laws is rudimentary. Supervisory mechanisms are either non-existent or poor. There are no meaningful procedures in place to make financial laws and regulations fully operational;

Score 2: Legal rules are somewhat unclear and sometimes contradictory. Supervision of banking and securities activities exists on an ad hoc basis. But there are few, if any, meaningful procedures in place to enforce the law. There may be a lack of adequately trained staff in either banking or capital markets regulatory authorities.

Score 3: Although legal rules governing banking and securities activities are reasonably clear, regulatory and supervisory support of the law may be inconsistent so as to create a degree of uncertainty. Although the regulator may have engaged in corrective actions against failing banks and securities markets practices, enforcement problems still exist.

Score 4: Legal rules governing banking and securities activities are readily ascertainable. Banking laws are generally well supported administratively and judicially, particularly regarding the efficient functioning of enforcement measures against failing institutions and illegal market practices. For example, the regulator has taken corrective action to liquidate failing banks. Enforcement actions against individuals and securities intermediaries are evident, but could still benefit from more systematic and rigorous enforcement. Courts have the authority to review enforcement decisions or other corrective actions for banks and/or securities firms.

1.2 IMPLEMENTATION OF BASEL II AND BASEL III

Table A1.2 Implementation of Basel II

Country	Elements[49]	Status[50]	Year[51]	Remark
Albania	SA	1	2012	(a) In the framework of cooperation with the Bank of Italy, a comprehensive revision of the Regulation "On capital adequacy ratio" was made in view of approximation with Directives 2006/48/EC and 2006/49/EC. This regulation has been partially revised several times during 2011, while the project for its comprehensive revision is now finalised by the working group and it is foreseen to be approved (after consultation with banking industry) in September 2012. (b) The Supervisory Review Process - Pillar 2. According to the provisions of regulation "On capital adequacy ratio" it is contemplated that the inspectors of the Bank of Albania, when they deem it is appropriate, may ask any bank at any time for an adequacy ratio higher than the minimum ratio (there are some cases when the Bank of Albania imposed a higher level of CAR i.e. 12.5% to banks). In addition, qualitative elements of Pillar 2 have been taken into consideration during situations of potential stress in the banking system, while a high demand for withdrawal of deposits has also been taken into account. Such elements include disallowing banks to distribute their dividend, meetings with bank administrators for risk assessment and establishment of the necessary capital to cover the risk that may stem from unexpected situations. Actually, Bank of Albania is working on the ICAAP under the technical assistance of Bank of Italy. (c) Market discipline/public disclosure (Pillar 3). The regulation "On minimum requirements of disclosing information from banks and foreign bank branches"
	FIRB	1	NA	
	AIRB	1	NA	
	BIA	1	2012	
	TSA	1	2012	
	AMA	1	NA	
	P2	1	2013	
	P3	4	2013-14	

[49] The following abbreviations are used in the table: Pillar 1 – Credit risk: SA = Standardised approach, FIRB = Foundation internal ratings-based approach, AIRB = Advanced internal ratings-based approach); Pillar 1 – Operational risk: BIA = Basic indicator approach, TSA = Standardised/alternative standardised approach, AMA = Advanced measurement approaches; P2 = Pillar 2; P3 = Pillar 3. Relevant references can be found in the Questionnaire in Annex 2.

[50] Status indicators are as follows: 1 = Draft regulation not published, 2 = Draft regulation published, 3 = Final rule published, 4 = Final rule in force, NA = Not applicable

[51] This column denotes the year in which the draft or final rule was or is expected to be published or when the final rule was or will be in force. NA means that the jurisdiction is not planning to implement this component or is planning to implement the component but does not know the year in which it will be implemented. If you use this please carry it to the other Sections

				(approved by decision no.60, dated 29.08.08 of the Supervisory Council of the Bank of Albania) sets out the minimum requirements, the methods and time lines associated with the information that needs to be published in the periodic reports of banks and foreign bank branches. According to this Regulation, banks should publish periodic reports which contain information in accordance with the main six categories defined by the Basel Committee and EU directive 2006/48/EC (Chapter 5, Annex XII) i.e. financial performance and their activities, risk profile, practices and strategies in risk management, CAR ratio, quality of loan portfolio, accounting policies, etc. This regulation is partly in alignment with the above mentioned EU directive. This regulation in force dealing with Pillar 3 is foreseen to be revised during 2013-2014.
BiH	SA	1	2016	The Revised Strategy was adopted in February in 2013 with the aim of complying with the CRD directive. The drafting of by-laws within Pillar 1 (credit, operational and market risk), which refers to the basic and standardised approaches, is expected to be finalised in draft form by the end of this year or in the first quarter of 2014. The plan is to start with a simpler approach to the advanced approaches. Bosnia and Herzegovina (BiH) is preparing for a Quantitative Impact Study in order to determine the impact of changes in the regulatory framework – i.e. the segment for calculating the capital requirements for the standardised approach for credit risk including credit risk mitigation to the level of capital adequacy in BiH.
	FIRB	1	2016	
	AIRB	1	2016	
	BIA	4	2009	
	TSA	1	2016	
	AMA	1	2016	
	P2	1	2016	
	P3	1	2016	
Croatia	SA	4	NA	
	FIRB	4	NA	
	AIRB	4	NA	
	BIA	4	NA	
	TSA	4		
	AMA	4		
	P2	4		
	P3	4		
Macedonia	SA	4	2012	Pillar II implementation has started in 2008, with the development of a new methodology for risk-based supervision and a new regulation for risk management. The regulation entered into force in 2009. In addition, in 2012 amendments were made to strengthen the ICAAP requirements.
	FIRB	1	2014	
	AIRB	1	2014	
	BIA	4	2012	
	TSA	4	2012	
	AMA	1	2014	

	P2	4	2009	
	P3	4	2007	
Montenegro	SA	4	2008	The Pillar II requirements of Basel II were incorporated into the Capital Adequacy Decision enacted in July 2011 and applied as of January 1, 2012. The introductuin of ICAAP and SREP enabled the supervisory authority to ensure that banks have sufficient capital to support all material risks to which they are exposed in their operations. The first ICAAP reports from banks were submitted to the supervisory authority in the first half of 2012. The Pilar III of Basel II was implemented through the Decision on public disclosure. The new Decision encouraged market discipline by introducing a set of disclosure requirements that will inform market participants on the financial statements of the bank, its strategies and policies, own funds, capital adequacy, information on the credit risk exposure, counterparty risk, operational risk etc.
	FIRB	1	NA	
	AIRB	1	NA	
	BIA	4	2008	
	TSA	4	2008	
	AMA	1	NA	
	P2	4	2012	
	P3	4	2012	
Serbia	SA	4	2012	All provisions of Basel II are enacted and in force, with the exception of provisions governing securitisation, because currently there is no legal basis for securitisation in Serbia and banks do not securitisation exposures in their portfolio.
	FIRB	4	2012	
	AIRB	4	2012	
	BIA	4	2012	
	TSA	4	2012	
	AMA	4	2012	
	P2	4	2012	
	P3	4	2012	

Source: Bank for International Settlement (BIS), Financial Stability Institute Survey Basel II, 2.5 and III Implementation (2012)

Table A1.3 Implementation of Basel III

Country	Elements	Status	Year	Remark
Albania	Liq	1	NA	(a) During 2011, The Bank of Albania conducted an impact study, regarding Basel III liquidity indicators, with participation of all banks. Currently there are no plans for including these indicators as part of our regulatory framework. (b) Bank of Albania is now in the process of comprehensive revision of the guideline in force on Regulatory Capital that is foreseen to be concluded within 2012
	Def cap	1	2012	
	Risk cov	1	NA	
	Conserv	1	NA	
	C-cycl	1	NA	
	LR	1	NA	
BiH	Liq	1	2016	
	Def cap	1	2016	
	Risk cov	1	2016	
	Conserv	1	2016	
	C-cycl	1	2016	
	LR	1	2016	
Croatia	Liq	1	01/07/2013	Croatia will implement Basel III rules with the implementation of the CRR/CRD4 EU regulatory package. New rules will enter into force on the date of accession of the Republic of Croatia to the European Union, which is expected to be 1 July 2013.
	Def cap	1	01/07/2013	
	Risk cov	1	01/07/2013	
	Conserv	1	01/07/2013	
	C-cycl	1	01/07/2013	
	LR	1	01/07/2013	
Macedonia	Liq	3	2009	There is a partial implementation of the liquidity standards and the definition of capital. In 2009, the National Bank of the Republic of Macedonia (NBRM) has issued liquidity risk regulation requiring banks to maintain two liquidity ratios for assets and liabilities maturing in the following 30, i.e. 180 days. Both ratios are similar to the LCR defined in Basel III and are adjusted to the features of the Macedonian banking system. Regarding the definition of capital, due to the more conservative approach of the current capital adequacy framework, banks were not able to use innovative instruments as part of their own funds. As a result, in the Macedonian capital adequacy methodology, there is no difference between the definition of core tier 1 and tier 1. In addition to this, with the latest changes of this methodology from 2012, there are further enhancements of the definition of capital, in line with Basel III requirements. However, the new methodology does not provide for an
	Def cap	3	2007 & 2012	
	Risk cov	1	2013+	
	Conserv	1	2013+	
	C-cycl	1	2013+	
	LR	1	2013+	

				adequate treatment of some of the deductible items.
Montenegro	Liq	1	2013	
	Def cap	1	2013	
	Risk cov	1	2013	
	Conserv	1	2013	
	C-cycl	1	2013	
	LR	1	2013	
Serbia	Liq	1	To be defined	National Bank of Serbia is currently analyzing the most suitable manner and timetable for Basel III implementation in Serbia, and is set to formalize a Strategy for implementation of Basel III during year 2012. The Strategy will cover all relevant issues of theNew set of standards and will put forward timetable for adoption of particular requirements regarding capital and liquidity standards, which will follow EU process for Basel III implementation. On the side note, some elements of Basel III have already been introduced by the regulation based on Basel II standards, such as: a) exclusion of Tier 3 capital from the total regulatory capital; and b) introduction of capital conservation buffer which effectively disallows banks with CAR of below 14.5% (or banks that would fall below CAR of 14.5% if dividends were to be paid) to pay out dividends.
	Def cap	1	To be defined	
	Risk cov	1	To be defined	
	Conserv	4	To be defined	
	C-cycl	1	To be defined	
	LR	1	To be defined	

Source: Bank for International Settlement (BIS), Financial Stability Institute Survey Basel II, 2.5 and III Implementation (2012)

APPENDIX TO CHAPTER 3

3.1 SUMMARY OF VARIABLES USED FOR ESTIMATION OF COST EFFICIENCY EMPLOYED IN OTHER STUDIES

Table A3.1 Summary of the variables used for cost efficiency estimation in the studies for transition economies

Author(s)	Definition	Dependent variable	Independent variables		Environmental factors		
			Output(s)	Input prices	Individual bank's characteristics	Structure of the banking industry	Country level variables
Mertnes and Urga 2001	Intermediation	*Total costs (*Σ of variable costs, expenses for bank's premises, furniture and equipment, and other administrative expenses)	Inter-bank loans Consumer loans Other investment (government and risky securities and investment in other enterprises	Labour (personnel expenses/period avg.TA) Deposits (total interest expenses/total deposits) Capital (expenses for FA other AE/average FA (used for scale efficiency estimation only)	*input variables:* bank capital; fixed assets; *bank-specific variable:* non-performing loans/total volume of loans		
Kraft et al. (2002)	Producti on	*Total costs*	Loans to enterprises Loans to households Deposits to enterprises Deposits to households	Capital cost ratio Labour cost ratio Funding cost ratio	Ownership status (ui) *Fixed netputs:* Total Assets. Total Equity		
Hasan and Merton (2003)	Production	*Total costs (*interest and noninterest expenses)	Total loans Total investments (other earning assets) Noninterest or fee-related income Total interest bearing borrowed funds	price of borrowed funds (total interest expense/total borrowed funds) price of labour (noninterest expenses/number of employees)	Netput variables: Equity capital, loan loss provision/total loan In the second stage: Liquid asset (cash and securities/TA); Short-term loan/TA; Total assests; Financial investment/TA; Loans to customers/TA; Customer short-term deposit/TA; Equity/TA; Age in business; Opening hours (average hours); Asset owned by foreign banks/TA; Acquisition dummy variable; Foreign ownership dummy variables (0.01–25%, 25.01–50%, 50.01–75%, and 75.01–100%)		

Weill (2003)	Intermediation	*Total costs (sum of personnel exoenses, interest paid and other non-interest expenses)*	Loans Other earning assets	Labour (personnel expenses/TA) Borrowed funds (Interest paid/Total funding) Physical capital (Other non-interest expenses/FA)	Equity; Country dummy In the second stage: Ownership dummy variable; Loans/investment assets; Deposits/TA; Total assets
Fries and Taci (2005)	Intermediation for costs; Value added for outputs	*Total costs (sum of interest expenses and general operating expenses.*	Loans to customers Deposits		Non-loan assets/TA; Non-performing loans/Total loans; Equity/TA; Ownership status; Bank capitalization; Dummy variable for different accounting standards; Other earning assets/TA; Deposit market share; ROA; ROE. CR5; Share of majority foreign-owned banks in total banking system assets; Intermediation % (loans/deposits); EBRD ordinal index of banking sector reform; Average ratio of capital to assets of the banking sector; GDP per capita; Nominal market interest rate; Density of deposits
Bonin et al (2005)	Production	Total costs (sum of interest and non-interest costs)	Total deposits Total loans Total liquid assets and investments Liquid assets	Price of capital (non-interest expenses/TA) Price of funds (interest expenses/total deposits	Ownership status
Rossi et al	Modified production	Total costs (operating expenses)	Loans (performing and nonperforming) with customers Deposits with customers Other earning assets	Labour (Staff expenses/TA) Capital (operative-capital expenses /adjusted FA) Deposits (interest expenses /customer deposits)	In the second stage: LLP/total loans; Equity/TA; Loan/TA; Market share; CR5; Ownership (% of foreign assets)
Kasman (2005)	intermediation		Total loans OEA	Labour (personnel expenses/TA) Capital (other operating costs/FA) Borrowed funds (total interest expenses/total funding?	In the second stage: ROA; Total costs/Total assets; Equity/Total assets; Total loans/TA; Total deposits/TA; lnTA; non-interest income/total income; financial investments/total assets; ownership status (dummy) Density population; Income per capita; Density of demand; Capital ratio; Intermediation ratio; Money/GDP; GDP growth; Inflation Telephone lines per 100km2
Kasman and Yildirim (2006)	Value added approach	total costs (interest expensesþnoninterest expenses)	Total loans total deposits OEA (investment securities)	Price of labour and physical capital (operating costs/TA) Price of funds (total interest expenses/total deposits and other purchased funds	Density ; of population, Income per capita; Density of Demand; Capital ratio; HHI; Intermediation ratio; Inflation; M2 to GDP; GDP growth; LnTA; Market capitalisation (%of GDP)

Yildirim and Philippatos (2007)	Modified value added	Total costs (sum of interest expenses, personnel expenses and other operating expenses)	Loans (Net loans) Investments (securities, equity investments and other investments) Deposits (demand, savings and time-deposits)	Price of labour (personnel expnses/TA) Price of borrowed funds (interest expenses/customer and short-term funding and other funding) Price of physical capital (other operating expenses/FA)	Equity In the second stage: Ln TA Shareholders' equity/TA Loans/ta Llp/gross loans Customer and short-term funding/total funding Interbank deposits/total deposits Off-balance activity/ta Ownership status (dummy) Listed on Stock Exchange (dummy)	In the second stage: PR H-statistics CR3	In the second stage: GDP growth
Staikouras et al (2008)	Intermediation			Price of non-financial inputs (non-interest expenses/TA) Price of funds (interest paid on borrowed funds/total fund.	level of equity cash and due to banks/TA LLP/total loans, on aggregate level ownership status In the second stage: loans/TA; bank deposits/total funds; equity/TA; LLP/loans; ROA; MS (in terms of assets); bank's age; GDP growth rate	HHI	GDP per capita Population density

APPENDIX TO CHAPTER 4

4.1 DESCRIPTIVE STATISTICS OF THE VARIABLES USED IN CHAPTER 4

Descriptive statics of the variables used for estimation of the banks' cost efficiency in SEECs

Legend of the abbreviations of the variables

Abbreviation	Full name of the variable
tc	Total costs in '000 USD
q1ta	Total net loans over total assets ratio
q2ta	Total other earning assets over total assets ratio
p1	Price of borrowed funds (total interest expenses over total deposits ratio)
p2	Price of physical capital (non-interest operating) expenses to fixed assets ratio)
p3	Price of labour (personnel expenses divided over total assets ratio)
llictac	Loan impairment charges to total assets ratio
mixed	1=if the share of foreign owners is between 21 and 89 per cent, otherwise 0
foreign9	1=if the share of foreign owners is = or >90 per cent, otherwise 0
eta	Capital (total equity to total assets ratio)
hhi	Herfindahl-Hirschman Index
inm	Intermediation ratio (total loans to total deposits in the banking sector ratio)
dd	Demand density (total deposits of the banking sector per km^2 ratio)
inflation	Inflation based on Consumer Price Index
gdpc	GDP per capita in constant 2005 prices (USD '000)
lpop	Population density (number of inhabitants per km^2)

by country name, sort : summarize tc q1ta q2ta p1 p2 p3 llictac mixed foreign9 eta eu hhi inm dd inflation gdpc lpop

-> country name = ALBANIA

Variable	Obs	Mean	Std. Dev.	Min	Max
tc	107	35834.31	36633.31	700	152614
q1ta	107	.3955908	.1925715	.0021518	.8750516
q2ta	107	.4600925	.2169455	.0270606	.9709077
p1	107	.0339577	.0100538	.0079051	.0676193
p2	107	.8879398	.4420119	.0285714	3.06247
p3	107	.0102573	.0040521	.0043079	.0254289
llictac	107	-2.877299	.1415482	-3.294038	-2.472275
mixed	107	.2336449	.4251401	0	1
foreign9	107	.6074766	.4906101	0	1
eta	107	.1078123	.0632944	.0234952	.3378863
eu	107	0	0	0	0
hhi	107	2085.61	849.9135	1367.395	4345.261
inm	107	.4007737	.2124605	.1015209	.6784759
dd	107	202.5841	88.11915	58.55817	333.0271
inflation	107	2.846825	1.687135	.0500181	7.770526
gdpc	107	2845.792	518.0856	1949.281	3549.45
lpop	107	4.758715	.0147686	4.74466	4.792633

-> country name = BIH

Variable	Obs	Mean	Std. Dev.	Min	Max
tc	280	23446.61	32287.43	190.08	183726.5
q1ta	280	.5619537	.1404547	.1515691	.848
q2ta	280	.1862785	.1476853	.0000997	.7980583
p1	280	.027252	.0224007	.0004028	.25
p2	280	.8201034	1.107531	.0413223	15.6875
p3	280	.0243466	.0133864	.0071722	.0789359
llictac	280	-2.722394	.2570872	-3.398018	-1.301839
mixed	280	.0821429	.2750739	0	1
foreign9	280	.5392857	.4993467	0	1
eta	280	.216568	.1687371	.0465995	.9447853
eu	280	0	0	0	0
hhi	280	737.2004	244.0119	134.4333	1002.159
inm	280	1.142644	.1169051	.9804901	1.544213
dd	280	114.5893	59.16649	18.22544	178.3865
inflation	280	2.736175	2.389849	-.3901942	7.416856
gdpc	280	2944.974	407.6704	2241.695	3391.468
lpop	280	4.32835	.0055061	4.319817	4.336285

-> country name = BULGARIA

Variable	Obs	Mean	Std. Dev.	Min	Max
tc	241	79344.77	91801.92	1385.838	358624.7
q1ta	241	.582962	.1695622	.1665924	.9038815
q2ta	241	.2796971	.1778533	.004017	.7303082
p1	241	.0414275	.046832	.0062156	.4242424
p2	241	1.503868	2.305935	.2193033	23.67073
p3	241	.0130945	.0062156	.0029914	.047259
llictac	241	-2.859455	.1978295	-3.698795	-1.939022
mixed	241	.1742739	.3801343	0	1
foreign9	241	.5767635	.4951005	0	1
eta	241	.1390867	.1054714	.051521	.8204483
eu	241	.6431535	.480066	0	1
hhi	241	737.7292	74.96388	631.1074	891.093
inm	241	.9176791	.0582502	.7932223	.9981217
dd	241	264.9783	133.1914	39.61499	427.227
inflation	241	5.594228	2.98468	2.157107	12.34877
gdpc	241	4027.607	533.7319	2872.957	4634.631
lpop	241	4.252373	.0217465	4.208961	4.283537

-> country_name = CROATIA

Variable	Obs	Mean	Std. Dev.	Min	Max
tc	329	108375.5	198856	1716.496	1208221
q1ta	329	.581893	.0956783	.2814412	.7507784
q2ta	329	.262978	.1219082	.0216509	.6516115
p1	329	.0400092	.0190681	.0152017	.2731164
p2	329	1.284113	1.525116	.0855346	11
p3	329	.0161193	.0068832	.0049042	.0514286
llictac	329	-2.872334	.2336222	-3.574766	.5169301
mixed	329	.0699088	.2553817	0	1
foreign9	329	.3130699	.4644489	0	1
eta	329	.1356956	.0677465	.0242274	.3979177
eu	329	.0759878	.2653823	0	1
hhi	329	1631.098	58.6022	1544.922	1754.916
inm	329	1.05975	.1581293	.7196448	1.287084
dd	329	540.381	203.8937	154.8855	753.4911
inflation	329	2.929091	1.308676	1.035615	6.091649
gdpc	329	10089.08	942.3944	8141.477	11376.47
lpop	329	4.367284	.013534	4.334029	4.374666

-> country name = MACEDONIA

Variable	Obs	Mean	Std. Dev.	Min	Max
tc	147	21065.73	24290.28	889.5174	102071.7
q1ta	147	.5193515	.1411967	.1591262	.7721533
q2ta	147	.2517826	.162239	.0026882	.7344576
p1	147	.0330381	.0124774	.0075065	.0694861
p2	147	.9111828	1.106895	.1571299	9.258741
p3	147	.0183067	.0067244	.0094439	.0516662
llictac	147	-2.796527	.2828785	-4.479529	-1.283205
mixed	147	.2721088	.4465672	0	1
foreign9	147	.4421769	.4983432	0	1
eta	147	.2075774	.1328879	.0679182	.665464
eu	147	0	0	0	0
hhi	147	1121.251	129.2089	734.1375	1257.581
inm	147	.7908921	.1013917	.5983645	1.002173
dd	147	131.2825	70.59025	22.10143	226.8739
inflation	147	2.843698	2.517929	-.739634	8.331897
gdpc	147	3061.005	334.9232	2560.248	3490.222
lpop	147	4.413409	.0103666	4.390704	4.424706

-> country name = MONTENEGRO

Variable	Obs	Mean	Std. Dev.	Min	Max
tc	79	20187.14	21605.89	1434.88	102150.2
q1ta	79	.6367747	.1375432	.3333333	.8884486
q2ta	79	.1297791	.097255	9.33e-06	.3728663
p1	79	.0356088	.0169649	.0053476	.0967742
p2	79	1.133069	.5270005	.4813206	2.647059
p3	79	.0276825	.0151836	.0051227	.0652174
llictac	79	-2.771804	.5139787	-6.73727	-1.633929
mixed	79	.1898734	.3947069	0	1
foreign9	79	.5822785	.4963352	0	1
eta	79	.2086625	.1562291	.0405735	.7794872
eu	79	0	0	0	0
hhi	79	1594.693	372.3834	1050.323	2330.12
inm	79	1.090302	.2289004	.7428108	1.365682
dd	79	145.1682	73.6305	19.81435	228.8677
inflation	79	4.220613	2.196549	.6549466	8.758728
gdpc	79	4232.007	451.4703	3382.366	4688.969
lpop	79	3.827592	.003706	3.820116	3.832482

-> country name = SERBIA

Variable	Obs	Mean	Std. Dev.	Min	Max
tc	269	110497.4	200473.2	1563.411	1648594
q1ta	269	.5441101	.1238057	.1185164	.8319448
q2ta	269	.1643793	.1222969	7.41e-07	.7507664
p1	269	.042477	.0240481	.004232	.2051444
p2	269	2.949892	5.284288	.0719501	43.39926
p3	269	.0269474	.0156229	.0042455	.1019022
llictac	269	-2.615218	.4366264	-3.647738	-.6682643
mixed	269	.1449814	.3527384	0	1
foreign9	269	.5799257	.4944905	0	1
eta	269	.2271636	.1209686	.0075599	.917936
eu	269	0	0	0	0
hhi	269	508.2773	77.10771	265.5162	575.1907
inm	269	1.178909	.1050029	.9890644	1.291758

dd	269	139.8881	60.80814	32.53541	205.5473
inflation	269	10.28424	3.367343	6.142554	19.49083
gdpc	269	3607.772	317.3958	2844.504	3903.545
lpop	269	4.432868	.0113162	4.413967	4.451481

-> country name = SLOVENIA

Variable	Obs	Mean	Std. Dev.	Min	Max
tc	215	142162.2	235968.2	3040.009	1595018
q1ta	215	.6001949	.1628065	.0097242	.8996958
q2ta	215	.3363015	.1650154	.0785721	.9518926
p1	215	.0396868	.0171839	.0111371	.130141
p2	215	.8596509	.624665	.1826625	3.648649
p3	215	.0116785	.0042242	.0020557	.0221966
llictac	215	-2.844082	.1415345	-3.394656	-2.295864
mixed	215	.0232558	.1510666	0	1
foreign9	215	.3209302	.4679235	0	1
eta	215	.0910403	.0434409	.0207913	.3228184
eu	215	.7906977	.40776	0	1
hhi	215	1886.438	343.3017	1189.411	2279.941
inm	215	.9015864	.1254658	.7318537	1.101928
dd	215	1811.569	852.4128	485.1053	2907.524
inflation	215	4.12934	2.50925	.8559201	8.878803
gdpc	215	18021.42	1671.915	15033.47	20706.67
lpop	215	4.606692	.0119845	4.592642	4.626856

4.2 BATTESE AND COELLI MODELS (PRINTOUTS)

4.2.1 BC1

BC1 MODEL (THE BASELINE MODEL WITH YEARS)

```
FRONTIER;cost; LHS = ltcp3ta ; rhs=vicka, llictac, leta, foreign9, mixed, lpop,
lDD, linm, lgdpc, lhhi, infl,eu,
y01,y02,y03,y04,y05,y06,y07,y08,y09,y10,y11,y12; output=3$
FRONTIER;cost; LHS = ltcp3ta ; rhs=vicka, llictac, leta, foreign9, mixed, lpop,
lDD, linm, lgdpc, lhhi, infl,eu,
y01,y02,y03,y04,y05,y06,y07,y08,y09,y10,y11,y12; output=3;
PDS=bank ; MODEL = BC ; halton=500; table=ebc1; EFF = UI_BC1$ create;
ebc1=exp(-ui_bc1)$ dstat; rhs=ebc1$

Vicka= one, LQ1TA, LQ2TA, LP1P3, LP2P3, lq1q2, lqq1, lqq2, lp1p3h, lp2p3h,
lp1p2, lq1p1, lq1p2, lq2p1, lq2p2$


Initial iterations cannot improve function.Status=3
  Error   805: Initial iterations cannot improve function.Status=3
Function= -.19074973211D+03, at entry, -.18924131118D+03 at exit

+---------------------------------------------+
| Limited Dependent Variable Model - FRONTIER |
| Maximum Likelihood Estimates                |
| Model estimated: Feb 25, 2014 at 06:56:29PM.|
| Dependent variable              LTCP3TA     |
| Weighting variable                 None     |
| Number of observations             1667     |
| Iterations completed                  1     |
| Log likelihood function        190.7497     |
| Number of parameters                 41     |
| Info. Criterion: AIC =           -.17966     |
|   Finite Sample: AIC =           -.17839     |
| Info. Criterion: BIC =           -.04639     |
| Info. Criterion:HQIC =           -.13028     |
+---------------------------------------------+
| Frontier model estimated with PANEL data.   |
| Estimation based on   153 individuals.      |
| Variances: Sigma-squared(v)=       .02296   |
|            Sigma-squared(u)=       .08023   |
|            Sigma(v)        =       .15152   |
|            Sigma(u)        =       .28325   |
| Sigma = Sqr[(s^2(u)+s^2(v)]=       .32123   |
| Stochastic Cost Frontier, e=v+u.            |
| Time varying u(i,t)=exp[-eta(t-T)]*|U(i)|   |
+---------------------------------------------+
+---------+--------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+---------+--------------+----------------+--------+--------+----------+
---------+Primary Index Equation for Model
 Constant|    -.27442714       .52121555     -.527   .5985
 LQ1TA   |     .14557255       .07945724     1.832   .0669   -.63996924
 LQ2TA   |     .16379424       .02340377     6.999   .0000  -1.70110077
 LP1P3   |     .07331971       .01566386     4.681   .0000    .70390787
 LP2P3   |     .01075605       .02012142      .535   .5930   3.99750610
```

```
 LQ1Q2   |     .09317155        .01840439     5.062   .0000     .89627491
 LQQ1    |     .03944467        .01508079     2.616   .0089     .30782592
 LQQ2    |     .00352202        .00237294     1.484   .1377    1.98486666
 LP1P3H  |    -.00410371        .00446204     -.920   .3577     .59791174
 LP2P3H  |     .01659100        .00282820     5.866   .0000    8.54926267
 LP1P2   |     .03877715        .00326936    11.861   .0000    3.26625619
 LQ1P1   |    -.00610029        .01070171     -.570   .5687    -.43396599
 LQ1P2   |    -.01320987        .01444229     -.915   .3604   -2.51821860
 LQ2P1   |    -.01743471        .00659343    -2.644   .0082   -1.11658896
 LQ2P2   |    -.03323895        .00291041   -11.421   .0000   -6.75933772
 LLICTAC |    -.03407762        .01537716    -2.216   .0267   -2.78902282
 LETA    |    -.08082214        .00731075   -11.055   .0000   -1.99239234
 FOREIGN9|    -.02958759        .01586149    -1.865   .0621     .47630474
 MIXED   |     .05449419        .01802930     3.023   .0025     .12717457
 LPOP    |     .25801813        .10916026     2.364   .0181    4.38920813
 LDD     |    -.00482979        .02889653     -.167   .8673    5.45846806
 LINM    |     .02295658        .03046951      .753   .4512    -.06002421
 LGDPC   |    -.05763781        .04610449    -1.250   .2112    8.55381656
 LHHI    |     .03255689        .02397702     1.358   .1745    6.93438002
 INFL    |    1.54408298        .18437855     8.375   .0000     .04672069
 EU      |    -.05606941        .01667397    -3.363   .0008     .20995801
 Y01     |     .00692600        .04091871      .169   .8656     .04499100
 Y02     |     .03928108        .03244601     1.211   .2260     .06118776
 Y03     |     .01589432        .03584439      .443   .6575     .07678464
 Y04     |    -.02602512        .03554562     -.732   .4641     .08458308
 Y05     |    -.08895267        .04071543    -2.185   .0289     .08878224
 Y06     |    -.09014305        .04763967    -1.892   .0585     .08998200
 Y07     |    -.04925609        .05130728     -.960   .3370     .09058188
 Y08     |    -.07849009        .05210571    -1.506   .1320     .08998200
 Y09     |     .02489374        .05277275      .472   .6371     .08878224
 Y10     |     .01113372        .05045829      .221   .8254     .08398320
 Y11     |    -.01480029        .05121715     -.289   .7726     .08398320
 Y12     |     .00463596        .04957604      .094   .9255     .08218356
---------+Variance parameters for compound error
 Lambda  |    1.86936024        .07006574    26.680   .0000
 Sigma(u)|     .28325305        .00473259    59.852   .0000
---------+Eta parameter for time varying inefficiency
 Eta     |     .01000000        .00486271     2.056   .0397

--> create; ebc1=exp(-ui_bc1)$
--> dstat; rhs=ebc1$
Descriptive Statistics
All results based on nonmissing observations.
================================================================================
Variable     Mean       Std.Dev.     Minimum      Maximum        Cases Missing
================================================================================
-------------------------------------------------------------------------------
All observations in current sample
-------------------------------------------------------------------------------
EBC1    |  .809146      .103707      .360280      .993644         1667       0
```

4.2.2 BC2

BC2 MODEL (HETEROSCEDASTIC WITH YEARS)

```
FRONTIER;cost; LHS = ltcp3ta ; rhs=vicka, lpop, lDD, linm, lgdpc, lhhi, infl,
eu, y01,y02,y03,y04,y05,y06,y07,y08,y09,y10,y11,y12; output=3$
FRONTIER;cost; LHS = ltcp3ta ; rhs=vicka, lpop, lDD, linm, lgdpc, lhhi, infl,
eu, y01,y02,y03,y04,y05,y06,y07,y08,y09,y10,y11,y12; output=3
;HFU = llictac, leta, foreign9, mixed; PDS=bank ;MODEL = BC
;EFF = UI_BC2; table=ebc2$ create; ebc2=exp(-ui_bc2)$ dstat; rhs=ebc2$

Vicka= one, LQ1TA, LQ2TA, LP1P3, LP2P3, lq1q2, lqq1, lqq2, lp1p3h, lp2p3h,
lp1p2, lq1p1, lq1p2, lq2p1, lq2p2$


Initial iterations cannot improve function.Status=3
  Error   805: Initial iterations cannot improve function.Status=3
Function= -.25062052975D+03, at entry, -.24869659489D+03 at exit

+----------------------------------------------+
| Limited Dependent Variable Model - FRONTIER |
| Maximum Likelihood Estimates                 |
| Model estimated: Feb 25, 2014 at 06:57:55PM.|
| Dependent variable              LTCP3TA      |
| Weighting variable                 None      |
| Number of observations             1667      |
| Iterations completed                  1      |
| Log likelihood function        250.6205      |
| Number of parameters                 40      |
| Info. Criterion: AIC =          -.25269      |
|   Finite Sample: AIC =          -.25148      |
| Info. Criterion: BIC =          -.12267      |
| Info. Criterion:HQIC =          -.20451      |
+----------------------------------------------+
| Frontier model estimated with PANEL data.    |
| Estimation based on   153 individuals.       |
| Variances: Sigma-squared(v)=        .02832   |
|            Sigma-squared(u)=        .06935   |
|            Sigma(v)        =        .16829   |
|            Sigma(u)        =        .26335   |
| Sigma = Sqr[(s^2(u)+s^2(v)]=        .31253   |
| Stochastic Cost Frontier, e=v+u.             |
| Time varying u(i,t)=exp[eta*z(i,t)]*|U(i)|   |
+----------------------------------------------+
+---------+--------------+----------------+--------+--------+----------+
|Variable| Coefficient   | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+---------+--------------+----------------+--------+--------+----------+
---------+Primary Index Equation for Model
 Constant|     .21575655       .48411686      .446   .6558
 LQ1TA   |     .21754597       .09857589     2.207   .0273   -.63996924
 LQ2TA   |     .19167183       .02843799     6.740   .0000  -1.70110077
 LP1P3   |     .10769724       .02086058     5.163   .0000    .70390787
 LP2P3   |     .01588409       .02434510      .652   .5141   3.99750610
 LQ1Q2   |     .10465513       .02097521     4.989   .0000    .89627491
 LQQ1    |     .05504690       .01629188     3.379   .0007    .30782592
 LQQ2    |     .00399459       .00279886     1.427   .1535   1.98486666
 LP1P3H  |   -.01097500       .00442994    -2.477   .0132    .59791174
 LP2P3H  |     .01288854       .00349260     3.690   .0002   8.54926267
```

```
 LP1P2   |     .03738222       .00379395      9.853   .0000   3.26625619
 LQ1P1   |     .00645657       .01120186       .576   .5644   -.43396599
 LQ1P2   |    -.02671772       .01704097     -1.568   .1169  -2.51821860
 LQ2P1   |    -.01354711       .00721703     -1.877   .0605  -1.11658896
 LQ2P2   |    -.03850793       .00377010    -10.214   .0000  -6.75933772
 LPOP    |     .23981502       .08788274      2.729   .0064   4.38920813
 LDD     |     .03179375       .03366025       .945   .3449   5.45846806
 LINM    |     .01784252       .03531406       .505   .6134   -.06002421
 LGDPC   |    -.09372585       .05121329     -1.830   .0672   8.55381656
 LHHI    |     .03360655       .02663336      1.262   .2070   6.93438002
 INFL    |    1.54143441       .18449729      8.355   .0000    .04672069
 EU      |    -.05224444       .02023288     -2.582   .0098    .20995801
 Y01     |     .01118437       .04885555       .229   .8189    .04499100
 Y02     |     .03614124       .03888133       .930   .3526    .06118776
 Y03     |     .00662208       .04130037       .160   .8726    .07678464
 Y04     |    -.04288146       .04158310     -1.031   .3024    .08458308
 Y05     |    -.10644815       .04810400     -2.213   .0269    .08878224
 Y06     |    -.12101581       .05319853     -2.275   .0229    .08998200
 Y07     |    -.10185548       .06155094     -1.655   .0980    .09058188
 Y08     |    -.13242822       .05942903     -2.228   .0259    .08998200
 Y09     |    -.03085888       .06217421      -.496   .6197    .08878224
 Y10     |    -.04163935       .05968513      -.698   .4854    .08398320
 Y11     |    -.06615051       .05677290     -1.165   .2439    .08398320
 Y12     |    -.04857798       .05688788      -.854   .3931    .08218356
---------+Variance parameters for compound error
 Lambda  |    1.56490629       .12074857     12.960   .0000
 Sigma(u)|     .26335165       .00665737     39.558   .0000
---------+Coefficients in u(i,t)=[exp{eta*z(i,t)}]*|U(i)|
 LLICTAC |     .00010000       .06498135       .002   .9988
 LETA    |     .00010000       .02937305       .003   .9973
 FOREIGN9|     .00010000       .08500599       .001   .9991
 MIXED   |     .00010000       .08355841       .001   .9990
```

--> create; ebc2=exp(-ui_bc2)$
--> dstat; rhs=ebc2$

```
Descriptive Statistics
All results based on nonmissing observations.
===============================================================================
Variable     Mean        Std.Dev.     Minimum      Maximum        Cases Missing
===============================================================================
------------------------------------------------------------------------------
All observations in current sample
------------------------------------------------------------------------------
EBC2    |  .817771      .100316      .398910      .993823          1667       0
```

4.2.3 BC3

BC3 MODEL (DISTRIBUTION OF UNDERLYING MEAN WITH YEARS)

```
FRONTIER;cost; LHS = ltcp3ta ; rhs=vicka, lpop, lDD, linm, lgdpc, lhhi, infl,
eu, y01,y02,y03,y04,y05,y06,y07,y08,y09,y10,y11,y12; output=3
;RH2 = one, llictac, leta, foreign9, mixed; PDS=bank ;MODEL = BC; table=bc3
;EFF = UI_BC3$ create; ebc3=exp(-ui_bc3)$ dstat; rhs=ebc3$

vicka= one, LQ1TA, LQ2TA, LP1P3, LP2P3, lq1q2, lqq1, lqq2, lp1p3h, lp2p3h,
lp1p2, lq1p1, lq1p2, lq2p1, lq2p2$


Initial iterations cannot improve function.Status=3
  Error   805: Initial iterations cannot improve function.Status=3
Function=  .73137687010D+02, at entry,  .29546147282D+02 at exit

+---------------------------------------------+
| Limited Dependent Variable Model - FRONTIER |
| Maximum Likelihood Estimates                |
| Model estimated: Feb 25, 2014 at 06:58:37PM.|
| Dependent variable              LTCP3TA     |
| Weighting variable                 None     |
| Number of observations             1667     |
| Iterations completed                  2     |
| Log likelihood function       -27.14132     |
| Number of parameters                 42     |
| Info. Criterion: AIC =           .08295     |
|   Finite Sample: AIC =           .08429     |
| Info. Criterion: BIC =           .21948     |
| Info. Criterion:HQIC =           .13355     |
+---------------------------------------------+
| Frontier model estimated with PANEL data.   |
| Estimation based on   153 individuals.      |
| Variances: Sigma-squared(v)=        .06212  |
|            Sigma-squared(u)=        .91686  |
|            Sigma(v)        =        .24925  |
|            Sigma(u)        =        .95753  |
| Sigma = Sqr[(s^2(u)+s^2(v)]=        .98944  |
| Stochastic Cost Frontier, e=v+u.            |
| Time varying u(i,t)=exp[-eta(t-T)]*|U(i)|   |
+---------------------------------------------+
+---------+--------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+---------+--------------+----------------+--------+--------+----------+
---------+Primary Index Equation for Model
 Constant|     .72306052       .79728090      .907   .3645
 LQ1TA   |     .26917213       .19464756     1.383   .1667   -.63996924
 LQ2TA   |     .19406333       .05029139     3.859   .0001  -1.70110077
 LP1P3   |     .00806643       .04309799      .187   .8515    .70390787
 LP2P3   |     .15758950       .05980579     2.635   .0084   3.99750610
 LQ1Q2   |     .08881018       .03848794     2.307   .0210    .89627491
 LQQ1    |     .05143407       .03488092     1.475   .1403    .30782592
 LQQ2    |     .00127157       .00500948      .254   .7996   1.98486666
 LP1P3H  |    -.07456416       .00927473    -8.040   .0000    .59791174
 LP2P3H  |    -.05195280       .00876753    -5.926   .0000   8.54926267
 LP1P2   |     .08418035       .00722807    11.646   .0000   3.26625619
 LQ1P1   |     .00390184       .02398936      .163   .8708   -.43396599
```

```
 LQ1P2   |    -.04401561       .03737207    -1.178   .2389  -2.51821860
 LQ2P1   |    -.01548468       .01437903    -1.077   .2815  -1.11658896
 LQ2P2   |    -.03694369       .00485074    -7.616   .0000  -6.75933772
 LPOP    |     .17088068       .10444369     1.636   .1018   4.38920813
 LDD     |     .08421152       .06410860     1.314   .1890   5.45846806
 LINM    |     .02192161       .08221411      .267   .7897   -.06002421
 LGDPC   |    -.15010416       .10099121    -1.486   .1372   8.55381656
 LHHI    |     .03653431       .05586477      .654   .5131   6.93438002
 INFL    |    1.36472786       .54229547     2.517   .0119    .04672069
 EU      |    -.03996249       .04388080     -.911   .3625    .20995801
 Y01     |     .01162910       .09433016      .123   .9019    .04499100
 Y02     |     .01948998       .08053427      .242   .8088    .06118776
 Y03     |    -.01766742       .09101121     -.194   .8461    .07678464
 Y04     |    -.08201526       .08813943     -.931   .3521    .08458308
 Y05     |    -.12289747       .10381217    -1.184   .2365    .08878224
 Y06     |    -.14901090       .10917265    -1.365   .1723    .08998200
 Y07     |    -.14808066       .13461570    -1.100   .2713    .09058188
 Y08     |    -.17507095       .12583874    -1.391   .1642    .08998200
 Y09     |    -.10386458       .13171791     -.789   .4304    .08878224
 Y10     |    -.11235994       .12092821     -.929   .3528    .08398320
 Y11     |    -.12847939       .12776392    -1.006   .3146    .08398320
 Y12     |    -.11128975       .11457985     -.971   .3314    .08218356
---------+Offset [mean=mu(i)] parameters in one sided error
 Constant|    1.51104170      15.1658287      .100   .9206   1.00000000
 LLICTAC |    1.15601553      11.2300330      .103   .9180  -2.78902282
 LETA    |    2.17439002      18.9078663      .115   .9084  -1.99239234
 FOREIGN9|     .13984995      2.25473986      .062   .9505    .47630474
 MIXED   |     .52863747      4.30286577      .123   .9022    .12717457
---------+Variance parameters for compound error
 Lambda  |    3.84168086      1.10837084     3.466   .0005
 Sigma(u)|     .95753060      4.26042016      .225   .8222
---------+Eta parameter for time varying inefficiency
 Constant|     .00868717       .01263757      .687   .4918

--> create; ebc3=exp(-ui_bc3)$
--> dstat; rhs=ebc3$
Descriptive Statistics
All results based on nonmissing observations.
==============================================================================
Variable     Mean        Std.Dev.     Minimum      Maximum        Cases Missing
==============================================================================
-----------------------------------------------------------------------------
All observations in current sample
-----------------------------------------------------------------------------
EBC3    |  .825763      .108165      .285669      .988428          1667       0
```

4.2.4 BC1T

BC1T MODEL (THE BASELINE MODEL WITH TIME TREND)

```
FRONTIER;cost; LHS = ltcp3ta ; rhs=vicka, llictac, leta, foreign9,mixed, lpop,
lDD, linm, lgdpc, lhhi, infl,eu, t,th,tq1, tq2, tp1, tp2,y08,y09; output=3$
FRONTIER;cost; LHS = ltcp3ta ; rhs=vicka, llictac, leta, foreign9,mixed, lpop,
lDD, linm, lgdpc, lhhi, infl,eu, t,th,tq1, tq2, tp1, tp2,y08,y09;
halton;pts=500;output=3; PDS=bank ; MODEL = BC ;table=ebc1t;EFF = UI_BC1T$
create; ebc1T=exp(-ui_bc1T)$ dstat; rhs=ebc1T$
vicka= one, LQ1TA, LQ2TA, LP1P3, LP2P3, lq1q2, lqq1, lqq2, lp1p3h, lp2p3h,
lp1p2, lq1p1, lq1p2, lq2p1, lq2p2$
```

```
Initial iterations cannot improve function.Status=3
  Error   805: Initial iterations cannot improve function.Status=3
Function= -.15957729140D+03, at entry, -.14894774831D+03 at exit

+----------------------------------------------+
| Limited Dependent Variable Model - FRONTIER |
| Maximum Likelihood Estimates                 |
| Model estimated: Feb 25, 2014 at 06:59:41PM.|
| Dependent variable               LTCP3TA     |
| Weighting variable                  None     |
| Number of observations              1667     |
| Iterations completed                   1     |
| Log likelihood function         159.5773     |
| Number of parameters                  37     |
| Info. Criterion: AIC =            -.14706     |
|   Finite Sample: AIC =            -.14603     |
| Info. Criterion: BIC =            -.02679     |
| Info. Criterion:HQIC =            -.10249     |
+----------------------------------------------+
| Frontier model estimated with PANEL data.    |
| Estimation based on   153 individuals.       |
| Variances: Sigma-squared(v)=        .02184   |
|            Sigma-squared(u)=        .08389   |
|            Sigma(v)        =        .14777   |
|            Sigma(u)        =        .28963   |
| Sigma = Sqr[(s^2(u)+s^2(v)]=        .32515   |
| Stochastic Cost Frontier, e=v+u.             |
| Time varying u(i,t)=exp[-eta(t-T)]*|U(i)|    |
+----------------------------------------------+
+---------+--------------+----------------+--------+--------+----------+
|Variable| Coefficient   | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+---------+--------------+----------------+--------+--------+----------+
---------+Primary Index Equation for Model
 Constant|     .13951851       .57072118      .244   .8069
 LQ1TA   |     .15042806       .06639421     2.266   .0235   -.63996924
 LQ2TA   |     .16611148       .02428300     6.841   .0000  -1.70110077
 LP1P3   |     .02101575       .01486898     1.413   .1575    .70390787
 LP2P3   |     .00118903       .01895428      .063   .9500   3.99750610
 LQ1Q2   |     .09590063       .01995518     4.806   .0000    .89627491
 LQQ1    |     .03494627       .01278680     2.733   .0063    .30782592
 LQQ2    |     .00665020       .00247235     2.690   .0071   1.98486666
 LP1P3H  |    -.00545892       .00446207    -1.223   .2212    .59791174
 LP2P3H  |     .02018239       .00264312     7.636   .0000   8.54926267
 LP1P2   |     .02902523       .00328657     8.831   .0000   3.26625619
```

```
 LQ1P1   |    -.02027437       .01004483    -2.018   .0436   -.43396599
 LQ1P2   |    -.01868831       .01223663    -1.527   .1267  -2.51821860
 LQ2P1   |    -.01680619       .00654430    -2.568   .0102  -1.11658896
 LQ2P2   |    -.04229389       .00341730   -12.376   .0000  -6.75933772
 LLICTAC |    -.03099743       .01386793    -2.235   .0254  -2.78902282
 LETA    |    -.07940294       .00793940   -10.001   .0000  -1.99239234
 FOREIGN9|    -.02982772       .01679750    -1.776   .0758    .47630474
 MIXED   |     .05195322       .01935192     2.685   .0073    .12717457
 LPOP    |     .22931282       .12579643     1.823   .0683   4.38920813
 LDD     |     .03448410       .02866108     1.203   .2289   5.45846806
 LINM    |     .02040247       .03386750      .602   .5469   -.06002421
 LGDPC   |    -.10111773       .04840555    -2.089   .0367   8.55381656
 LHHI    |     .03550615       .02348220     1.512   .1305   6.93438002
 INFL    |    1.54818484       .16676372     9.284   .0000    .04672069
 EU      |    -.08359009       .01952350    -4.282   .0000    .20995801
 T       |    -.03377495       .00958795    -3.523   .0004   7.62267546
 TH      |     .00600535       .00095242     6.305   .0000   34.9109178
 TQ1     |     .00537385       .00398355     1.349   .1773  -4.37594550
 TQ2     |     .00526132       .00127405     4.130   .0000  -14.0808136
 TP1     |     .01130258       .00175748     6.431   .0000   5.99915400
 TP2     |    -.00285947       .00092112    -3.104   .0019   31.7636015
 Y08     |    -.02986275       .02592450    -1.152   .2494    .08998200
 Y09     |     .06136098       .02487653     2.467   .0136    .08878224
---------+Variance parameters for compound error
 Lambda  |    1.96000710       .06177932    31.726   .0000
 Sigma(u)|     .28963271       .00448146    64.629   .0000
---------+Eta parameter for time varying inefficiency
 Eta     |     .01000000       .00479432     2.086   .0370

--> create; ebc1T=exp(-ui_bc1T)$
--> dstat; rhs=ebc1T$
Descriptive Statistics
All results based on nonmissing observations.
===============================================================================
Variable     Mean       Std.Dev.     Minimum      Maximum        Cases Missing
===============================================================================
------------------------------------------------------------------------------
All observations in current sample
------------------------------------------------------------------------------
EBC1T   |  .806124      .104502      .353852      .994078         1667       0
```

4.2.5 BC2T

BC2T MODEL (HETEROSCEDASTIC WITH TIME TREND)

```
FRONTIER;cost; LHS = ltcp3ta ; rhs=vicka, lpop, lDD, linm, lgdpc, lhhi, infl,
eu, t,th,tq1, tq2, tp1, tp2,y08,y09; output=3
;HFU = llictac, leta, foreign9, mixed; PDS=bank ;MODEL = BC; table=ebc2t
;EFF = UI_BC2T$ create; ebc2T=exp(-ui_bc2T)$ dstat; rhs=ebc2T$
vicka= one, LQ1TA, LQ2TA, LP1P3, LP2P3, lq1q2, lqq1, lqq2, lp1p3h, lp2p3h,
lp1p2, lq1p1, lq1p2, lq2p1, lq2p2$
```

```
Initial iterations cannot improve function.Status=3
  Error   805: Initial iterations cannot improve function.Status=3
Function= -.24192340780D+03, at entry, -.23222893417D+03 at exit

+---------------------------------------------+
| Limited Dependent Variable Model - FRONTIER |
| Maximum Likelihood Estimates                |
| Model estimated: Feb 25, 2014 at 07:00:30PM.|
| Dependent variable              LTCP3TA     |
| Weighting variable                 None     |
| Number of observations             1667     |
| Iterations completed                  1     |
| Log likelihood function        241.9234     |
| Number of parameters                 36     |
| Info. Criterion: AIC =          -.24706     |
|   Finite Sample: AIC =          -.24608     |
| Info. Criterion: BIC =          -.13004     |
| Info. Criterion:HQIC =          -.20369     |
+---------------------------------------------+
| Frontier model estimated with PANEL data.   |
| Estimation based on   153 individuals.      |
| Variances: Sigma-squared(v)=        .02740  |
|            Sigma-squared(u)=        .07189  |
|            Sigma(v)        =        .16554  |
|            Sigma(u)        =        .26812  |
| Sigma = Sqr[(s^2(u)+s^2(v)]=        .31511  |
| Stochastic Cost Frontier, e=v+u.            |
| Time varying u(i,t)=exp[eta*z(i,t)]*|U(i)|  |
+---------------------------------------------+
+--------+--------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+--------+--------------+----------------+--------+--------+----------+
---------+Primary Index Equation for Model
 Constant|     .50722085       .51768413      .980   .3272
 LQ1TA   |     .22209911       .08378136     2.651   .0080   -.63996924
 LQ2TA   |     .19748889       .02798217     7.058   .0000  -1.70110077
 LP1P3   |     .05181622       .01846197     2.807   .0050    .70390787
 LP2P3   |     .00442164       .02325288      .190   .8492   3.99750610
 LQ1Q2   |     .10642623       .02234433     4.763   .0000    .89627491
 LQQ1    |     .05001484       .01419658     3.523   .0004    .30782592
 LQQ2    |     .00688837       .00264025     2.609   .0091   1.98486666
 LP1P3H  |    -.01016765       .00435806    -2.333   .0196    .59791174
 LP2P3H  |     .01871123       .00336902     5.554   .0000   8.54926267
 LP1P2   |     .02607966       .00417727     6.243   .0000   3.26625619
 LQ1P1   |    -.01094138       .01130393     -.968   .3331   -.43396599
 LQ1P2   |    -.03042854       .01482605    -2.052   .0401  -2.51821860
```

```
 LQ2P1    |    -.01158703       .00737468    -1.571   .1161  -1.11658896
 LQ2P2    |    -.04819601       .00432292   -11.149   .0000  -6.75933772
 LPOP     |     .22065861       .09902155     2.228   .0259   4.38920813
 LDD      |     .05740557       .03538544     1.622   .1047   5.45846806
 LINM     |     .01242589       .03935969      .316   .7522   -.06002421
 LGDPC    |    -.12019182       .05323415    -2.258   .0240   8.55381656
 LHHI     |     .03779245       .02648086     1.427   .1535   6.93438002
 INFL     |    1.54533030       .18398828     8.399   .0000    .04672069
 EU       |    -.07612770       .02493726    -3.053   .0023    .20995801
 T        |    -.03974805       .01137634    -3.494   .0005   7.62267546
 TH       |     .00644374       .00107536     5.992   .0000   34.9109178
 TQ1      |     .00486406       .00412231     1.180   .2380  -4.37594550
 TQ2      |     .00495278       .00153110     3.235   .0012  -14.0808136
 TP1      |     .01244830       .00207420     6.001   .0000   5.99915400
 TP2      |    -.00361450       .00113722    -3.178   .0015   31.7636015
 Y08      |    -.03983170       .03302396    -1.206   .2278    .08998200
 Y09      |     .05448884       .03112602     1.751   .0800    .08878224
---------+Variance parameters for compound error
 Lambda   |    1.61965141       .10329392    15.680   .0000
 Sigma(u)|      .26812095       .00592728    45.235   .0000
---------+Coefficients in u(i,t)=[exp{eta*z(i,t)}]*|U(i)|
 LLICTAC |      .00010000       .05402059      .002   .9985
 LETA     |     .00010000       .02666754      .004   .9970
 FOREIGN9|      .00010000       .07747811      .001   .9990
 MIXED    |     .00010000       .07453970      .001   .9989

--> create; ebc2T=exp(-ui_bc2T)$
--> dstat; rhs=ebc2T$
Descriptive Statistics
All results based on nonmissing observations.
==============================================================================
Variable     Mean        Std.Dev.     Minimum      Maximum        Cases Missing
==============================================================================
------------------------------------------------------------------------------
All observations in current sample
------------------------------------------------------------------------------
EBC2T   |  .815739      .101173      .392813      .994188         1667       0
```

4.2.6 BC3T

BC3 MODEL (DISTRIBUTION OF UNDERLYING MEAN WITH TIME TREND)

```
FRONTIER;cost; LHS = ltcp3ta ; rhs=vicka, lpop, lDD, linm, lgdpc, lhhi, infl,
eu, t,th,tq1, tq2, tp1, tp2,y08,y09; output=3
;RH2 = one, llictac, leta, foreign9, mixed; PDS=bank ;MODEL = BC; table=ebc3t
;EFF = UI_BC3T$ create; ebc3T=exp(-ui_bc3T)$ dstat; rhs=ebc3T$
vicka= one, LQ1TA, LQ2TA, LP1P3, LP2P3, lq1q2, lqq1, lqq2, lp1p3h, lp2p3h,
lp1p2, lq1p1, lq1p2, lq2p1, lq2p2$
```

```
Initial iterations cannot improve function.Status=3
  Error   805: Initial iterations cannot improve function.Status=3
Function=  .20493342945D+03, at entry,  .21061553074D+03 at exit

+---------------------------------------------+
| Limited Dependent Variable Model - FRONTIER |
| Maximum Likelihood Estimates                |
| Model estimated: Feb 25, 2014 at 07:00:55PM.|
| Dependent variable              LTCP3TA     |
| Weighting variable                 None     |
| Number of observations             1667     |
| Iterations completed                  1     |
| Log likelihood function       -204.9334     |
| Number of parameters                 38     |
| Info. Criterion: AIC =           .29146     |
|   Finite Sample: AIC =           .29255     |
| Info. Criterion: BIC =           .41499     |
| Info. Criterion:HQIC =           .33724     |
+---------------------------------------------+
| Frontier model estimated with PANEL data.   |
| Estimation based on   153 individuals.      |
| Variances: Sigma-squared(v)=       .02169   |
|            Sigma-squared(u)=      1.70218   |
|            Sigma(v)        =       .14727   |
|            Sigma(u)        =      1.30467   |
| Sigma = Sqr[(s^2(u)+s^2(v)]=      1.31296   |
| Stochastic Cost Frontier, e=v+u.            |
| Time varying u(i,t)=exp[-eta(t-T)]*|U(i)|   |
+---------------------------------------------+
+---------+--------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+---------+--------------+----------------+--------+--------+----------+
---------+Primary Index Equation for Model
 Constant|     .87161009       .31795659     2.741   .0061
 LQ1TA   |     .26037112       .06990755     3.725   .0002   -.63996924
 LQ2TA   |     .18951986       .01838243    10.310   .0000  -1.70110077
 LP1P3   |    -.05569111       .01495373    -3.724   .0002    .70390787
 LP2P3   |     .16301229       .02170781     7.509   .0000   3.99750610
 LQ1Q2   |     .08316172       .01396363     5.956   .0000    .89627491
 LQQ1    |     .04677644       .01163503     4.020   .0001    .30782592
 LQQ2    |     .00373811       .00177011     2.112   .0347   1.98486666
 LP1P3H  |    -.09485200       .00358576   -26.452   .0000    .59791174
 LP2P3H  |    -.03758874       .00307866   -12.209   .0000   8.54926267
 LP1P2   |     .07406705       .00323630    22.886   .0000   3.26625619
 LQ1P1   |    -.00365433       .00939396     -.389   .6973   -.43396599
```

```
 LQ1P2    |    -.04625590       .01410230    -3.280   .0010  -2.51821860
 LQ2P1    |    -.00656136       .00484262    -1.355   .1754  -1.11658896
 LQ2P2    |    -.04621699       .00307550   -15.027   .0000  -6.75933772
 LPOP     |     .14802293       .05214039     2.839   .0045   4.38920813
 LDD      |     .08950476       .02521375     3.550   .0004   5.45846806
 LINM     |     .01257644       .02996296      .420   .6747   -.06002421
 LGDPC    |    -.15892462       .03964392    -4.009   .0001   8.55381656
 LHHI     |     .04019020       .02114240     1.901   .0573   6.93438002
 INFL     |    1.35705137       .16336413     8.307   .0000    .04672069
 EU       |    -.05284859       .01783674    -2.963   .0030    .20995801
 T        |    -.04782630       .00932837    -5.127   .0000   7.62267546
 TH       |     .00604645       .00086627     6.980   .0000   34.9109178
 TQ1      |     .00123557       .00322626      .383   .7017  -4.37594550
 TQ2      |     .00275889       .00127735     2.160   .0308  -14.0808136
 TP1      |     .01440435       .00133683    10.775   .0000   5.99915400
 TP2      |    -.00375445       .00092603    -4.054   .0001   31.7636015
 Y08      |    -.03228641       .02367219    -1.364   .1726    .08998200
 Y09      |     .03322352       .02131559     1.559   .1191    .08878224
---------+Offset [mean=mu(i)] parameters in one sided error
 Constant|    2.17951646      32.6111629      .067   .9467   1.00000000
 LLICTAC |    1.94343654      29.6857553      .065   .9478  -2.78902282
 LETA    |    3.72556382      55.0026789      .068   .9460  -1.99239234
 FOREIGN9|     .10881189      3.30451040      .033   .9737    .47630474
 MIXED   |     .80318361      12.0499360      .067   .9469    .12717457
---------+Variance parameters for compound error
 Lambda  |    8.85884630       .84116292    10.532   .0000
 Sigma(u)|    1.30467499      16.9680964      .077   .9387
---------+Eta parameter for time varying inefficiency
 Constant|     .01000000       .00418585     2.389   .0169
```

--> create; ebc3T=exp(-ui_bc3T)$
--> dstat; rhs=ebc3T$

```
Descriptive Statistics
All results based on nonmissing observations.
==============================================================================
Variable     Mean        Std.Dev.      Minimum      Maximum        Cases Missing
==============================================================================
------------------------------------------------------------------------------
All observations in current sample
------------------------------------------------------------------------------
EBC3T    |  .844513      .110302      .320541      .995611          1667       0
```

4.3 RANDOM PARAMETERS MODELS

4.3.1 TRE1

TRE1 MODEL (THE BASELINE MODEL WITH YEARS)

```
fron;cost;lhs=ltcp3ta;rhs=vicka,leta,llictac,foreign9, mixed,lpop,
lDD,linm,lgdpc,lhhi,infl,eu, y01,y02,y03,y04,y05,y06,y07,y08,y09,y10,y11,y12;
output=3 $
fron;cost;lhs=ltcp3ta;rhs=vicka,leta,llictac,foreign9, mixed,lpop,
lDD,linm,lgdpc,lhhi,infl,eu, y01,y02,y03,y04,y05,y06,y07,y08,y09,y10,y11,y12;
;pds=bank;rpm;fcn=one(n) ;halton;pts=500;output=3; eff=u_tr1; table=etr1$
create; etr1=exp(-u_tr1)$ dstat; rhs=etr1$ kernel;rhs=etr1$

vicka= one, LQ1TA, LQ2TA, LP1P3, LP2P3, lq1q2, lqq1, lqq2, lp1p3h, lp2p3h,
lp1p2, lq1p1, lq1p2, lq2p1, lq2p2$
```

```
      * Converged
Normal exit from iterations. Exit status=0.
Function= -.13018196230D+03, at entry, -.49474407225D+03 at exit

+----------------------------------------------+
| Random Coefficients  Frontier Model          |
| Maximum Likelihood Estimates                 |
| Model estimated: Feb 25, 2014 at 06:21:22PM.|
| Dependent variable              LTCP3TA      |
| Weighting variable                 None      |
| Number of observations             1667      |
| Iterations completed                 51      |
| Log likelihood function        494.7441      |
| Number of parameters                 41      |
| Info. Criterion: AIC =         -.54438       |
|   Finite Sample: AIC =         -.54311       |
| Info. Criterion: BIC =         -.41111       |
| Info. Criterion:HQIC =         -.49500       |
| Restricted log likelihood      .0000000      |
| Chi squared                    989.4881      |
| Degrees of freedom                    1      |
| Prob[ChiSqd > value] =         .0000000      |
| Unbalanced panel has     153 individuals.    |
| Stochastic frontier (half normal)            |
| Simulation based on 500 Halton draws         |
| Sigma( u) (1 sided)  =      .22174           |
| Sigma( v) (symmetric)=      .09243           |
+----------------------------------------------+
+---------+--------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+---------+--------------+----------------+--------+--------+----------+
---------+Production / Cost parameters, nonrandom first
 LQ1TA   |     .16510482       .07109498     2.322   .0202   -.63996924
 LQ2TA   |     .18132081       .02557437     7.090   .0000  -1.70110077
 LP1P3   |     .16675514       .01851236     9.008   .0000    .70390787
 LP2P3   |    -.01882624       .01955638     -.963   .3357   3.99750610
 LQ1Q2   |     .08040451       .01716940     4.683   .0000    .89627491
 LQQ1    |     .01613077       .01621761      .995   .3199    .30782592
 LQQ2    |     .00638684       .00249671     2.558   .0105   1.98486666
```

```
 LP1P3H  |     .08516862       .00629463    13.530   .0000    .59791174
 LP2P3H  |     .04210840       .00303916    13.855   .0000   8.54926267
 LP1P2   |     .00111331       .00410175      .271   .7861   3.26625619
 LQ1P1   |    -.03937156       .01261680    -3.121   .0018   -.43396599
 LQ1P2   |    -.01452042       .01301702    -1.115   .2646  -2.51821860
 LQ2P1   |     .01287013       .00638274     2.016   .0438  -1.11658896
 LQ2P2   |    -.03621685       .00398988    -9.077   .0000  -6.75933772
 LETA    |    -.03924540       .00657453    -5.969   .0000  -1.99239234
 LLICTAC |    -.02970646       .01320245    -2.250   .0244  -2.78902282
 FOREIGN9|    -.04760175       .00895126    -5.318   .0000    .47630474
 MIXED   |    -.00645082       .01312287     -.492   .6230    .12717457
 LPOP    |     .23146067       .03263158     7.093   .0000   4.38920813
 LDD     |     .02697741       .02284399     1.181   .2376   5.45846806
 LINM    |     .11200524       .02998448     3.735   .0002   -.06002421
 LGDPC   |    -.10643633       .03554248    -2.995   .0027   8.55381656
 LHHI    |     .07011296       .02015208     3.479   .0005   6.93438002
 INFL    |     .68393462       .16271694     4.203   .0000    .04672069
 EU      |    -.02704988       .01417936    -1.908   .0564    .20995801
 Y01     |    -.00463397       .04273983     -.108   .9137    .04499100
 Y02     |    -.01119594       .03307470     -.339   .7350    .06118776
 Y03     |    -.05972645       .03285819    -1.818   .0691    .07678464
 Y04     |    -.10587144       .03350757    -3.160   .0016    .08458308
 Y05     |    -.14886971       .03500529    -4.253   .0000    .08878224
 Y06     |    -.16665136       .03986064    -4.181   .0000    .08998200
 Y07     |    -.14160563       .04235169    -3.344   .0008    .09058188
 Y08     |    -.13422553       .04409041    -3.044   .0023    .08998200
 Y09     |    -.09336941       .04381924    -2.131   .0331    .08878224
 Y10     |    -.11429474       .04140474    -2.760   .0058    .08398320
 Y11     |    -.13010779       .04555267    -2.856   .0043    .08398320
 Y12     |    -.12899958       .04258509    -3.029   .0025    .08218356
---------+Means for random parameters
 Constant|     .04030437       .24608021      .164   .8699
---------+Scale parameters for dists. of random parameters
 Constant|     .22896342       .00513221    44.613   .0000
---------+Variance parameter for v +/- u
 Sigma   |     .24023341       .00428472    56.068   .0000
---------+Asymmetry parameter, lambda
 Lambda  |    2.39903266       .16745290    14.327   .0000


Implied standard deviations of random parameters

Matrix S.D_Beta has  1 rows and  1 columns.
              1
        +--------------
       1|     .22896
--> create; etr1=exp(-u_tr1)$
--> dstat; rhs=etr1$
Descriptive Statistics
All results based on nonmissing observations.
===============================================================================
Variable     Mean        Std.Dev.     Minimum      Maximum        Cases Missing
===============================================================================
------------------------------------------------------------------------------
All observations in current sample
------------------------------------------------------------------------------
ETR1    |  .850855      .860377E-01  .326686      .982816         1667       0
```

4.3.2 TRE2

TRE2 MODEL (HETEROSCEDASTIC WITH YEARS)

```
fron;cost;lhs=ltcp3ta;rhs=vicka,lpop,lDD,linm,lgdpc,lhhi,infl,eu,y01,y02,y03,y0
4,y05,y06,y07,y08,y09,y10,y11,y12; output=3$
fron;cost;lhs=ltcp3ta;rhs=vicka,lpop,lDD,linm,lgdpc,lhhi,infl,eu,y01,y02,y03,y0
4,y05,y06,y07,y08,y09,y10,y11,y12
;hfn=one,llictac,leta,foreign9,mixed; rpm; pds=bank; output=3
;fcn=one(n);halton;pts=500 ;maxit=200; eff=u_tr2; table=etr2$
create;etr2=exp(-u_tr2)$ dstat;rhs=etr2$ kernel; rhs=etr2$

vicka= one, LQ1TA, LQ2TA, LP1P3, LP2P3, lq1q2, lqq1, lqq2, lp1p3h, lp2p3h,
lp1p2, lq1p1, lq1p2, lq2p1, lq2p2$
```

```
          * Converged
Normal exit from iterations. Exit status=0.
Function=  .23278782375D+04, at entry, -.60059387533D+03 at exit
+----------------------------------------------+
| Random Coefficients  FrntrTrn Model          |
| Maximum Likelihood Estimates                 |
| Model estimated: Feb 25, 2014 at 06:33:29PM.|
| Dependent variable              LTCP3TA      |
| Weighting variable                 None      |
| Number of observations             1667      |
| Iterations completed                108      |
| Log likelihood function        600.5939      |
| Number of parameters                 41      |
| Info. Criterion: AIC =          -.67138      |
|   Finite Sample: AIC =          -.67011      |
| Info. Criterion: BIC =          -.53810      |
| Info. Criterion:HQIC =          -.62199      |
| Restricted log likelihood      .0000000      |
| Chi squared                    1201.188      |
| Degrees of freedom                    1      |
| Prob[ChiSqd > value] =         .0000000      |
| Unbalanced panel has     153 individuals.    |
| Stochastic frontier, trunc./hetero.          |
| Simulation based on 500 Halton draws         |
+----------------------------------------------+

+----------------------------------------------+
| Random Coefficients  FrntrTrn Model          |
| Estimated parameters of efficiency distn.    |
| s(u)  =     .244006      s(v)=     .062882   |
| avgE[u|e]=   .29182   avgE[TE|e]=   .77700   |
| Lambda  =su/sv                =    3.880382  |
+----------------------------------------------+
+--------+--------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+--------+--------------+----------------+--------+--------+----------+
---------+Nonrandom parameters
 LQ1TA   |     .19467927      .05942357     3.276   .0011   -.63996924
 LQ2TA   |     .20275622      .02313974     8.762   .0000  -1.70110077
 LP1P3   |     .22829781      .01855004    12.307   .0000    .70390787
 LP2P3   |    -.01582227      .01767754     -.895   .3708   3.99750610
 LQ1Q2   |     .05462572      .01420077     3.847   .0001    .89627491
```

```
 LQQ1     |     .01758185       .01166352     1.507   .1317    .30782592
 LQQ2     |     .00400847       .00303768     1.320   .1870   1.98486666
 LP1P3H   |     .05997302       .00768798     7.801   .0000    .59791174
 LP2P3H   |     .02271923       .00284729     7.979   .0000   8.54926267
 LP1P2    |     .02328416       .00414015     5.624   .0000   3.26625619
 LQ1P1    |    -.01388835       .01157680    -1.200   .2303   -.43396599
 LQ1P2    |    -.03650815       .01193325    -3.059   .0022  -2.51821860
 LQ2P1    |     .03069575       .00581988     5.274   .0000  -1.11658896
 LQ2P2    |    -.04790493       .00414343   -11.562   .0000  -6.75933772
 LPOP     |     .21821693       .02485668     8.779   .0000   4.38920813
 LDD      |     .02305511       .01835651     1.256   .2091   5.45846806
 LINM     |     .07980316       .02051279     3.890   .0001   -.06002421
 LGDPC    |    -.06608728       .02739438    -2.412   .0158   8.55381656
 LHHI     |     .06268980       .01583036     3.960   .0001   6.93438002
 INFL     |     .60811004       .13585520     4.476   .0000    .04672069
 EU       |    -.00997249       .01111084     -.898   .3694    .20995801
 Y01      |     .03236769       .03486309      .928   .3532    .04499100
 Y02      |     .02544322       .02786956      .913   .3613    .06118776
 Y03      |    -.00399336       .02786918     -.143   .8861    .07678464
 Y04      |    -.05664813       .02747717    -2.062   .0392    .08458308
 Y05      |    -.08198049       .02895224    -2.832   .0046    .08878224
 Y06      |    -.10015961       .03078268    -3.254   .0011    .08998200
 Y07      |    -.09553992       .03624278    -2.636   .0084    .09058188
 Y08      |    -.10116787       .03326036    -3.042   .0024    .08998200
 Y09      |    -.07446552       .03536568    -2.106   .0352    .08878224
 Y10      |    -.08937891       .03530949    -2.531   .0114    .08398320
 Y11      |    -.10656813       .03576426    -2.980   .0029    .08398320
 Y12      |    -.11029079       .03442668    -3.204   .0014    .08218356
 suONE    |    3.05155796       .11457468    26.634   .0000   1.00000000
 suLLICTA|      .16710347       .04051427     4.125   .0000  -2.78902282
 suLETA   |     .61200792       .02012101    30.416   .0000  -1.99239234
 suFOREIG|     -.11534422       .02225819    -5.182   .0000    .47630474
 suMIXED |     -.46314287       .04884374    -9.482   .0000    .12717457
---------+Means for random parameters
 Constant|     -.08813692       .19874908     -.443   .6574
---------+Scale parameters for dists. of random parameters
 Constant|      .32865640       .00565364    58.132   .0000
---------+Sigma(v) from symmetric disturbance.
 Sigma(v)|      .06288195       .00325464    19.321   .0000


Implied standard deviations of random parameters

Matrix S.D_Beta has  1 rows and  1 columns.
              1
        +--------------
       1|     .32866
--> create;etr2=exp(-u_tr2)$
--> dstat;rhs=etr2$
Descriptive Statistics
All results based on nonmissing observations.
==============================================================================
Variable     Mean        Std.Dev.     Minimum      Maximum        Cases Missing
==============================================================================
------------------------------------------------------------------------------
All observations in current sample
------------------------------------------------------------------------------
ETR2    |  .855476      .703923E-01  .387555      .994199         1667       0
```

4.3.3 TRE3

TRE3 MODEL (HETEROSCEDASTIC WITH YEARS AND RANDOM PARAMETERS)

```
fron;cost;lhs=ltcp3ta;  rhs=vicka, lpop, lDD, linm, lgdpc, lhhi,
infl,eu,y01,y02,y03,y04,y05,y06,y07,y08,y09,y10,y11,y12;halton;pts=500;maxit=20
0;output=3$
fron;cost;lhs=ltcp3ta;  rhs=vicka, lpop, lDD, linm, lgdpc, lhhi,
infl,eu,y01,y02,y03,y04,y05,y06,y07,y08,y09,y10,y11,y12
; hfn=one, llictac,foreign9,mixed,leta;rpm; pds=bank; output=3
; fcn=one(n),lq1ta(n),lq2ta(n),llictac<n>;halton;pts=500 ; maxit=200;
eff=u_tr3; table=etr3$
create; etr3=exp(-u_tr3)$ dstat; rhs=etr3$ kernel; rhs=etr3$
vicka= one, LQ1TA, LQ2TA, LP1P3, LP2P3, lq1q2, lqq1, lqq2, lp1p3h, lp2p3h,
lp1p2, lq1p1, lq1p2, lq2p1, lq2p2$

              * Converged
Normal exit from iterations. Exit status=0.
Function=  .89149604990D+04, at entry, -.10351776014D+04 at exit
+---------------------------------------------+
| Random Coefficients  FrntrTrn Model         |
| Maximum Likelihood Estimates                |
| Model estimated: Feb 25, 2014 at 06:49:24PM.|
| Dependent variable             LTCP3TA      |
| Weighting variable                None      |
| Number of observations            1667      |
| Iterations completed                96      |
| Log likelihood function       1035.178      |
| Number of parameters                44      |
| Info. Criterion: AIC =        -1.18918      |
|   Finite Sample: AIC =        -1.18771      |
| Info. Criterion: BIC =        -1.04615      |
| Info. Criterion:HQIC =        -1.13617      |
| Restricted log likelihood      .0000000     |
| Chi squared                   2070.355      |
| Degrees of freedom                   4      |
| Prob[ChiSqd > value] =        .0000000      |
| Unbalanced panel has     153 individuals.   |
| Stochastic frontier, trunc./hetero.         |
| Simulation based on 500 Halton draws        |
+---------------------------------------------+

+---------------------------------------------+
| Random Coefficients  FrntrTrn Model         |
| Estimated parameters of efficiency distn.   |
| s(u)  =     .246943      s(v)=     .046640  |
| avgE[u|e]=   .22604   avgE[TE|e]=   .83094  |
| Lambda  =su/sv               =    5.294693  |
+---------------------------------------------+
+--------+--------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+--------+--------------+----------------+--------+--------+----------+
---------+Nonrandom parameters
 LP1P3   |      .19798786      .01456089    13.597   .0000    .70390787
 LP2P3   |      .22306791      .01454839    15.333   .0000   3.99750610
 LQ1Q2   |      .00930369      .00954542      .975   .3297    .89627491
 LQQ1    |    -.03699621      .00985123    -3.755   .0002    .30782592
 LQQ2    |      .00402230      .00164244     2.449   .0143   1.98486666
```

```
 LP1P3H   |     .08105009       .00429940    18.851   .0000     .59791174
 LP2P3H   |   -.03400976       .00276552   -12.298   .0000    8.54926267
 LP1P2    |     .02647208       .00296668     8.923   .0000    3.26625619
 LQ1P1    |   -.01234349       .00744694    -1.658   .0974    -.43396599
 LQ1P2    |   -.01240270       .00833266    -1.488   .1366  -2.51821860
 LQ2P1    |     .02120873       .00381937     5.553   .0000  -1.11658896
 LQ2P2    |   -.02482907       .00299498    -8.290   .0000  -6.75933772
 LPOP     |     .57966936       .01689109    34.318   .0000    4.38920813
 LDD      |     .06008498       .00973054     6.175   .0000    5.45846806
 LINM     |     .22039738       .01310512    16.818   .0000    -.06002421
 LGDPC    |   -.23608485       .01504877   -15.688   .0000    8.55381656
 LHHI     |     .07533215       .00854205     8.819   .0000    6.93438002
 INFL     |     .29122093       .07687192     3.788   .0002     .04672069
 EU       |   -.00971540       .00555290    -1.750   .0802     .20995801
 Y01      |     .01627275       .01096744     1.484   .1379     .04499100
 Y02      |   -.01044262       .01240722     -.842   .4000     .06118776
 Y03      |   -.05614186       .01175173    -4.777   .0000     .07678464
 Y04      |   -.10826774       .01363960    -7.938   .0000     .08458308
 Y05      |   -.13432954       .01328799   -10.109   .0000     .08878224
 Y06      |   -.14712207       .01544870    -9.523   .0000     .08998200
 Y07      |   -.15919126       .01825655    -8.720   .0000     .09058188
 Y08      |   -.16588827       .01883251    -8.809   .0000     .08998200
 Y09      |   -.16820120       .01832312    -9.180   .0000     .08878224
 Y10      |   -.17516200       .01822042    -9.614   .0000     .08398320
 Y11      |   -.18556713       .01991451    -9.318   .0000     .08398320
 Y12      |   -.17727370       .01854601    -9.559   .0000     .08218356
 suONE    |    2.45360704       .13664746    17.956   .0000    1.00000000
 suFOREIG|    -.04316834       .05161874     -.836   .4030     .47630474
 suMIXED |    -.38822214       .07888144    -4.922   .0000     .12717457
 suLETA   |     .26665173       .03894481     6.847   .0000  -1.99239234
---------+Means for random parameters
 Constant|    -.89253687       .12533011    -7.121   .0000
 LQ1TA    |   -.05615514       .04268412    -1.316   .1883    -.63996924
 LQ2TA    |     .08974550       .01685306     5.325   .0000  -1.70110077
 suLLICTA|     .31849051       .04383617     7.265   .0000  -2.78902282
---------+Scale parameters for dists. of random parameters
 Constant|     .42886437       .00511198    83.894   .0000
 LQ1TA    |     .14257786       .00300312    47.477   .0000
 LQ2TA    |     .07803539       .00148349    52.603   .0000
 suLLICTA|     .41362486       .01697916    24.361   .0000
---------+Sigma(v) from symmetric disturbance.
 Sigma(v)|     .04663969       .00148137    31.484   .0000

Implied standard deviations of random parameters

Matrix S.D_Beta has  4 rows and  1 columns.
              1
        +--------------
       1|     .42886
       2|     .14258
       3|     .07804
       4|     .41362
```

--> create; etr3=exp(-u_tr3)$
--> dstat; rhs=etr3$

```
Descriptive Statistics
===============================================================================
Variable     Mean        Std.Dev.     Minimum      Maximum        Cases Missing
===============================================================================
ETR3    |  .865415      .677366E-01  .328384      .995721          1667       0
```

4.3.4 TRE1T

TRE1T MODEL (BASELINE MODEL WITH TIME TREND)

```
fron;cost;lhs=ltcp3ta;rhs=vicka,leta,llictac,foreign9,mixed,lpop,lDD,linm,lgdpc
,lhhi,infl, eu,t,th,tq1, tq2, tp1, tp2, Y08, Y09; output=3 $
fron;cost;lhs=ltcp3ta;rhs=vicka,leta,llictac,foreign9,mixed,lpop,lDD,linm,lgdpc
,lhhi,infl,eu,t,th, tq1, tq2, tp1, tp2, Y08,y09;
;pds=bank;rpm;fcn=one(n) ;halton;pts=500; eff=u_tr1t; table=etr1t$
create; etr1t=exp(-u_tr1t)$ dstat; rhs=etr1t$ kernel;rhs=etr1t$

vicka= one, LQ1TA, LQ2TA, LP1P3, LP2P3, lq1q2, lqq1, lqq2, lp1p3h, lp2p3h,
lp1p2, lq1p1, lq1p2, lq2p1, lq2p2$


Normal exit from iterations. Exit status=0.

+---------------------------------------------+
| Random Coefficients  Frontier Model         |
| Maximum Likelihood Estimates                |
| Model estimated: Feb 25, 2014 at 06:07:28PM.|
| Dependent variable             LTCP3TA      |
| Weighting variable                None      |
| Number of observations            1667      |
| Iterations completed                47      |
| Log likelihood function       491.1071      |
| Number of parameters                37      |
| Info. Criterion: AIC =         -.54482      |
|   Finite Sample: AIC =         -.54378      |
| Info. Criterion: BIC =         -.42455      |
| Info. Criterion:HQIC =         -.50025      |
| Restricted log likelihood      .0000000     |
| Chi squared                   982.2142      |
| Degrees of freedom                   1      |
| Prob[ChiSqd > value] =         .0000000     |
| Unbalanced panel has     153 individuals.   |
| Stochastic frontier (half normal)           |
| Simulation based on 500 Halton draws        |
| Sigma( u) (1 sided)  =      .22254          |
| Sigma( v) (symmetric)=      .09229          |
+---------------------------------------------+
+--------+--------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+--------+--------------+----------------+--------+--------+----------+
---------+Production / Cost parameters, nonrandom first
 LQ1TA   |     .17027634       .07224179     2.357   .0184   -.63996924
 LQ2TA   |     .16038799       .02756764     5.818   .0000  -1.70110077
 LP1P3   |     .15871516       .01772580     8.954   .0000    .70390787
 LP2P3   |    -.00964713       .02025240     -.476   .6338   3.99750610
 LQ1Q2   |     .05848167       .01893814     3.088   .0020    .89627491
 LQQ1    |     .02517955       .01734504     1.452   .1466    .30782592
 LQQ2    |     .00674873       .00277610     2.431   .0151   1.98486666
 LP1P3H  |     .08315364       .00569777    14.594   .0000    .59791174
 LP2P3H  |     .04460453       .00327287    13.629   .0000   8.54926267
 LP1P2   |    -.00120977       .00400447     -.302   .7626   3.26625619
 LQ1P1   |    -.03823174       .01350441    -2.831   .0046   -.43396599
 LQ1P2   |    -.00738274       .01361131     -.542   .5875  -2.51821860
 LQ2P1   |     .01010281       .00661616     1.527   .1268  -1.11658896
```

```
 LQ2P2   |    -.04180616       .00419047    -9.976   .0000  -6.75933772
 LETA    |    -.03736936       .00662690    -5.639   .0000  -1.99239234
 LLICTAC |    -.02414905       .01353645    -1.784   .0744  -2.78902282
 FOREIGN9|    -.05109314       .00901250    -5.669   .0000    .47630474
 MIXED   |    -.00752920       .01308507     -.575   .5650    .12717457
 LPOP    |     .24720271       .03278515     7.540   .0000   4.38920813
 LDD     |     .04205587       .02213654     1.900   .0575   5.45846806
 LINM    |     .11413455       .02796561     4.081   .0000   -.06002421
 LGDPC   |    -.13772576       .03387459    -4.066   .0000   8.55381656
 LHHI    |     .07892062       .01813106     4.353   .0000   6.93438002
 INFL    |     .47153621       .15445365     3.053   .0023    .04672069
 EU      |    -.04181871       .01467405    -2.850   .0044    .20995801
 T       |    -.05840065       .00803766    -7.266   .0000   7.62267546
 TH      |     .00756164       .00081495     9.279   .0000   34.9109178
 TQ1     |    -.00948655       .00370616    -2.560   .0105  -4.37594550
 TQ2     |     .00384939       .00137335     2.803   .0051  -14.0808136
 TP1     |     .00237611       .00168128     1.413   .1576   5.99915400
 TP2     |    -.00276707       .00099740    -2.774   .0055   31.7636015
 Y08     |     .02904067       .02362971     1.229   .2191    .08998200
 Y09     |     .05404420       .02356132     2.294   .0218    .08878224
---------+Means for random parameters
 Constant|     .19984785       .25950641      .770   .4412
---------+Scale parameters for dists. of random parameters
 Constant|     .22923750       .00511155    44.847   .0000
---------+Variance parameter for v +/- u
 Sigma   |     .24092039       .00425056    56.680   .0000
---------+Asymmetry parameter, lambda
 Lambda  |    2.41119560       .16639148    14.491   .0000


Implied standard deviations of random parameters

Matrix S.D_Beta has  1 rows and  1 columns.
               1
        +--------------
       1|     .22924
--> create; etr1t=exp(-u_tr1t)$
--> dstat; rhs=etr1t$
Descriptive Statistics
All results based on nonmissing observations.
===============================================================================
Variable     Mean        Std.Dev.     Minimum      Maximum        Cases Missing
===============================================================================
------------------------------------------------------------------------------
All observations in current sample
------------------------------------------------------------------------------
ETR1T   |  .850211      .865358E-01  .323710      .982062         1667       0
```

4.3.5 TRE2T

TRE2T MODEL (HETEROSCEDASTIC WITH TIME TREND)

```
fron;cost;lhs=ltcp3ta;rhs=vicka,lpop,lDD,linm,lgdpc,lhhi,infl,eu,t,th,tq1, tq2,
tp1, tp2, y08, y09; output=3$
fron;cost;lhs=ltcp3ta;rhs=vicka,lpop,lDD,linm,lgdpc,lhhi,infl,eu,t,th,tq1, tq2,
tp1, tp2, y08, y09
;hfn=one,llictac,leta,foreign9,mixed; rpm; pds=bank; output=3
;fcn=one(n);halton;pts=500;maxit=200; eff=u_tr2t; table=etr2t $
create;etr2t=exp(-u_tr2t)$ dstat;rhs=etr2t$
kernel; rhs=etr2t$

vicka= one, LQ1TA, LQ2TA, LP1P3, LP2P3, lq1q2, lqq1, lqq2, lp1p3h, lp2p3h,
lp1p2, lq1p1, lq1p2, lq2p1, lq2p2$
```

```
                * Converged
Normal exit from iterations. Exit status=0.
Function=  .19369382925D+04, at entry, -.60167429468D+03 at exit
+---------------------------------------------+
| Random Coefficients  FrntrTrn Model         |
| Maximum Likelihood Estimates                |
| Model estimated: Feb 25, 2014 at 05:58:59PM.|
| Dependent variable              LTCP3TA     |
| Weighting variable                 None     |
| Number of observations             1667     |
| Iterations completed                104     |
| Log likelihood function        601.6743     |
| Number of parameters                 37     |
| Info. Criterion: AIC =          -.67747     |
|   Finite Sample: AIC =          -.67644     |
| Info. Criterion: BIC =          -.55720     |
| Info. Criterion:HQIC =          -.63290     |
| Restricted log likelihood      .0000000     |
| Chi squared                    1203.349     |
| Degrees of freedom                   37     |
| Prob[ChiSqd > value] =         .0000000     |
| Unbalanced panel has     153 individuals.   |
| Stochastic frontier, trunc./hetero.         |
| Simulation based on 500 Halton draws        |
+---------------------------------------------+

+---------------------------------------------+
| Random Coefficients  FrntrTrn Model         |
| Estimated parameters of efficiency distn.   |
| s(u)  =      .241690      s(v)=      .065720 |
| avgE[u|e]=   .28392   avgE[TE|e]=   .78162  |
| Lambda  =su/sv                =    3.677590 |
+---------------------------------------------+
+---------+--------------+----------------+--------+--------+----------+
|Variable| Coefficient   | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+---------+--------------+----------------+--------+--------+----------+
---------+Nonrandom parameters
 LQ1TA   |      .15577777       .05736767     2.715   .0066   -.63996924
 LQ2TA   |      .18242404       .02462208     7.409   .0000  -1.70110077
 LP1P3   |      .22238698       .01842603    12.069   .0000    .70390787
 LP2P3   |      .00294867       .01797717      .164   .8697   3.99750610
```

```
 LQ1Q2   |      .02464743       .01545145     1.595   .1107     .89627491
 LQQ1    |      .01840423       .01307892     1.407   .1594     .30782592
 LQQ2    |      .00230768       .00357137      .646   .5182    1.98486666
 LP1P3H  |      .05651052       .00647987     8.721   .0000     .59791174
 LP2P3H  |      .02903901       .00304193     9.546   .0000    8.54926267
 LP1P2   |      .01127268       .00385153     2.927   .0034    3.26625619
 LQ1P1   |     -.02824592       .01228727    -2.299   .0215    -.43396599
 LQ1P2   |     -.01357696       .01135879    -1.195   .2320   -2.51821860
 LQ2P1   |      .03231624       .00607653     5.318   .0000   -1.11658896
 LQ2P2   |     -.05044171       .00423719   -11.905   .0000   -6.75933772
 LPOP    |      .24965615       .02630999     9.489   .0000    4.38920813
 LDD     |      .02645864       .01775370     1.490   .1361    5.45846806
 LINM    |      .06388808       .02057799     3.105   .0019    -.06002421
 LGDPC   |     -.09782850       .02600313    -3.762   .0002    8.55381656
 LHHI    |      .07226355       .01543272     4.682   .0000    6.93438002
 INFL    |      .49664534       .12976927     3.827   .0001     .04672069
 EU      |     -.02426617       .01216756    -1.994   .0461     .20995801
 T       |     -.04136436       .00684715    -6.041   .0000    7.62267546
 TH      |      .00443988       .00064075     6.929   .0000    34.9109178
 TQ1     |     -.01281876       .00277157    -4.625   .0000   -4.37594550
 TQ2     |      .00090432       .00117611      .769   .4419   -14.0808136
 TP1     |      .00778714       .00149114     5.222   .0000    5.99915400
 TP2     |     -.00368624       .00091837    -4.014   .0001    31.7636015
 Y08     |      .00774100       .01690064      .458   .6469     .08998200
 Y09     |      .02738306       .01673260     1.637   .1017     .08878224
 suONE   |     3.04655459       .11441217    26.628   .0000    1.00000000
 suLLICTA|      .16933821       .04192595     4.039   .0001   -2.78902282
 suLETA  |      .63959999       .01998850    31.998   .0000   -1.99239234
 suFOREIG|     -.10547884       .02198043    -4.799   .0000     .47630474
 suMIXED |     -.46337093       .05073995    -9.132   .0000     .12717457
---------+Means for random parameters
 Constant|      .01057807       .20357835      .052   .9586
---------+Scale parameters for dists. of random parameters
 Constant|      .31898017       .00539231    59.155   .0000
---------+Sigma(v) from symmetric disturbance.
 Sigma(v)|      .06571968       .00327691    20.055   .0000


Implied standard deviations of random parameters

Matrix S.D_Beta has  1 rows and  1 columns.
              1
        +--------------
       1|     .31898
--> create;etr2t=exp(-u_tr2t)$
--> dstat;rhs=etr2t$
Descriptive Statistics
All results based on nonmissing observations.
===============================================================================
Variable     Mean        Std.Dev.     Minimum      Maximum        Cases Missing
===============================================================================
------------------------------------------------------------------------------
All observations in current sample
------------------------------------------------------------------------------
ETR2T   |  .857363      .701052E-01  .384733      .993934         1667       0
```

4.3.6 TRE3T

TRE3T MODEL (HETEROSCEDASTIC WITH TIME TREND AMD RANDOM PARAMETERS)

```
fron;cost;lhs=ltcp3ta;  rhs=vicka, lpop, lDD, linm, lgdpc, lhhi,
infl,eu,t,th,tq1, tq2, tp1, tp2, y08, y09; output=3$
fron;cost;lhs=ltcp3ta;  rhs=vicka, lpop, lDD, linm, lgdpc, lhhi,
infl,eu,t,th,tq1, tq2, tp1, tp2, y08, y09
; hfn=one, llictac, leta, foreign9,mixed;rpm; pds=bank;
; fcn=one(n),lq1ta(n),lq2ta(n),llictac<n>;halton;pts=500 ; output=3; maxit=200;
eff=u_tr3t; table=etr3t$
create; etr3t=exp(-u_tr3t)$ dstat; rhs=etr3t$ kernel; rhs=etr3t$
vicka= one, LQ1TA, LQ2TA, LP1P3, LP2P3, lq1q2, lqq1, lqq2, lp1p3h, lp2p3h,
lp1p2, lq1p1, lq1p2, lq2p1, lq2p2$
```

```
  * Converged
Normal exit from iterations. Exit status=0.
Function=  .19345463448D+04, at entry, -.10278089529D+04 at exit
+----------------------------------------------+
| Random Coefficients  FrntrTrn Model          |
| Maximum Likelihood Estimates                 |
| Model estimated: Feb 25, 2014 at 05:34:35PM.|
| Dependent variable             LTCP3TA       |
| Weighting variable                None       |
| Number of observations            1667       |
| Iterations completed               132       |
| Log likelihood function       1027.809       |
| Number of parameters                40       |
| Info. Criterion: AIC =        -1.18513       |
|   Finite Sample: AIC =        -1.18392       |
| Info. Criterion: BIC =        -1.05511       |
| Info. Criterion:HQIC =        -1.13695       |
| Restricted log likelihood      .0000000      |
| Chi squared                   2055.618       |
| Degrees of freedom                  40       |
| Prob[ChiSqd > value] =        .0000000       |
| Unbalanced panel has     153 individuals.    |
| Stochastic frontier, trunc./hetero.          |
| Simulation based on 500 Halton draws         |
+----------------------------------------------+

+----------------------------------------------+
| Random Coefficients  FrntrTrn Model          |
| Estimated parameters of efficiency distn.    |
| s(u)  =     .192869      s(v)=     .047130   |
| avgE[u|e]=   .20324   avgE[TE|e]=   .84520   |
| Lambda  =su/sv              =    4.092293    |
+----------------------------------------------+
+--------+--------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+--------+--------------+----------------+--------+--------+----------+
---------+Nonrandom parameters
 LP1P3   |     .22272538       .01378380    16.158   .0000    .70390787
 LP2P3   |     .17179667       .01452801    11.825   .0000   3.99750610
 LQ1Q2   |     .00526019       .01002167      .525   .5997    .89627491
 LQQ1    |    -.04072519       .00934913    -4.356   .0000    .30782592
 LQQ2    |     .00607771       .00151888     4.001   .0001   1.98486666
 LP1P3H  |     .06779360       .00439807    15.414   .0000    .59791174
```

```
 LP2P3H  |    -.02309269       .00295809    -7.807   .0000   8.54926267
 LP1P2   |     .02444179       .00308512     7.922   .0000   3.26625619
 LQ1P1   |    -.00473519       .00830590     -.570   .5686   -.43396599
 LQ1P2   |    -.01462952       .00889439    -1.645   .1000  -2.51821860
 LQ2P1   |     .04105510       .00438958     9.353   .0000  -1.11658896
 LQ2P2   |    -.03322468       .00325653   -10.202   .0000  -6.75933772
 LPOP    |     .25038834       .01464025    17.103   .0000   4.38920813
 LDD     |     .07868867       .00998636     7.880   .0000   5.45846806
 LINM    |     .15047199       .01241398    12.121   .0000   -.06002421
 LGDPC   |    -.21054292       .01518939   -13.861   .0000   8.55381656
 LHHI    |     .07592949       .00819543     9.265   .0000   6.93438002
 INFL    |     .21193010       .07868648     2.693   .0071    .04672069
 EU      |    -.01513093       .00596502    -2.537   .0112    .20995801
 T       |    -.04579310       .00414963   -11.035   .0000   7.62267546
 TH      |     .00521560       .00034947    14.924   .0000   34.9109178
 TQ1     |     .00017912       .00229861      .078   .9379  -4.37594550
 TQ2     |     .00292487       .00086652     3.375   .0007  -14.0808136
 TP1     |     .00397621       .00088469     4.494   .0000   5.99915400
 TP2     |    -.00207380       .00069801    -2.971   .0030   31.7636015
 Y08     |     .01322113       .00896522     1.475   .1403    .08998200
 Y09     |     .01308490       .00831384     1.574   .1155    .08878224
 suONE   |    2.61230976       .13890320    18.807   .0000   1.00000000
 suLETA  |     .34856805       .03865308     9.018   .0000  -1.99239234
 suFOREIG|    -.22113586       .04840130    -4.569   .0000    .47630474
 suMIXED |    -.36950375       .07904355    -4.675   .0000    .12717457
---------+Means for random parameters
 Constant|     .45664393       .11855905     3.852   .0001
 LQ1TA   |    -.02890309       .04393141     -.658   .5106   -.63996924
 LQ2TA   |     .09308759       .01682043     5.534   .0000  -1.70110077
 suLLICTA|     .34468990       .04329664     7.961   .0000  -2.78902282
---------+Scale parameters for dists. of random parameters
 Constant|     .35906399       .00472015    76.070   .0000
 LQ1TA   |     .25920611       .00498701    51.976   .0000
 LQ2TA   |     .06940342       .00138817    49.996   .0000
 suLLICTA|     .37775530       .01594214    23.695   .0000
---------+Sigma(v) from symmetric disturbance.
 Sigma(v)|     .04712983       .00144847    32.538   .0000


Implied standard deviations of random parameters

Matrix S.D_Beta has  4 rows and  1 columns.
              1
        +--------------
       1|     .35906
       2|     .25921
       3|     .06940
       4|     .37776
--> create; etr3t=exp(-u_tr3t)$
--> dstat; rhs=etr3t$
Descriptive Statistics
All results based on nonmissing observations.
===============================================================================
Variable     Mean       Std.Dev.     Minimum      Maximum        Cases Missing
===============================================================================
------------------------------------------------------------------------------
All observations in current sample
------------------------------------------------------------------------------
ETR3T   |  .874514      .699672E-01  .324833      .995680         1667       0
```

4.4 TECHNICAL CHANGE ACROSS COUNTRIES AND TIME (TRE3T)

Table A4.1. Technical change and its component across countries and time (TRE3T)

$$-(\rho_T + \rho_{TT}T + \theta_{1T}\overline{lnLoans} + \theta_{2T}\overline{lnOEA} + \vartheta_{1T}\overline{lnInterest} + \vartheta_{2T}\overline{lnCapital})$$

	Technical	Radial	Scale Augmenting	Disembodied	Technical	Radial	Scale Augmenting	Disembodied
			ALBANIA				**BOSNIA and HERZEGOVINA**	
2000	0.0444	0.0406	0.0017	0.0022	0.0515	0.0406	0.0049	0.0060
2001	0.0403	0.0354	0.0016	0.0034	0.0477	0.0354	0.0058	0.0065
2002	0.0365	0.0301	0.0019	0.0044	0.0442	0.0301	0.0062	0.0078
2003	0.0312	0.0249	0.0021	0.0042	0.0386	0.0249	0.0061	0.0076
2004	0.0270	0.0197	0.0026	0.0048	0.0321	0.0197	0.0053	0.0071
2005	0.0223	0.0145	0.0025	0.0053	0.0270	0.0145	0.0052	0.0073
2006	0.0172	0.0093	0.0028	0.0051	0.0217	0.0093	0.0055	0.0070
2007	0.0115	0.0041	0.0032	0.0042	0.0161	0.0041	0.0058	0.0062
2008	0.0062	-0.0011	0.0040	0.0033	0.0111	-0.0011	0.0062	0.0061
2009	0.0016	-0.0064	0.0042	0.0037	0.0062	-0.0064	0.0069	0.0057
2010	-0.0038	-0.0116	0.0035	0.0043	0.0022	-0.0116	0.0074	0.0063
2011	-0.0085	-0.0168	0.0035	0.0047	-0.0022	-0.0168	0.0080	0.0066
2012	-0.0137	-0.0220	0.0036	0.0046	-0.0065	-0.0220	0.0086	0.0070
			BULGARIA				**CROATIA**	
2000					0.0466	0.0406	0.0029	0.0031
2001	0.0456	0.0354	0.0022	0.0081	0.0421	0.0354	0.0031	0.0037
2002	0.0402	0.0301	0.0029	0.0071	0.0377	0.0301	0.0032	0.0044
2003	0.0340	0.0249	0.0033	0.0058	0.0333	0.0249	0.0034	0.0050
2004	0.0297	0.0197	0.0039	0.0061	0.0290	0.0197	0.0041	0.0052
2005	0.0245	0.0145	0.0040	0.0060	0.0244	0.0145	0.0044	0.0055
2006	0.0187	0.0093	0.0037	0.0057	0.0193	0.0093	0.0044	0.0055
2007	0.0146	0.0041	0.0051	0.0054	0.0136	0.0041	0.0043	0.0052
2008	0.0093	-0.0011	0.0061	0.0044	0.0081	-0.0011	0.0048	0.0045
2009	0.0039	-0.0064	0.0058	0.0045	0.0029	-0.0064	0.0051	0.0042
2010	-0.0021	-0.0116	0.0050	0.0044	-0.0015	-0.0116	0.0052	0.0049
2011	-0.0074	-0.0168	0.0050	0.0044	-0.0060	-0.0168	0.0055	0.0053
2012	-0.0118	-0.0220	0.0055	0.0047	-0.0115	-0.0220	0.0054	0.0052
			MACEDONIA				**SLOVENIA**	
2000	0.0479	0.0406	0.0034	0.0039	0.0461	0.0406	0.0030	0.0025
2001	0.0434	0.0354	0.0038	0.0043	0.0397	0.0354	0.0028	0.0016
2002	0.0369	0.0301	0.0027	0.0040	0.0352	0.0301	0.0027	0.0023
2003	0.0328	0.0249	0.0029	0.0049	0.0310	0.0249	0.0029	0.0032
2004	0.0311	0.0197	0.0046	0.0068	0.0270	0.0197	0.0029	0.0044
2005	0.0241	0.0145	0.0033	0.0063	0.0226	0.0145	0.0030	0.0051
2006	0.0189	0.0093	0.0037	0.0059	0.0174	0.0093	0.0033	0.0047
2007	0.0154	0.0041	0.0056	0.0057	0.0122	0.0041	0.0041	0.0040
2008	0.0106	-0.0011	0.0068	0.0049	0.0060	-0.0011	0.0044	0.0027
2009	0.0049	-0.0064	0.0062	0.0050	0.0023	-0.0064	0.0042	0.0044
2010	-0.0010	-0.0116	0.0057	0.0049	-0.0021	-0.0116	0.0044	0.0051
2011	-0.0046	-0.0168	0.0069	0.0054	-0.0079	-0.0168	0.0046	0.0043
2012	-0.0093	-0.0220	0.0072	0.0055	-0.0124	-0.0220	0.0046	0.0050

	SERBIA				MONTENEGRO			
2002	0.0413	0.0301	0.0032	0.0080				
2003	0.0377	0.0249	0.0043	0.0084	0.0388	0.0249	0.0062	0.0077
2004	0.0335	0.0197	0.0054	0.0083	0.0330	0.0197	0.0058	0.0075
2005	0.0291	0.0145	0.0068	0.0078	0.0284	0.0145	0.0062	0.0077
2006	0.0228	0.0093	0.0073	0.0062	0.0248	0.0093	0.0062	0.0093
2007	0.0163	0.0041	0.0068	0.0054	0.0186	0.0041	0.0070	0.0076
2008	0.0106	-0.0011	0.0075	0.0042	0.0152	-0.0011	0.0112	0.0051
2009	0.0061	-0.0064	0.0063	0.0061	0.0070	-0.0064	0.0079	0.0055
2010	0.0022	-0.0116	0.0069	0.0069	0.0025	-0.0116	0.0083	0.0058
2011	-0.0031	-0.0168	0.0069	0.0068	-0.0037	-0.0168	0.0075	0.0055
2012	-0.0068	-0.0220	0.0076	0.0076	-0.0094	-0.0220	0.0069	0.0057

Source: Author's own calculation

4.5 COST EFFICIENCY ESTIMATES ACROSS COUNTRIES & TIME

Table A4.2. Cost efficiency estimates across countries through time

	TRE1T	TRE2T	TRE3T	TRE1T	TRE2T	TRE3T
		ALBANIA		**BOSNIA and HERZEGOVINA**		
2000	83.9%	88.0%	84.4%	81.9%	83.4%	87.5%
2001	84.2%	88.6%	80.3%	84.1%	83.8%	86.8%
2002	84.2%	88.6%	83.2%	83.0%	82.8%	87.1%
2003	84.5%	88.9%	84.3%	83.1%	82.9%	87.6%
2004	85.3%	89.0%	86.4%	86.6%	86.4%	90.0%
2005	87.6%	89.0%	88.8%	86.2%	86.6%	89.9%
2006	87.6%	88.8%	89.3%	86.3%	87.0%	90.1%
2007	84.3%	87.9%	89.3%	85.3%	86.5%	89.8%
2008	82.0%	86.4%	88.7%	86.3%	86.6%	89.9%
2009	86.2%	87.6%	89.1%	86.2%	86.4%	89.8%
2010	86.1%	88.5%	89.6%	83.7%	85.6%	88.9%
2011	88.2%	89.3%	89.9%	85.2%	86.3%	88.9%
2012	89.9%	90.0%	90.6%	81.6%	83.6%	86.8%
		BULGARIA			**CROATIA**	
2000				86.9%	88.5%	90.1%
2001	88.1%	85.2%	86.9%	85.2%	87.3%	88.8%
2002	87.0%	83.6%	85.8%	83.0%	86.0%	88.0%
2003	85.7%	84.4%	87.1%	85.5%	87.0%	89.0%
2004	89.0%	86.0%	88.4%	85.4%	87.0%	88.7%
2005	88.4%	86.6%	88.1%	85.8%	87.6%	89.0%
2006	85.1%	85.7%	87.4%	86.8%	87.9%	89.2%
2007	85.3%	86.5%	88.4%	85.5%	87.8%	89.1%
2008	86.0%	86.2%	87.9%	85.9%	87.8%	89.3%
2009	83.5%	84.6%	87.0%	86.4%	87.6%	89.0%
2010	81.4%	84.3%	87.0%	85.7%	87.4%	89.0%
2011	84.1%	84.9%	87.1%	88.0%	87.9%	89.1%
2012	85.2%	85.3%	86.9%	86.9%	87.8%	88.9%
		MACEDONIA			**SLOVENIA**	
2000	89.1%	87.1%	89.6%	86.4%	88.5%	89.3%
2001	85.3%	85.2%	87.2%	79.0%	86.2%	87.2%
2002	78.9%	82.8%	85.7%	80.0%	87.3%	88.2%
2003	85.8%	86.0%	88.8%	81.4%	87.8%	88.9%
2004	87.7%	87.3%	89.8%	87.1%	90.0%	91.0%
2005	87.4%	87.4%	89.7%	88.8%	90.4%	91.0%
2006	88.6%	87.8%	90.1%	87.1%	89.9%	90.6%
2007	85.5%	86.4%	88.9%	85.8%	89.4%	90.5%
2008	84.6%	85.7%	88.3%	81.9%	87.8%	89.0%
2009	85.7%	85.9%	88.7%	90.2%	90.3%	91.2%
2010	84.2%	85.5%	88.1%	90.4%	90.5%	91.5%
2011	89.1%	87.5%	88.9%	87.1%	89.2%	90.3%
2012	89.7%	87.5%	88.7%	90.0%	89.7%	90.5%
		SERBIA			**MONTENEGRO**	
2002	84.1%	83.0%	83.2%			
2003	84.7%	80.2%	82.9%	85.2%	84.8%	86.4%
2004	77.4%	76.6%	78.8%	84.9%	84.0%	86.3%
2005	83.1%	80.6%	82.8%	84.2%	84.9%	86.6%
2006	83.9%	82.2%	84.2%	89.0%	85.5%	87.6%
2007	85.6%	84.0%	85.9%	88.3%	86.6%	88.7%
2008	88.9%	86.0%	88.0%	87.6%	86.5%	88.3%
2009	81.4%	79.7%	80.2%	83.2%	83.7%	86.2%
2010	77.9%	77.6%	78.2%	82.2%	85.1%	87.3%
2011	76.9%	77.2%	76.3%	85.4%	86.2%	88.3%
2012	78.1%	77.7%	75.7%	86.7%	87.0%	88.5%

APPENDIX TO CHAPTER 6

6.1 REGULATORY AND SUPERVISORY PRACTICES

OVERALL ACTIVITIY RESTRICTIONS (OAR):

Questions included in the index for Activity Restrictiveness:

- Securities: What is the level of regulatory restrictiveness for bank participation in securities activities (the ability of banks to engage in the business of securities underwriting, brokering, dealing, and all aspects of the mutual fund industry)?
- Insurance: What is the level of regulatory restrictiveness for bank participation in insurance activities (the ability of banks to engage in insurance underwriting and selling)?
- Real Estate: What is the level of regulatory restrictiveness for bank participation in real estate activities (the ability of banks to engage in real estate investment, development, and management)?

Possible answers:

Unrestricted=1; A full range of activities in the given category can be conducted directly in the bank?

Permitted=2; A full range of activities can be conducted, but all or some must be conducted in subsidiaries.

Restricted=3; Less than a full range of activities can be conducted in the bank or subsidiaries.

Prohibited=4; The activity cannot be conducted in either the bank or subsidiaries.

These types of regulations determine the degree to which a bank may diversify its business operations as well as to capitalize on any synergies that may arise from complimentary activities.

The Overall Activity Restrictiveness Index is calculated as a sum of the values of the three answers.

CAPITAL REGULATORY INDEX (CRINDEX)

Questions included in the index for Capital Regulatory Index:

Overall Capital Stringency: whether the capital requirement reflects certain risk elements and deducts certain market value losses from capital before minimum capital adequacy is determined.

(1) Is the minimum capital-to asset ratio requirement risk weighted in line with Basel I/II guidelines?;

(2) Does the minimum ratio vary as a function of an individual bank's credit risk?;

(3) Does the minimum ratio vary as a function of market risk?;

(4) Before minimum capital adequacy is determined is the market value of loan losses not realized on accounting books deducted from the book value of capital?;

(5) Before minimum capital adequacy is determined, are unrealized losses in securities deducted from the book value of capital?;

(6) Before minimum capital adequacy is determined, are unrealized foreign exchange losses deducted from the book value of capital?

(7) What fraction of revaluation gains is allowed as part of capital?

Initial Capital Stringency: whether certain funds may be used to initially capitalize a bank and whether they are officially verified.

(8) Are the sources of funds to be used as capital verified by the regulatory/supervisory authorities?

(9) Can the initial disbarments of capital can be done with borrowed funds?; and

(10) Can initial disbarments or subsequent injection of capital be done with assets other than cash or government securities?;

Possible answers: YES/NO.

If the answer is YES=1, for NO=0. Only for questions 9 and 10 YES=0 and NO=1 and 1 if (7)<0.75.

Capital Regulatory Index: is simply the sum of overall capital stringency and initial capital stringency, therefore captures both the amount of capital and verifiable sources of capital that a bank is required to possess.

MITIGATING MORAL HAZARD INDEX (MORALH)

Questions included in Mitigating Moral Hazard Index:

(1) Is explicit deposit insurance protection system funded by (check one): the government, the banks, or both?

(2) Do deposit insurance fees charged to banks vary based on some assessment of risk?

(3) Is there formal coinsurance, that is, are depositors explicitly insured for less than 100% of their deposits?

Possible answers: YES/NO

If YES=1 and if NO=0. If regarding (1) the answer is banks then 1, otherwise 0.

OFFICIAL SUPERVISORY POWER INDEX (OSPOWER)

Questions included in Official Supervisory Power Index:

(1) Does the supervisory agency have the right to meet with external auditors to discuss their reports without the approval of the bank?;

(2) Are auditors required by law to communicate directly to the supervisory agency any presumed involvement of bank directors or senior managers in illicit activities, fraud, or insider abuse?;

(3) Are off-balance sheet items disclosed to the supervisors?;

(4) Can supervisors take legal action against external auditors for negligence?;

(5) Can supervisors force a bank to change its internal organizational structure?

(6) Can the supervisory agency order a bank's directors or management to constitute provisions to cover actual or potential losses?;

(7) Can the supervisory agency suspend the directors' decision to distribute dividends?;

(8) Can the supervisory agency suspend the directors' decision to distribute bonuses?;

(9) Can the supervisory agency suspend the directors' decision to distribute management fees?;

(10) Who can legally declare – such that this declaration supersedes some of the rights of shareholders – that a bank is insolvent?;

- Bank supervisor
- Court
- Deposit Insurance agency
- Bank restructuring or Asset Management Agency
- Other

(11) According to the Banking Law, who has authority to intervene – that is, suspend some or all ownership rights – a problem bank?;

- Bank supervisor
- Court
- Deposit Insurance agency
- Bank restructuring or Asset Management Agency
- Other

(12) Regarding bank restructuring and reorganization, can the supervisory agency or any other government agency supersede shareholder rights?;

- Bank supervisor
- Court
- Deposit Insurance agency
- Bank restructuring or Asset Management Agency
- Other

(13) Regarding bank restructuring and reorganization, can the supervisory agency or any other government agency remove or replace management?;

- Bank supervisor
- Court
- Deposit Insurance agency
- Bank restructuring or Asset Management Agency
- Other

(14) Regarding bank restructuring and reorganization, can the supervisory agency or any other government agency remove or replace directors?

- Bank supervisor
- Court
- Deposit Insurance agency
- Bank restructuring or Asset Management Agency
- Other

Possible answers:

For questions 1-9 YES=1 and NO=0; For questions 10-14 if: Bank supervisor=1; Court=0; Deposit Insurance agency=0.5; Bank restructuring or Asset Management Agency=0.5; Other=0.

The index is created as a sum of the values for each answer.

<u>PRIVATE MONITORING INDEX (PMINDEX)</u>

Questions included in Private Monitoring Index:

(1) Is an external audit a compulsory obligation for banks?

(2) How many of the top ten banks (in terms of total domestic assets) are rated by international credit rating agencies (e.g., Moody's, Standard and Poor)?

(3) How many of the top ten banks (in terms of total domestic assets) are rated by domestic credit rating agencies?

(4) Is there an explicit deposit insurance protection system?

(5)And/or Were insured depositors wholly compensated (to the extent of legal protection) the last time a bank failed?

(5) Does accrued, though unpaid, interest/principal enter the income statement while the loan is still performing?

(6) Does accrued, though unpaid, interest/principal enter the income statement while the loan is still non-performing?

(7) Are financial institutions required to produce consolidated accounts covering all bank and any nonk-bank financial subsidiaries (including affiliates of common holding companies)?

(8) Are bank directors legally liable if information disclosed is erroneous or misleading?

(10) Is subordinated debt allowable as part of regulatory capital?

(11) Is subordinated debt required as part of regulatory capital?

(12) Are off-balance sheet items disclosed to the public?

(13) Must banks disclose their risk management procedures to the public?

(14) Are bank regulators/supervisors required to make public formal enforcement actions, which include cease and desist orders and written agreements between a bank regulatory/supervisory body and a banking organization

Possible answers: YES=1 and NO=0, except for (2) and (3) where the answer is expressed in percent.

The index is created as follows: 1+[1 if (2) equals 100%, otherwise 0]+[1 if (3) equals 100%, otherwise 0]+[1 if (4)=0 and/or (5)=0, otherwise 0]+(6)+[(7)-1]*1+(8)+(9)+[1 if (10) or (11) equals "yes"]+(12)+(13)+(14)

6.2 DESCRIPTIVE STATISTICS

6.2.1 Median Z-score and median capital ratio across countries and time

```
. by country_name year, sort : summarize mzscore meqratio (To be incorporated. Same for the
collinearity matrices.

-> country_name = ALBANIA, year = 2002

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |         8    21.40908           0   21.40908   21.40908
    meqratio |         8    9.022774           0   9.022774   9.022774
----------------------------------------------------------
-> country_name = ALBANIA, year = 2003

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |         9    14.59159           0   14.59159   14.59159
    meqratio |         9    7.587985           0   7.587985   7.587985
----------------------------------------------------------
-> country_name = ALBANIA, year = 2004

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        10     14.7713           0    14.7713    14.7713
    meqratio |        10    8.937478           0   8.937478   8.937478
----------------------------------------------------------
-> country_name = ALBANIA, year = 2005

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |         9    12.62851           0   12.62851   12.62851
    meqratio |         9    6.971005           0   6.971005   6.971005
----------------------------------------------------------
-> country_name = ALBANIA, year = 2006

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |         8    20.91444           0   20.91444   20.91444
    meqratio |         8    5.393842           0   5.393842   5.393842
----------------------------------------------------------
-> country_name = ALBANIA, year = 2007

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |         9    23.12221           0   23.12221   23.12221
    meqratio |         9    7.747523           0   7.747523   7.747523

-> country_name = BIH, year = 2002

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        23    32.87799           0   32.87799   32.87799
    meqratio |        23    19.42857           0   19.42857   19.42857
----------------------------------------------------------
-> country_name = BIH, year = 2003

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
```

```
     mzscore |        24    33.03078           0   33.03078   33.03078
    meqratio |        24    17.32929           0   17.32929   17.32929
----------------------------------------------------------
-> country_name = BIH, year = 2004

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        22    25.07537           0   25.07537   25.07537
    meqratio |        22    15.93368           0   15.93368   15.93368
----------------------------------------------------------
-> country_name = BIH, year = 2005

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        23    23.80123           0   23.80123   23.80123
    meqratio |        23    12.95702           0   12.95702   12.95702
----------------------------------------------------------
-> country_name = BIH, year = 2006

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        23    21.77667           0   21.77667   21.77667
    meqratio |        23    14.34994           0   14.34994   14.34994

----------------------------------------------------------
-> country_name = BIH, year = 2007
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        24    19.88685           0   19.88685   19.88685
    meqratio |        24    12.10414           0   12.10414   12.10414
----------------------------------------------------------
-> country_name = BIH, year = 2008

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        23    22.38288           0   22.38288   22.38288
    meqratio |        23    10.39604           0   10.39604   10.39604
----------------------------------------------------------
-> country_name = BIH, year = 2009

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        23    22.22865           0   22.22865   22.22865
    meqratio |        23    12.14155           0   12.14155   12.14155
----------------------------------------------------------
-> country_name = BIH, year = 2010

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        21    19.77815           0   19.77815   19.77815
    meqratio |        21    12.30689           0   12.30689   12.30689
----------------------------------------------------------
-> country_name = BIH, year = 2011

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        21    23.50443           0   23.50443   23.50443
    meqratio |        21    14.05628           0   14.05628   14.05628
---------------------------------------------------------
-> country_name = BIH, year = 2012
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        21     22.0195           0    22.0195    22.0195
```

```
    meqratio |        21    13.56713           0   13.56713   13.56713
----------------------------------------------------------
-> country_name = BULGARIA, year = 2002

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        14    18.61655           0   18.61655   18.61655
    meqratio |        14    10.40186           0   10.40186   10.40186
----------------------------------------------------------
-> country_name = BULGARIA, year = 2003

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        19    20.64908           0   20.64908   20.64908
    meqratio |        19     12.6734           0    12.6734    12.6734
----------------------------------------------------------
-> country_name = BULGARIA, year = 2004

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        22    17.56775           0   17.56775   17.56775
    meqratio |        22    11.29424           0   11.29424   11.29424
----------------------------------------------------------
-> country_name = BULGARIA, year = 2005

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        24    16.08247           0   16.08247   16.08247
    meqratio |        24    10.40606           0   10.40606   10.40606
----------------------------------------------------------
-> country_name = BULGARIA, year = 2006

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        24    14.49736           0   14.49736   14.49736
    meqratio |        24    10.09247           0   10.09247   10.09247
---------------------------------------------------------
-> country_name = BULGARIA, year = 2007

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        23    17.30852           0   17.30852   17.30852
    meqratio |        23    10.01473           0   10.01473   10.01473
----------------------------------------------------------
-> country_name = BULGARIA, year = 2008

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        23    15.98937           0   15.98937   15.98937
    meqratio |        23    11.18912           0   11.18912   11.18912
----------------------------------------------------------
-> country_name = BULGARIA, year = 2009

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        23    19.38023           0   19.38023   19.38023
    meqratio |        23    12.59668           0   12.59668   12.59668

----------------------------------------------------------
-> country_name = BULGARIA, year = 2010

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
```

```
     mzscore |        21    19.82916           0   19.82916   19.82916
    meqratio |        21    11.96537           0   11.96537   11.96537
-----------------------------------------------------------
-> country_name = BULGARIA, year = 2011

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        21    17.11117           0   17.11117   17.11117
    meqratio |        21    11.92966           0   11.92966   11.92966
-----------------------------------------------------------
-> country_name = BULGARIA, year = 2012

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        20     19.7517           0    19.7517    19.7517
    meqratio |        20     11.8236           0    11.8236    11.8236
-----------------------------------------------------------
-> country_name = CROATIA, year = 2002

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        24    28.32521           0   28.32521   28.32521
    meqratio |        24    11.36379           0   11.36379   11.36379

-----------------------------------------------------------
-> country_name = CROATIA, year = 2003

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        27     23.3094           0    23.3094    23.3094
    meqratio |        27    10.52075           0   10.52075   10.52075
-----------------------------------------------------------
-> country_name = CROATIA, year = 2004

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        27    24.24134           0   24.24134   24.24134
    meqratio |        27    9.987146           0   9.987146   9.987146

-----------------------------------------------------------
-> country_name = CROATIA, year = 2005

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        28    25.30219           0   25.30219   25.30219
    meqratio |        28    10.26927           0   10.26927   10.26927
-----------------------------------------------------------
-> country_name = CROATIA, year = 2006

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        28    22.88859           0   22.88859   22.88859
    meqratio |        28    11.44208           0   11.44208   11.44208

-----------------------------------------------------------




-> country_name = CROATIA, year = 2007
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
```

```
     mzscore |        28    26.26147           0   26.26147   26.26147
    meqratio |        28    12.63552           0   12.63552   12.63552
----------------------------------------------------------
-> country_name = CROATIA, year = 2008

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        28    27.86552           0   27.86552   27.86552
    meqratio |        28    12.86811           0   12.86811   12.86811
----------------------------------------------------------
-> country_name = CROATIA, year = 2009

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        27     24.5365           0    24.5365    24.5365
    meqratio |        27    13.18873           0   13.18873   13.18873
----------------------------------------------------------
-> country_name = CROATIA, year = 2010

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        25    20.34022           0   20.34022   20.34022
    meqratio |        25    12.93627           0   12.93627   12.93627
----------------------------------------------------------
-> country_name = CROATIA, year = 2011

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        25    19.41292           0   19.41292   19.41292
    meqratio |        25    12.53843           0   12.53843   12.53843

----------------------------------------------------------
-> country_name = CROATIA, year = 2012

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        25    20.34139           0   20.34139   20.34139
    meqratio |        25    13.15463           0   13.15463   13.15463
----------------------------------------------------------
-> country_name = MACEDONIA, year = 2002

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |         9    15.95917           0   15.95917   15.95917
    meqratio |         9    27.27615           0   27.27615   27.27615
----------------------------------------------------------
-> country_name = MACEDONIA, year = 2003

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |         9    15.12254           0   15.12254   15.12254
    meqratio |         9    28.25365           0   28.25365   28.25365
----------------------------------------------------------
-> country_name = MACEDONIA, year = 2004
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        12    16.98734           0   16.98734   16.98734
    meqratio |        12    25.48431           0   25.48431   25.48431

----------------------------------------------------------
-> country_name = MACEDONIA, year = 2005
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
```

```
     mzscore |        12    15.54517           0   15.54517   15.54517
    meqratio |        12    19.09271           0   19.09271   19.09271
----------------------------------------------------------
-> country_name = MACEDONIA, year = 2006

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        13     14.2442           0    14.2442    14.2442
    meqratio |        13     17.0867           0    17.0867    17.0867
----------------------------------------------------------
-> country_name = MACEDONIA, year = 2007

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        13    14.09849           0   14.09849   14.09849
    meqratio |        13    14.80051           0   14.80051   14.80051
----------------------------------------------------------
-> country_name = MACEDONIA, year = 2008

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        13      11.925           0     11.925     11.925
    meqratio |        13    12.65285           0   12.65285   12.65285
----------------------------------------------------------
-> country_name = MACEDONIA, year = 2009

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        13     10.8514           0    10.8514    10.8514
    meqratio |        13    11.62113           0   11.62113   11.62113
----------------------------------------------------------
-> country_name = MACEDONIA, year = 2010

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        12    9.504449           0   9.504449   9.504449
    meqratio |        12    11.64633           0   11.64633   11.64633
----------------------------------------------------------
-> country_name = MACEDONIA, year = 2011

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        12    10.87278           0   10.87278   10.87278
    meqratio |        12    12.46909           0   12.46909   12.46909
----------------------------------------------------------
-> country_name = MACEDONIA, year = 2012

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        11    10.17664           0   10.17664   10.17664
    meqratio |        11     11.5886           0    11.5886    11.5886
----------------------------------------------------------
-> country_name = MONTENEGRO, year = 2003

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |         5     34.2201           0    34.2201    34.2201
    meqratio |         5    28.81041           0   28.81041   28.81041

----------------------------------------------------------
-> country_name = MONTENEGRO, year = 2004
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
```

```
     mzscore |         6    29.15806           0   29.15806   29.15806
    meqratio |         6    29.42649           0   29.42649   29.42649
----------------------------------------------------------
-> country_name = MONTENEGRO, year = 2005

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |         9    21.44777           0   21.44777   21.44777
    meqratio |         9     23.4657           0    23.4657    23.4657
----------------------------------------------------------
-> country_name = MONTENEGRO, year = 2006

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |         9    16.86323           0   16.86323   16.86323
    meqratio |         9     14.8728           0    14.8728    14.8728
----------------------------------------------------------
-> country_name = MONTENEGRO, year = 2007

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |         9    10.96963           0   10.96963   10.96963
    meqratio |         9    12.66179           0   12.66179   12.66179
----------------------------------------------------------
-> country_name = SERBIA, year = 2002

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |         7    10.04769           0   10.04769   10.04769
    meqratio |         7    15.22322           0   15.22322   15.22322
----------------------------------------------------------
-> country_name = SERBIA, year = 2003

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        18    13.73723           0   13.73723   13.73723
    meqratio |        18    24.09228           0   24.09228   24.09228
----------------------------------------------------------
-> country_name = SERBIA, year = 2004

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        25    9.023963           0   9.023963   9.023963
    meqratio |        25    21.02032           0   21.02032   21.02032
----------------------------------------------------------
-> country_name = SERBIA, year = 2005

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        26    11.35772           0   11.35772   11.35772
    meqratio |        26    18.58267           0   18.58267   18.58267
----------------------------------------------------------
-> country_name = SERBIA, year = 2006

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |        28    12.19102           0   12.19102   12.19102
    meqratio |        28    21.13504           0   21.13504   21.13504

----------------------------------------------------------
-> country_name = SERBIA, year = 2007
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
```

```
     mzscore |        28    14.07311           0   14.07311   14.07311
    meqratio |        28    22.70097           0   22.70097   22.70097
-----------------------------------------------------------
-> country_name = SLOVENIA, year = 2002

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+-----------------------------------------------------------
     mzscore |        16    12.18303           0   12.18303   12.18303
    meqratio |        16    9.482502           0   9.482502   9.482502
-----------------------------------------------------------
-> country_name = SLOVENIA, year = 2003

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+-----------------------------------------------------------
     mzscore |        17    12.93736           0   12.93736   12.93736
    meqratio |        17      8.5569           0     8.5569     8.5569
-----------------------------------------------------------
-> country_name = SLOVENIA, year = 2004

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+-----------------------------------------------------------
     mzscore |        17    12.37467           0   12.37467   12.37467
    meqratio |        17    8.172556           0   8.172556   8.172556
-----------------------------------------------------------
-> country_name = SLOVENIA, year = 2005

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+-----------------------------------------------------------
     mzscore |        17    13.17817           0   13.17817   13.17817
    meqratio |        17    8.539326           0   8.539326   8.539326
-----------------------------------------------------------
-> country_name = SLOVENIA, year = 2006

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+-----------------------------------------------------------
     mzscore |        17    12.94133           0   12.94133   12.94133
    meqratio |        17    7.318168           0   7.318168   7.318168
-----------------------------------------------------------
-> country_name = SLOVENIA, year = 2007

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+-----------------------------------------------------------
     mzscore |        17    12.13407           0   12.13407   12.13407
    meqratio |        17    7.763221           0   7.763221   7.763221
-----------------------------------------------------------
-> country_name = SLOVENIA, year = 2008

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+-----------------------------------------------------------
     mzscore |        17    11.62269           0   11.62269   11.62269
    meqratio |        17    7.815962           0   7.815962   7.815962
-----------------------------------------------------------
-> country_name = SLOVENIA, year = 2009

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+-----------------------------------------------------------
     mzscore |        17    10.70814           0   10.70814   10.70814
    meqratio |        17     7.90565           0    7.90565    7.90565
-----------------------------------------------------------

-> country_name = SLOVENIA, year = 2010

    Variable |       Obs        Mean    Std. Dev.       Min        Max
```

```
-------------+--------------------------------------------------------
     mzscore |         17    10.52102           0   10.52102   10.52102
    meqratio |         17    7.614955           0   7.614955   7.614955
----------------------------------------------------------------------
-> country_name = SLOVENIA, year = 2011

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |         17    9.856792           0   9.856792   9.856792
    meqratio |         17     7.49342           0    7.49342    7.49342
----------------------------------------------------------------------
-> country_name = SLOVENIA, year = 2012

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     mzscore |         17    9.098861           0   9.098861   9.098861
    meqratio |         17     7.98761           0    7.98761    7.98761
```

6.2.2 Descriptive statistics of the baseline model

Table A.6.1: Printout of the descriptive statistics conducted after estimation of the baseline dynamic panel model.

```
. estat summarize

  Estimation sample xtabond2            Number of obs =   1069

  -------------------------------------------------------------
      Variable |        Mean     Std. Dev.        Min        Max
  -------------+-----------------------------------------------
          lmsa |
           --. |    .8807052     1.328827   -3.30295    3.89291
           L1. |     .841625      1.34002   -3.30295    3.99009
               |
          leff |    4.480671     .0700428    3.69333    4.60073
        bden10 |    9.852569     11.57999    .091946    84.4091
           dzs |    6.790243     37.90319   -32.0342    544.637
           deq |     2.45849     10.50219   -20.0642    70.3052
      foreign9 |    .4733396     .4995224          0          1
          lpop |    4.391394      .160404    3.82211     4.7726
         lgdpc |    8.652325     .6984335    7.74693    9.93821
            eu |     .303087     .4598076          0          1
           oar |    6.872778     .9080878          6          8
       ospower |    11.14266     2.269835        5.5         14
       crindex |    6.359214      1.57463          4         10
        moralh |     1.29841     .6329049          0          2
       pmindex |    5.968195     .8724447          4          7
           y04 |    .1000935     .3002652          0          1
           y05 |    .1178672     .3226017          0          1
           y06 |    .1262862     .3323272          0          1
           y07 |    .1328344     .3395546          0          1
           y08 |    .0935454     .2913315          0          1
           y09 |    .0916745     .2887009          0          1
           y10 |    .0860617     .2805865          0          1
           y11 |    .0860617     .2805865          0          1
           y12 |    .0860617     .2805865          0          1
  -------------------------------------------------------------
```

6.3 BASELINE MODELS (PRINTOUTS)

Table A.6.2: Printout of baseline dynamic panel system GMM estimation for the bank's market share determinants in SEECs, 2002-2012 (Dependent variable MSA)

```
. xtabond2 lmsa l.lmsa leff bden10 dzs deq foreign9 lpop lgdpc eu oar ospower crindex moralh
pmindex y04 y05 y06 y07 y08 y09 y10 y11 y12, gmm(l.lmsa, lag(3 3)coll) gmm(leff, lag(2 3)coll)
gmm(bden10, lag(2 2)coll) gmm(dzs, lag(4 .)coll) gmm(deq, lag(2 2)coll) iv(foreign9 lpop lgdpc
eu) iv(oar ospower crindex moralh pmindex) iv(y04 y05 y06 y07 y08 y09 y10 y11 y12) two robust
orthogonal
Favoring speed over space. To switch, type or click on mata: mata set matafavor space, perm.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      1069
Time variable : year                            Number of groups   =       148
Number of instruments = 36                      Obs per group: min =         1
Wald chi2(23) =   4612.27                                      avg =      7.22
Prob > chi2   =     0.000                                      max =        10
------------------------------------------------------------------------------
             |              Corrected
        lmsa |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lmsa |
         L1. |   .8652739   .0406499    21.29   0.000     .7856016    .9449463
             |
        leff |   .3038362   .5469671     0.56   0.579    -.7681996    1.375872
      bden10 |   .0181853   .0073297     2.48   0.013     .0038194    .0325513
         dzs |  -.0014579   .0005138    -2.84   0.005    -.0024649   -.0004509
         deq |  -.0092091   .0029329    -3.14   0.002    -.0149575   -.0034608
    foreign9 |   .0314756   .0627668     0.50   0.616    -.0915452    .1544963
        lpop |   .0757773   .0929446     0.82   0.415    -.1063908    .2579454
       lgdpc |  -.0625507   .0507386    -1.23   0.218    -.1619965    .0368952
          eu |   .0419253   .0353258     1.19   0.235    -.0273121    .1111626
         oar |   .0951986   .0430302     2.21   0.027     .0108608    .1795363
     ospower |   -.025138   .0121103    -2.08   0.038    -.0488739   -.0014022
     crindex |  -.0377869   .0148874    -2.54   0.011    -.0669656   -.0086082
      moralh |  -.0269566   .0567056    -0.48   0.635    -.1380977    .0841844
     pmindex |  -.0341685   .0194597    -1.76   0.079    -.0723089    .0039719
         y04 |   .0145411   .0216964     0.67   0.503    -.0279831    .0570653
         y05 |   .0017635   .0261398     0.07   0.946    -.0494696    .0529965
         y06 |  -.0359942   .0281255    -1.28   0.201    -.0911191    .0191307
         y07 |  -.0591399    .031585    -1.87   0.061    -.1210454    .0027656
         y08 |  -.1483051   .0736921    -2.01   0.044     -.292739   -.0038712
         y09 |  -.1720891   .0746383    -2.31   0.021    -.3183775   -.0258007
         y10 |  -.1484349   .0724616    -2.05   0.041    -.2904571   -.0064128
         y11 |   -.176618   .0713699    -2.47   0.013    -.3165006   -.0367355
         y12 |   -.188624   .0712535    -2.65   0.008    -.3282784   -.0489696
       _cons |  -.9781973   2.375554    -0.41   0.681    -5.634197    3.677803
------------------------------------------------------------------------------
Instruments for orthogonal deviations equation
  Standard
    FOD.(y04 y05 y06 y07 y08 y09 y10 y11 y12)
    FOD.(oar ospower crindex moralh pmindex)
    FOD.(foreign9 lpop lgdpc eu)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L2.deq collapsed
    L(4/10).dzs collapsed
    L2.bden10 collapsed
    L(2/3).leff collapsed
    L3.L.lmsa collapsed
Instruments for levels equation
  Standard
    y04 y05 y06 y07 y08 y09 y10 y11 y12
    oar ospower crindex moralh pmindex
    foreign9 lpop lgdpc eu
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.deq collapsed
    DL3.dzs collapsed
```

```
    DL.bden10 collapsed
    DL.leff collapsed
    DL2.L.lmsa collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -4.19  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -0.59  Pr > z =  0.555
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(12)   =   5.30  Prob > chi2 =  0.947
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(12)   =   9.26  Prob > chi2 =  0.680
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(7)    =   7.24  Prob > chi2 =  0.404
    Difference (null H = exogenous): chi2(5)    =   2.02  Prob > chi2 =  0.846
  gmm(L.lmsa, collapse lag(3 3))
    Hansen test excluding group:     chi2(10)   =   7.98  Prob > chi2 =  0.631
    Difference (null H = exogenous): chi2(2)    =   1.29  Prob > chi2 =  0.526
  gmm(leff, collapse lag(2 3))
    Hansen test excluding group:     chi2(9)    =   8.37  Prob > chi2 =  0.497
    Difference (null H = exogenous): chi2(3)    =   0.89  Prob > chi2 =  0.827
  gmm(bden10, collapse lag(2 2))
    Hansen test excluding group:     chi2(10)   =   6.90  Prob > chi2 =  0.735
    Difference (null H = exogenous): chi2(2)    =   2.36  Prob > chi2 =  0.307
  gmm(dzs, collapse lag(4 .))
    Hansen test excluding group:     chi2(4)    =   0.75  Prob > chi2 =  0.945
    Difference (null H = exogenous): chi2(8)    =   8.52  Prob > chi2 =  0.385
  gmm(deq, collapse lag(2 2))
    Hansen test excluding group:     chi2(10)   =   7.40  Prob > chi2 =  0.687
    Difference (null H = exogenous): chi2(2)    =   1.87  Prob > chi2 =  0.393
  iv(foreign9 lpop lgdpc eu)
    Hansen test excluding group:     chi2(8)    =   3.54  Prob > chi2 =  0.896
    Difference (null H = exogenous): chi2(4)    =   5.73  Prob > chi2 =  0.221
  iv(oar ospower crindex moralh pmindex)
    Hansen test excluding group:     chi2(7)    =   4.41  Prob > chi2 =  0.731
    Difference (null H = exogenous): chi2(5)    =   4.85  Prob > chi2 =  0.434
  iv(y04 y05 y06 y07 y08 y09 y10 y11 y12)
    Hansen test excluding group:     chi2(3)    =   1.80  Prob > chi2 =  0.616
    Difference (null H = exogenous): chi2(9)    =   7.47  Prob > chi2 =  0.589
```

LONG RUN COEFFICIENTS

```
. nlcom (LRleff: _b[leff]/(1-_b[l.lmsa])) (LRbden10: _b[bden10]/(1-_b[l.lmsa])) (LRdzs: _b[dzs]/(1-_b[l.lmsa])) (LRdeq: _b[deq]/(1-_b[l.lmsa])) (LRforeign9: _b[foreign9]/(1-_b[l.lmsa])) (LRlpop: _b[lpop]/(1-_b[l.lmsa])) (LRlgdpc: _b[lgdpc]/(1-_b[l.lmsa])) (LReu: _b[eu]/(1-_b[l.lmsa])) (LRoar: _b[oar]/(1-_b[l.lmsa])) (LRospower: _b[ospower]/(1-_b[l.lmsa])) (LRcrindex: _b[crindex]/(1-_b[l.lmsa])) (LRmoralh: _b[moralh]/(1-_b[l.lmsa])) (LRpmindex: _b[pmindex]/(1-_b[l.lmsa]))
      LRleff:  _b[leff]/(1-_b[l.lmsa])
    LRbden10:  _b[bden10]/(1-_b[l.lmsa])
       LRdzs:  _b[dzs]/(1-_b[l.lmsa])
       LRdeq:  _b[deq]/(1-_b[l.lmsa])
  LRforeign9:  _b[foreign9]/(1-_b[l.lmsa])
      LRlpop:  _b[lpop]/(1-_b[l.lmsa])
     LRlgdpc:  _b[lgdpc]/(1-_b[l.lmsa])
        LReu:  _b[eu]/(1-_b[l.lmsa])
       LRoar:  _b[oar]/(1-_b[l.lmsa])
   LRospower:  _b[ospower]/(1-_b[l.lmsa])
   LRcrindex:  _b[crindex]/(1-_b[l.lmsa])
    LRmoralh:  _b[moralh]/(1-_b[l.lmsa])
   LRpmindex:  _b[pmindex]/(1-_b[l.lmsa])
------------------------------------------------------------------------------
        lmsa |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      LRleff |   2.255215   4.089419     0.55   0.581    -5.759899    10.27033
    LRbden10 |   .1349801   .0608934     2.22   0.027     .0156311     .254329
       LRdzs |  -.0108211   .0053974    -2.00   0.045    -.0213999   -.0002424
       LRdeq |  -.0683543   .0280293    -2.44   0.015    -.1232907   -.0134179
  LRforeign9 |   .2336263   .4256344     0.55   0.583    -.6006018    1.067854
      LRlpop |   .5624545   .7441696     0.76   0.450     -.896091       2.021
     LRlgdpc |  -.4642804    .396623    -1.17   0.242    -1.241647    .3130864
        LReu |    .311189   .2589289     1.20   0.229    -.1963023    .8186804
       LRoar |   .7066082   .3104439     2.28   0.023     .0981493    1.315067
   LRospower |  -.1865863   .0828764    -2.25   0.024     -.349021   -.0241515
   LRcrindex |  -.2804722   .1147506    -2.44   0.015    -.5053793   -.0555652
    LRmoralh |  -.2000848   .3870832    -0.52   0.605    -.9587539    .5585843
   LRpmindex |  -.2536146   .1818698    -1.39   0.163    -.6100728    .1028437
------------------------------------------------------------------------------
```

Table A.6.3. Printout of baseline dynamic panel model estimated by fixed-effect panel model for the bank's market share determinants in SEECs, 2002-2012 (Dependent variable MSA)

```
. xtreg lmsa l.lmsa leff bden10 dzs deq foreign9 lpop lgdpc eu oar ospower crindex moralh
pmindex y04 y05 y06 y07 y08 y09 y10 y11 y12, fe
note: oar omitted because of collinearity

Fixed-effects (within) regression               Number of obs      =      1069
Group variable: id                              Number of groups   =       148

R-sq:  within  = 0.6530                         Obs per group: min =         1
       between = 0.7690                                        avg =       7.2
       overall = 0.7272                                        max =        10

                                                F(22,899)          =     76.89
corr(u_i, Xb)  = -0.1235                        Prob > F           =    0.0000

------------------------------------------------------------------------------
        lmsa |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lmsa |
         L1. |   .6690711   .0197032    33.96   0.000     .6304014    .7077408
             |
        leff |   .0335798   .1149889     0.29   0.770    -.1920981    .2592577
      bden10 |   .0056255   .0021726     2.59   0.010     .0013616    .0098894
         dzs |   .0000327   .0005738     0.06   0.955    -.0010936    .0011589
         deq |  -.0077902   .0011985    -6.50   0.000    -.0101425   -.0054379
    foreign9 |    .086135   .0257285     3.35   0.001       .03564      .13663
        lpop |  -1.159705   .6897471    -1.68   0.093    -2.513407     .193997
       lgdpc |  -.7852739   .2865834    -2.74   0.006    -1.347724   -.2228236
          eu |   .0385913   .0275808     1.40   0.162     -.015539    .0927215
         oar |  (omitted)
     ospower |   .1025049   .0376745     2.72   0.007     .0285647     .176445
     crindex |   .0566561   .0264503     2.14   0.032     .0047447    .1085676
      moralh |   .0083571   .0379773     0.22   0.826    -.0661774    .0828916
     pmindex |  -.0721347   .0206773    -3.49   0.001    -.1127161   -.0315533
         y04 |   .0507662   .0255375     1.99   0.047     .0006461    .1008863
         y05 |   .0938402   .0354079     2.65   0.008     .0243485     .163332
         y06 |   .1273581   .0489526     2.60   0.009     .0312835    .2234327
         y07 |    .162965   .0655283     2.49   0.013     .0343587    .2915713
         y08 |   .2681898   .1138239     2.36   0.019     .0447983    .4915812
         y09 |    .222664   .0998271     2.23   0.026     .0267426    .4185854
         y10 |   .2499807   .1015274     2.46   0.014     .0507224    .4492391
         y11 |   .2339768    .106466     2.20   0.028     .0250259    .4429276
         y12 |   .2140568   .1047919     2.04   0.041     .0083915    .4197221
       _cons |   10.72309   4.104778     2.61   0.009     2.667032    18.77916
-------------+----------------------------------------------------------------
     sigma_u |  .63584672
     sigma_e |  .13944687
         rho |   .9541107   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(147, 899) =     4.37            Prob > F = 0.0000
```

Table A.6.4 Printout of baseline dynamic panel model estimated by Ordinary Least Square (OLS) for the bank's market share determinants in SEECs, 2002-2012 (Dependent variable MSA)

```
. reg lmsa l.lmsa leff bden10 dzs deq foreign9 lpop lgdpc eu oar ospower crindex moralh  pmindex
y04 y05 y06 y07 y08 y09 y10 y11 y12

Source |       SS       df       MS              Number of obs =    1069
-------------+------------------------------           F( 23,  1045) = 2814.00
       Model |  1855.88972    23  80.6908573           Prob > F      =  0.0000
    Residual |  29.9651692  1045  .028674803           R-squared     =  0.9841
-------------+------------------------------           Adj R-squared =  0.9838
       Total |  1885.85489  1068  1.76578173           Root MSE      =  .16934

------------------------------------------------------------------------------
        lmsa |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lmsa |
         L1. |   .9554135   .0060655   157.52   0.000     .9435116    .9673154
             |
        leff |  -.1031567   .0809406    -1.27   0.203    -.2619813    .0556679
      bden10 |   .0006759   .0006337     1.07   0.286    -.0005675    .0019193
         dzs |  -.0000781   .0001504    -0.52   0.604    -.0003732    .0002169
         deq |  -.0039526   .0005906    -6.69   0.000    -.0051115   -.0027936
    foreign9 |   .0485743    .011782     4.12   0.000     .0254553    .0716933
        lpop |   .1423298    .047769     2.98   0.003     .0485956    .2360639
       lgdpc |  -.0232191   .0184388    -1.26   0.208    -.0594005    .0129623
          eu |   .0616478   .0215194     2.86   0.004     .0194217    .1038739
         oar |   .0255486   .0224876     1.14   0.256    -.0185774    .0696745
     ospower |  -.0108615    .006497    -1.67   0.095    -.0236102    .0018872
     crindex |  -.0130792   .0109379    -1.20   0.232     -.034542    .0083835
      moralh |  -.0115309   .0208945    -0.55   0.581    -.0525308    .0294691
     pmindex |  -.0224888   .0118019    -1.91   0.057    -.0456468    .0006692
         y04 |   .0167761   .0247516     0.68   0.498    -.0317925    .0653446
         y05 |   .0232622   .0240607     0.97   0.334    -.0239507     .070475
         y06 |   .0010907   .0241878     0.05   0.964    -.0463714    .0485528
         y07 |  -.0134915   .0242736    -0.56   0.578    -.0611221    .0341392
         y08 |  -.0611171   .0387339    -1.58   0.115    -.1371221    .0148879
         y09 |  -.0672611   .0382247    -1.76   0.079    -.1422671    .0077448
         y10 |  -.0454893   .0386846    -1.18   0.240    -.1213976    .0304191
         y11 |  -.0707304   .0391978    -1.80   0.071    -.1476457    .0061849
         y12 |  -.0950659    .040841    -2.33   0.020    -.1752057   -.0149262
       _cons |   .2817007    .397271     0.71   0.478     -.497839     1.06124
------------------------------------------------------------------------------
```

6.4 ALTERNATIVE MODEL SPECIFICATION (PRINTOUTS: DIFFERENT BANK SIZE-CLASSES)

Table A.6.5 Printout of the alternative dynamic panel model specification examining the systematic variation in determinants across different size-classes (only bank-specific variables are interacted with the four biggest banks in each country)

```
xtabond2 lmsa l.lmsa leff leffc4 bden10 bden10c4 dzs dzsc4 deq deqc4 foreign9 lpop lgdpc eu
oar ospower crindex moralh pmindex y04 y05 y06 y07 y08 y09 y10 y11 y12 c4, gmm(l.lmsa, lag(3
.)coll) gmm(leff, lag(2 2)coll) gmm(leffc4, lag(2 5)coll) gmm(bden10, lag(2 2)coll)
gmm(bden10c4, lag(2 3)coll) gmm(dzs, lag(4 .)coll) gmm(dzsc4, lag(4 .)coll) gmm(deq, lag(2
2)coll)gmm(deqc4, lag(2 .)coll) iv(foreign9 lpop lgdpc eu) iv(oar ospower crindex moralh
pmindex) iv(y04 y05 y06 y07 y08 y09 y10 y11 y12 c4) two robust orthogonal
Favoring speed over space. To switch, type or click on mata: mata set matafavor space, perm.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      1068
Time variable : year                            Number of groups   =       148
Number of instruments = 68                      Obs per group: min =         1
Wald chi2(28) =  13482.98                                      avg =      7.22
Prob > chi2   =     0.000                                      max =        10
------------------------------------------------------------------------------
             |              Corrected
        lmsa |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lmsa |
         L1. |   .8891942   .0396685    22.42   0.000     .8114453     .966943
             |
        leff |   .6665467   .6411527     1.04   0.299    -.5900895    1.923183
      leffc4 |  -2.426776   1.039264    -2.34   0.020    -4.463695   -.3898567
      bden10 |   .0182309   .0086658     2.10   0.035     .0012461    .0352156
    bden10c4 |   -.004713   .0092963    -0.51   0.612    -.0229335    .0135074
         dzs |  -.0020725   .0009959    -2.08   0.037    -.0040244   -.0001206
       dzsc4 |   .0037601   .0032191     1.17   0.243    -.0025492    .0100694
         deq |  -.0057667   .0032788    -1.76   0.079     -.012193    .0006597
       deqc4 |  -.0193227   .0081848    -2.36   0.018    -.0353646   -.0032807
    foreign9 |   .0225053   .0347668     0.65   0.517    -.0456364    .0906471
        lpop |   .1567467   .0951221     1.65   0.099    -.0296891    .3431825
       lgdpc |  -.0532572   .0391295    -1.36   0.173    -.1299497    .0234352
          eu |   .0326697   .0304544     1.07   0.283    -.0270198    .0923593
         oar |   .0799278   .0396632     2.02   0.044     .0021893    .1576662
     ospower |  -.0241172   .0115244    -2.09   0.036    -.0467046   -.0015297
     crindex |   -.025804   .0167825    -1.54   0.124    -.0586971    .0070891
      moralh |  -.0390816   .0387757    -1.01   0.314    -.1150806    .0369174
     pmindex |  -.0317227   .0200958    -1.58   0.114    -.0711097    .0076644
         y04 |   .0320541   .0224635     1.43   0.154    -.0119737    .0760818
         y05 |   .0385151   .0256605     1.50   0.133    -.0117785    .0888088
         y06 |   .0005213   .0252995     0.02   0.984    -.0490648    .0501074
         y07 |  -.0237478   .0313988    -0.76   0.449    -.0852884    .0377927
         y08 |  -.1264354   .0569312    -2.22   0.026    -.2380185   -.0148523
         y09 |  -.1364055   .0614817    -2.22   0.027    -.2569074   -.0159037
         y10 |  -.1173627   .0599213    -1.96   0.050    -.2348064    .0000809
         y11 |  -.1423489   .0592345    -2.40   0.016    -.2584464   -.0262513
         y12 |  -.1485205   .0593834    -2.50   0.012    -.2649099   -.0321311
          c4 |   10.79354   4.634889     2.33   0.020     1.709322    19.87775
       _cons |  -3.041175   2.811632    -1.08   0.279    -8.551872    2.469523
```

```
------------------------------------------------------------------------------
Instruments for orthogonal deviations equation
  Standard
    FOD.(y04 y05 y06 y07 y08 y09 y10 y11 y12 c4)
    FOD.(oar ospower crindex moralh pmindex)
    FOD.(foreign9 lpop lgdpc eu)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/10).deqc4 collapsed
    L2.deq collapsed
    L(4/10).dzsc4 collapsed
    L(4/10).dzs collapsed
    L(2/3).bden10c4 collapsed
    L2.bden10 collapsed
    L(2/5).leffc4 collapsed
    L2.leff collapsed
    L(3/10).L.lmsa collapsed
Instruments for levels equation
  Standard
    y04 y05 y06 y07 y08 y09 y10 y11 y12 c4
    oar ospower crindex moralh pmindex
    foreign9 lpop lgdpc eu
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.deqc4 collapsed
    DL.deq collapsed
    DL3.dzsc4 collapsed
    DL3.dzs collapsed
    DL.bden10c4 collapsed
    DL.bden10 collapsed
    DL.leffc4 collapsed
    DL.leff collapsed
    DL2.L.lmsa collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -4.55  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -0.72  Pr > z =  0.469
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(39)   =  23.97  Prob > chi2 =  0.972
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(39)   =  31.93  Prob > chi2 =  0.782
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(30)   =  26.68  Prob > chi2 =  0.640
    Difference (null H = exogenous): chi2(9)    =   5.25  Prob > chi2 =  0.812
  gmm(L.lmsa, collapse lag(3 .))
    Hansen test excluding group:     chi2(31)   =  25.72  Prob > chi2 =  0.735
    Difference (null H = exogenous): chi2(8)    =   6.21  Prob > chi2 =  0.624
  gmm(leff, collapse lag(2 2))
    Hansen test excluding group:     chi2(37)   =  31.22  Prob > chi2 =  0.736
    Difference (null H = exogenous): chi2(2)    =   0.71  Prob > chi2 =  0.700
  gmm(leffc4, collapse lag(2 5))
    Hansen test excluding group:     chi2(34)   =  27.47  Prob > chi2 =  0.778
    Difference (null H = exogenous): chi2(5)    =   4.46  Prob > chi2 =  0.486
  gmm(bden10, collapse lag(2 2))
    Hansen test excluding group:     chi2(37)   =  31.27  Prob > chi2 =  0.734
    Difference (null H = exogenous): chi2(2)    =   0.66  Prob > chi2 =  0.720
  gmm(bden10c4, collapse lag(2 3))
    Hansen test excluding group:     chi2(36)   =  30.26  Prob > chi2 =  0.738
    Difference (null H = exogenous): chi2(3)    =   1.67  Prob > chi2 =  0.643
  gmm(dzs, collapse lag(4 .))
    Hansen test excluding group:     chi2(31)   =  24.37  Prob > chi2 =  0.795
    Difference (null H = exogenous): chi2(8)    =   7.56  Prob > chi2 =  0.477
```

```
  gmm(dzsc4, collapse lag(4 .))
    Hansen test excluding group:     chi2(31)    =  27.01  Prob > chi2 =  0.672
    Difference (null H = exogenous): chi2(8)     =   4.92  Prob > chi2 =  0.766
  gmm(deq, collapse lag(2 2))
    Hansen test excluding group:     chi2(37)    =  29.21  Prob > chi2 =  0.816
    Difference (null H = exogenous): chi2(2)     =   2.72  Prob > chi2 =  0.257
  gmm(deqc4, collapse lag(2 .))
    Hansen test excluding group:     chi2(29)    =  23.29  Prob > chi2 =  0.763
    Difference (null H = exogenous): chi2(10)    =   8.64  Prob > chi2 =  0.566
  iv(foreign9 lpop lgdpc eu)
    Hansen test excluding group:     chi2(35)    =  30.68  Prob > chi2 =  0.677
    Difference (null H = exogenous): chi2(4)     =   1.25  Prob > chi2 =  0.870
  iv(oar ospower crindex moralh pmindex)
    Hansen test excluding group:     chi2(34)    =  30.49  Prob > chi2 =  0.640
    Difference (null H = exogenous): chi2(5)     =   1.44  Prob > chi2 =  0.920
  iv(y04 y05 y06 y07 y08 y09 y10 y11 y12 c4)
    Hansen test excluding group:     chi2(29)    =  25.76  Prob > chi2 =  0.638
    Difference (null H = exogenous): chi2(10)    =   6.17  Prob > chi2 =  0.800

. lincom bden10+bden10c4

 ( 1)  bden10 + bden10c4 = 0

------------------------------------------------------------------------------
        lmsa |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   .0135178   .0071168     1.90   0.058    -.0004309    .0274666
------------------------------------------------------------------------------

. lincom leff+leffc4

 ( 1)  leff + leffc4 = 0

------------------------------------------------------------------------------
        lmsa |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |  -1.760229   .8702079    -2.02   0.043    -3.465806   -.0546531
------------------------------------------------------------------------------

. lincom dzs+dzsc4

 ( 1)  dzs + dzsc4 = 0

------------------------------------------------------------------------------
        lmsa |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   .0016876   .0030243     0.56   0.577    -.0042399    .0076151
------------------------------------------------------------------------------

. lincom deq+deqc4

 ( 1)  deq + deqc4 = 0

------------------------------------------------------------------------------
        lmsa |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |  -.0250893   .0072102    -3.48   0.001    -.0392212   -.0109575
------------------------------------------------------------------------------
```

Table A.6.6: Printout of the alternative dynamic panel model specification examining the systemic variation in determinants across different size-classes (only bank-specific variables are interacted with the four biggest banks in each country)

```
. xtreg lmsa l.lmsa leff leffc4 bden10 bden10c4 dzs dzsc4 deq deqc4 foreign9 lpop lgdpc eu oar
ospower crindex moralh pmindex y04 y05 y06 y07 y08 y09 y10 y11 y12 c4, fe
note: oar omitted because of collinearity
note: c4 omitted because of collinearity

Fixed-effects (within) regression               Number of obs      =      1068
Group variable: id                              Number of groups   =       148

R-sq:  within  = 0.6560                         Obs per group: min =         1
       between = 0.0165                                        avg =       7.2
       overall = 0.0084                                        max =        10

                                                F(26,894)          =     65.58
corr(u_i, Xb)  = -0.6291                        Prob > F           =    0.0000

------------------------------------------------------------------------------
        lmsa |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lmsa |
         L1. |   .6699948   .0199365    33.61   0.000     .6308671    .7091226
             |
        leff |   .2027172   .1323781     1.53   0.126    -.0570908    .4625253
      leffc4 |  -.7179753   .2825145    -2.54   0.011    -1.272444   -.1635063
      bden10 |   .0071954   .0027886     2.58   0.010     .0017224    .0126685
    bden10c4 |  -.0009549   .0037518    -0.25   0.799    -.0083183    .0064086
         dzs |   .0002178   .0006077     0.36   0.720    -.0009748    .0014105
       dzsc4 |  -.0017553   .0015436    -1.14   0.256    -.0047847    .0012741
         deq |  -.0070894    .001267    -5.60   0.000    -.0095759   -.0046028
       deqc4 |  -.0054875   .0040635    -1.35   0.177    -.0134626    .0024876
    foreign9 |   .0775921   .0259757     2.99   0.003     .0266117    .1285726
        lpop |  -1.222057   .6876862    -1.78   0.076    -2.571724    .1276106
       lgdpc |  -.7676483   .2863744    -2.68   0.007    -1.329693   -.2056038
          eu |    .035342   .0275031     1.29   0.199    -.0186362    .0893201
         oar |          0  (omitted)
     ospower |   .0965886   .0376038     2.57   0.010     .0227865    .1703907
     crindex |   .0569911    .026488     2.15   0.032     .0050052     .108977
      moralh |     .00256   .0378936     0.07   0.946    -.0718108    .0769308
     pmindex |  -.0664921   .0206335    -3.22   0.001     -.106988   -.0259963
         y04 |    .050224   .0254578     1.97   0.049     .0002601    .1001879
         y05 |   .0966648   .0353162     2.74   0.006     .0273524    .1659772
         y06 |   .1292575   .0489492     2.64   0.008     .0331888    .2253262
         y07 |   .1643151   .0655081     2.51   0.012     .0357475    .2928828
         y08 |   .2629767   .1134977     2.32   0.021     .0402238    .4857296
         y09 |   .2189562   .0995145     2.20   0.028     .0236469    .4142654
         y10 |    .245667   .1012401     2.43   0.015     .0469712    .4443629
         y11 |   .2329565   .1061714     2.19   0.028     .0245822    .4413308
         y12 |   .2157787   .1045512     2.06   0.039     .0105844     .420973
          c4 |          0  (omitted)
       _cons |   10.85567   4.113087     2.64   0.008     2.783238     18.9281
-------------+----------------------------------------------------------------
     sigma_u |  1.6359689
     sigma_e |   .1386139
         rho |  .99287218   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(147, 894) =     4.22            Prob > F = 0.0000
```

Table A.6.7: Printout of the alternative dynamic panel model specification examining the systemic variation in determinants across different size-classes (only bank-specific variables are interacted with the four biggest banks in each country)

```
. reg lmsa l.lmsa leff leffc4 bden10 bden10c4 dzs dzsc4 deq deqc4 foreign9 lpop lgdpc eu oar
ospower crindex moralh pmindex y04 y05 y06 y07 y08 y09 y10 y11 y12 c4

      Source |       SS       df       MS              Number of obs =    1068
-------------+------------------------------           F( 28,  1039) = 2375.29
       Model |  1855.51745    28  66.2684804           Prob > F      =  0.0000
    Residual |  28.9872064  1039   .02789914           R-squared     =  0.9846
-------------+------------------------------           Adj R-squared =  0.9842
       Total |  1884.50466  1067  1.76617119           Root MSE      =  .16703

------------------------------------------------------------------------------
        lmsa |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lmsa |
         L1. |   .9459217   .0068325   138.44   0.000     .9325146    .9593288
             |
        leff |  -.0712842   .0858752    -0.83   0.407    -.2397927    .0972243
      leffc4 |  -.3664003   .2189415    -1.67   0.095    -.7960182    .0632176
      bden10 |   .0010009   .0009866     1.01   0.311    -.0009351     .002937
    bden10c4 |  -.0004254   .0011668    -0.36   0.716    -.0027149    .0018641
         dzs |  -.0002701   .0001555    -1.74   0.083    -.0005753    .0000351
       dzsc4 |   .0023461   .0005653     4.15   0.000     .0012368    .0034554
         deq |  -.0034157   .0006082    -5.62   0.000     -.004609   -.0022223
       deqc4 |  -.0100129   .0027236    -3.68   0.000    -.0153573   -.0046685
    foreign9 |   .0453882   .0118275     3.84   0.000     .0221797    .0685967
        lpop |   .1448536   .0471944     3.07   0.002     .0522464    .2374609
       lgdpc |   -.032954   .0182922    -1.80   0.072    -.0688479    .0029399
          eu |   .0565938   .0213678     2.65   0.008     .0146649    .0985228
         oar |   .0258724   .0227685     1.14   0.256     -.018805    .0705498
     ospower |    -.00791   .0065495    -1.21   0.227    -.0207618    .0049418
     crindex |  -.0044474   .0110983    -0.40   0.689    -.0262251    .0173303
      moralh |  -.0202446   .0207874    -0.97   0.330    -.0610347    .0205455
     pmindex |  -.0155451    .011743    -1.32   0.186    -.0385878    .0074975
         y04 |   .0170133   .0244192     0.70   0.486    -.0309033      .06493
         y05 |   .0322675   .0238258     1.35   0.176    -.0144846    .0790196
         y06 |   .0127798   .0240303     0.53   0.595    -.0343736    .0599333
         y07 |  -.0000237   .0241698    -0.00   0.999    -.0474509    .0474034
         y08 |  -.0460577   .0386682    -1.19   0.234    -.1219343    .0298188
         y09 |  -.0522663   .0381706    -1.37   0.171    -.1271666     .022634
         y10 |    -.03324   .0387154    -0.86   0.391    -.1092094    .0427293
         y11 |  -.0540854    .039256    -1.38   0.169    -.1311155    .0229447
         y12 |  -.0752102   .0410197    -1.83   0.067    -.1557012    .0052808
          c4 |   1.647071   .9794546     1.68   0.093    -.2748633    3.569006
       _cons |   .0798839   .4184505     0.19   0.849    -.7412206    .9009884
------------------------------------------------------------------------------
```

Table A.6.8 Printout of the alternative dynamic panel model specification examining the systemic variation in determinants across different size-classes (only regulatory and supervisory practices are interacted with the four biggest banks in each country)

```
. xtabond2 lmsa l.lmsa leff bden10 dzs deq foreign9 lpop lgdpc eu oar oarc4 ospower ospowerc4
crindex crindexc4 moralh moralhc4 pmindex pmindexc4 c4 y04 y05 y06 y07 y08 y09 y10 y11 y12,
gmm(l.lmsa, lag(3 3)coll) gmm(leff, lag(2 2)coll) gmm(bden10, lag(2 2)coll) gmm(dzs, lag(4
.)coll) gmm(deq, lag(2 2)coll) iv(foreign9 lpop lgdpc eu) iv(oar oarc4 ospower ospowerc4
crindex crindexc4 moralh moralhc4 pmindex pmindexc4 c4) iv(y04 y05 y06 y07 y08 y09 y10 y11
y12) two robust orthogonal
Favoring speed over space. To switch, type or click on mata: mata set matafavor space, perm.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      1069
Time variable : year                            Number of groups   =       148
Number of instruments = 41                      Obs per group: min =         1
Wald chi2(29) =  12012.43                                      avg =      7.22
Prob > chi2   =     0.000                                      max =        10
------------------------------------------------------------------------------
             |              Corrected
        lmsa |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lmsa |
         L1. |   .8271412   .0506185    16.34   0.000     .7279308    .9263517
             |
        leff |    .327164   .5860441     0.56   0.577    -.8214613    1.475789
      bden10 |    .017055   .0073454     2.32   0.020     .0026583    .0314517
         dzs |  -.0015289   .0005897    -2.59   0.010    -.0026847   -.0003731
         deq |  -.0072128    .003174    -2.27   0.023    -.0134337    -.000992
    foreign9 |       .072   .0421507     1.71   0.088    -.0106138    .1546138
        lpop |   .0618039   .0984335     0.63   0.530    -.1311221    .2547299
       lgdpc |  -.0607379   .0467501    -1.30   0.194    -.1523664    .0308905
          eu |   .0488753   .0357442     1.37   0.172    -.0211821    .1189327
         oar |   .1124461   .0446492     2.52   0.012     .0249353     .199957
       oarc4 |  -.0834744   .0793732    -1.05   0.293    -.2390431    .0720942
     ospower |  -.0273036   .0127224    -2.15   0.032    -.0522391   -.0023682
   ospowerc4 |   .0061418   .0221031     0.28   0.781    -.0371795    .0494632
     crindex |  -.0261539   .0177889    -1.47   0.141    -.0610196    .0087117
   crindexc4 |   -.034935   .0320509    -1.09   0.276    -.0977536    .0278836
      moralh |  -.0707007   .0504182    -1.40   0.161    -.1695185    .0281171
    moralhc4 |   .0798583     .06583     1.21   0.225    -.0491662    .2088827
     pmindex |   -.020966   .0249305    -0.84   0.400    -.0698289     .027897
   pmindexc4 |  -.0168773   .0561529    -0.30   0.764     -.126935    .0931804
          c4 |   .7391124   .6983643     1.06   0.290    -.6296565    2.107881
         y04 |   .0155587   .0212548     0.73   0.464       -.0261    .0572174
         y05 |  -.0008535   .0256792    -0.03   0.973    -.0511839    .0494769
         y06 |  -.0350442   .0265004    -1.32   0.186    -.0869841    .0168957
         y07 |  -.0613501   .0305916    -2.01   0.045    -.1213086   -.0013916
         y08 |  -.1669199   .0628517    -2.66   0.008     -.290107   -.0437329
         y09 |  -.1892781   .0634691    -2.98   0.003    -.3136753   -.0648809
         y10 |  -.1639691     .06129    -2.68   0.007    -.2840953   -.0438428
         y11 |  -.1880611   .0611385    -3.08   0.002    -.3078903   -.0682319
         y12 |  -.1997679   .0615924    -3.24   0.001    -.3204868    -.079049
       _cons |  -1.209122   2.548733    -0.47   0.635    -6.204546    3.786302
------------------------------------------------------------------------------
Instruments for orthogonal deviations equation
  Standard
    FOD.(y04 y05 y06 y07 y08 y09 y10 y11 y12)
    FOD.(oar oarc4 ospower ospowerc4 crindex crindexc4 moralh moralhc4 pmindex
    pmindexc4 c4)
    FOD.(foreign9 lpop lgdpc eu)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L2.deq collapsed
    L(4/10).dzs collapsed
    L2.bden10 collapsed
    L2.leff collapsed
    L3.L.lmsa collapsed
Instruments for levels equation
```

```
  Standard
    y04 y05 y06 y07 y08 y09 y10 y11 y12
    oar oarc4 ospower ospowerc4 crindex crindexc4 moralh moralhc4 pmindex
    pmindexc4 c4
    foreign9 lpop lgdpc eu
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.deq collapsed
    DL3.dzs collapsed
    DL.bden10 collapsed
    DL.leff collapsed
    DL2.L.lmsa collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -3.93  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -0.59  Pr > z =  0.554
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(11)   =   4.81  Prob > chi2 =  0.940
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(11)   =   8.04  Prob > chi2 =  0.710
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(6)    =   6.16  Prob > chi2 =  0.405
    Difference (null H = exogenous): chi2(5)    =   1.88  Prob > chi2 =  0.866
  gmm(L.lmsa, collapse lag(3 3))
    Hansen test excluding group:     chi2(9)    =   7.13  Prob > chi2 =  0.623
    Difference (null H = exogenous): chi2(2)    =   0.90  Prob > chi2 =  0.636
  gmm(leff, collapse lag(2 2))
    Hansen test excluding group:     chi2(9)    =   7.42  Prob > chi2 =  0.593
    Difference (null H = exogenous): chi2(2)    =   0.62  Prob > chi2 =  0.735
  gmm(bden10, collapse lag(2 2))
    Hansen test excluding group:     chi2(9)    =   7.17  Prob > chi2 =  0.620
    Difference (null H = exogenous): chi2(2)    =   0.87  Prob > chi2 =  0.647
  gmm(dzs, collapse lag(4 .))
    Hansen test excluding group:     chi2(3)    =   0.43  Prob > chi2 =  0.933
    Difference (null H = exogenous): chi2(8)    =   7.61  Prob > chi2 =  0.473
  gmm(deq, collapse lag(2 2))
    Hansen test excluding group:     chi2(9)    =   5.88  Prob > chi2 =  0.751
    Difference (null H = exogenous): chi2(2)    =   2.15  Prob > chi2 =  0.341
  iv(foreign9 lpop lgdpc eu)
    Hansen test excluding group:     chi2(7)    =   2.94  Prob > chi2 =  0.890
    Difference (null H = exogenous): chi2(4)    =   5.10  Prob > chi2 =  0.278
  iv(oar oarc4 ospower ospowerc4 crindex crindexc4 moralh moralhc4 pmindex pmindexc4 c4)
    Hansen test excluding group:     chi2(0)    =   0.00  Prob > chi2 =      .
    Difference (null H = exogenous): chi2(11)   =   8.04  Prob > chi2 =  0.710
  iv(y04 y05 y06 y07 y08 y09 y10 y11 y12)
    Hansen test excluding group:     chi2(2)    =   0.05  Prob > chi2 =  0.975
    Difference (null H = exogenous): chi2(9)    =   7.99  Prob > chi2 =  0.535


. lincom oar+oarc4

 ( 1)  oar + oarc4 = 0

------------------------------------------------------------------------------
        lmsa |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   .0289717   .0750896     0.39   0.700    -.1182013    .1761447
------------------------------------------------------------------------------

. lincom ospower+ospowerc4

 ( 1)  ospower + ospowerc4 = 0

------------------------------------------------------------------------------
        lmsa |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |  -.0211618   .0199108    -1.06   0.288    -.0601864    .0178627
------------------------------------------------------------------------------
```

```
. lincom crindex+crindexc4

 ( 1)  crindex + crindexc4 = 0

------------------------------------------------------------------------------
        lmsa |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |  -.0610889   .0280271    -2.18   0.029    -.1160211   -.0061568
------------------------------------------------------------------------------

. lincom pmindex + pmindexc4

 ( 1)  pmindex + pmindexc4 = 0

------------------------------------------------------------------------------
        lmsa |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |  -.0378433   .0481224    -0.79   0.432    -.1321614    .0564748
------------------------------------------------------------------------------

. lincom moralh+moralhc4

 ( 1)  moralh + moralhc4 = 0

------------------------------------------------------------------------------
        lmsa |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   .0091576   .0676204     0.14   0.892     -.123376    .1416911
------------------------------------------------------------------------------
```

Table A.6.9: Printout of the alternative dynamic panel model specification examining the systemic variation in determinants across different size-classes (only regulatory and supervisory practices are interacted with the four biggest banks in each country) (using fixed-effects)

```
xtreg lmsa l.lmsa leff bden10 dzs deq foreign9 lpop lgdpc eu oar oarc4 ospower ospowerc4
crindex crindexc4 moralh moralhc4 pmindex pmindexc4 c4 y04 y05 y06 y07 y08 y09 y10 y11 y12, fe
note: oar omitted because of collinearity
note: oarc4 omitted because of collinearity
note: c4 omitted because of collinearity

Fixed-effects (within) regression               Number of obs      =      1069
Group variable: id                              Number of groups   =       148

R-sq:  within  = 0.6588                         Obs per group: min =         1
       between = 0.8017                                        avg =       7.2
       overall = 0.7724                                        max =        10

                                                F(26,895)          =     66.46
corr(u_i, Xb)  = -0.4531                        Prob > F           =    0.0000

------------------------------------------------------------------------------
        lmsa |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lmsa |
         L1. |    .663117   .0197416    33.59   0.000     .6243718    .7018622
             |
        leff |   .0296949   .1143484     0.26   0.795    -.1947273    .2541171
      bden10 |   .0062221   .0022583     2.76   0.006     .0017899    .0106544
         dzs |   .0003327   .0005824     0.57   0.568    -.0008102    .0014757
         deq |  -.0082752   .0012135    -6.82   0.000    -.0106568   -.0058935
    foreign9 |   .0884352   .0259685     3.41   0.001     .0374689    .1394015
        lpop |  -1.213924   .6856533    -1.77   0.077      -2.5596    .1317512
       lgdpc |  -.7869887   .2849309    -2.76   0.006    -1.346199   -.2277781
          eu |   .0379334   .0274308     1.38   0.167    -.0159028    .0917695
         oar |          0  (omitted)
       oarc4 |          0  (omitted)
     ospower |    .100552   .0385211     2.61   0.009     .0249497    .1761543
   ospowerc4 |   .0144062    .052808     0.27   0.785    -.0892358    .1180481
     crindex |   .0400592   .0271889     1.47   0.141    -.0133022    .0934205
   crindexc4 |   .0548503   .0307097     1.79   0.074    -.0054211    .1151217
      moralh |   .0283295   .0398782     0.71   0.478    -.0499361    .1065951
    moralhc4 |  -.0596991   .0494695    -1.21   0.228    -.1567889    .0373906
     pmindex |  -.0997658   .0226313    -4.41   0.000    -.1441824   -.0553492
   pmindexc4 |   .0861596   .0415887     2.07   0.039     .0045369    .1677823
          c4 |          0  (omitted)
         y04 |   .0499366   .0253848     1.97   0.049      .000116    .0997572
         y05 |   .0929588   .0351942     2.64   0.008      .023886    .1620317
         y06 |   .1267663   .0486618     2.61   0.009     .0312617    .2222709
         y07 |   .1615745   .0651378     2.48   0.013     .0337339    .2894152
         y08 |   .2625629   .1131641     2.32   0.021     .0404649    .4846609
         y09 |   .2159091   .0992567     2.18   0.030     .0211061    .4107121
         y10 |   .2429282   .1009571     2.41   0.016     .0447878    .4410685
         y11 |   .2262618   .1058746     2.14   0.033     .0184704    .4340533
         y12 |   .2064618   .1042206     1.98   0.048     .0019166    .4110069
       _cons |   11.04424   4.080409     2.71   0.007     3.035955    19.05252
-------------+----------------------------------------------------------------
     sigma_u |  .64698741
     sigma_e |  .13858557
         rho |  .95613061   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(147, 895) =     4.31             Prob > F = 0.0000
```

Table A.6.10: Printout of the alternative dynamic panel model specification examining the systemic variation in determinants across different size-classes (only regulatory and supervisory practices are interacted with the four biggest banks in each country)(using OLS)

```
reg lmsa l.lmsa leff bden10 dzs deq foreign9 lpop lgdpc eu oar oarc4 ospower ospowerc4 crindex
crindexc4 moralh moralhc4 pmindex pmindexc4 c4 y04 y05 y06 y07 y08 y09 y10 y11 y12

      Source |       SS       df       MS              Number of obs =    1069
-------------+------------------------------           F( 29,  1039) = 2268.94
       Model |   1856.5393    29  64.0185966           Prob > F      =  0.0000
    Residual |  29.3155846  1039  .028215192           R-squared     =  0.9845
-------------+------------------------------           Adj R-squared =  0.9840
       Total |  1885.85489  1068  1.76578173           Root MSE      =  .16797

------------------------------------------------------------------------------
        lmsa |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lmsa |
         L1. |   .9468567   .0068814   137.60   0.000     .9333536    .9603599
             |
        leff |  -.1289463    .080644    -1.60   0.110    -.2871899    .0292973
      bden10 |    .000342   .0006984     0.49   0.624    -.0010285    .0017125
         dzs |  -.0001565   .0001524    -1.03   0.305    -.0004556    .0001426
         deq |  -.0038509   .0005948    -6.47   0.000     -.005018   -.0026839
    foreign9 |   .0489052   .0117507     4.16   0.000     .0258474    .0719629
        lpop |   .1613602   .0488949     3.30   0.001     .0654163    .2573042
       lgdpc |  -.0258983   .0185078    -1.40   0.162    -.0622152    .0104186
          eu |   .0624658   .0214918     2.91   0.004     .0202934    .1046381
         oar |   .0245989   .0238944     1.03   0.303    -.0222878    .0714857
       oarc4 |  -.0021102   .0340957    -0.06   0.951    -.0690144    .0647941
     ospower |  -.0089148   .0070361    -1.27   0.205    -.0227213    .0048918
   ospowerc4 |  -.0039739   .0104487    -0.38   0.704     -.024477    .0165291
     crindex |  -.0059084   .0114992    -0.51   0.607    -.0284726    .0166559
   crindexc4 |   -.025679   .0158853    -1.62   0.106      -.05685    .0054919
      moralh |  -.0221183   .0216701    -1.02   0.308    -.0646404    .0204038
    moralhc4 |   .0422878   .0248495     1.70   0.089    -.0064731    .0910486
     pmindex |  -.0296801   .0128108    -2.32   0.021    -.0548181    -.004542
   pmindexc4 |   .0431121   .0191552     2.25   0.025     .0055247    .0806994
          c4 |  -.0494616   .1514535    -0.33   0.744    -.3466513     .247728
         y04 |   .0160936    .024558     0.66   0.512    -.0320953    .0642825
         y05 |   .0249624   .0238803     1.05   0.296    -.0218967    .0718215
         y06 |   .0043277   .0240279     0.18   0.857    -.0428211    .0514765
         y07 |  -.0083008   .0241605    -0.34   0.731    -.0557099    .0391082
         y08 |  -.0584018   .0386852    -1.51   0.131    -.1343118    .0175081
         y09 |  -.0643587   .0381774    -1.69   0.092    -.1392722    .0105548
         y10 |  -.0421409   .0386436    -1.09   0.276    -.1179692    .0336875
         y11 |   -.066673   .0391785    -1.70   0.089     -.143551    .0102049
         y12 |   -.091252   .0408191    -2.24   0.026    -.1713493   -.0111547
       _cons |   .3317843   .3959859     0.84   0.402     -.445239    1.108808
------------------------------------------------------------------------------
```

6.5 ALTERNATIVE MODEL SPECIFICATION (PRINTOUTS: DIFFERENT RISK-TAKING BEHAVIOUR

Table A.6.11: Printout of the alternative dynamic panel model specification: Is there systematic variation in regulatory and supervisory practices across different risk-taking behaviour (the bank-level effect)?

```
. xtabond2 lmsa l.lmsa leff bden10 dzs deq foreign9 lpop lgdpc eu oar oarrisk ospower
ospowerrisk crindex crindexrisk moralh moralhrisk pmindex pmindexrisk y04 y05 y06 y07 y08 y09
y10 y11 y12, gmm(l.lmsa, lag(3 4)coll) gmm(leff, lag(2 2)coll) gmm(bden10,lag(2 3)coll)
gmm(dzs, lag(2 3)coll) gmm(deq, lag(3 3)coll) gmm(oarrisk, lag(2 3)coll) gmm(ospowerrisk,
lag(3 6)coll) gmm(crindexrisk, lag(3 6)coll) gmm(moralhrisk, lag(3 .)coll) gmm(pmindexrisk,
lag(3 5)coll) iv(foreign9 lpop lgdpc eu) iv(oar ospower crindex moralh pmindex) iv(y04 y05 y06
y07 y08 y09 y10 y11 y12) two robust orthogonal
Favoring space over speed. To switch, type or click on mata: mata set matafavor speed, perm.
Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      1069
Time variable : year                            Number of groups   =       148
Number of instruments = 58                      Obs per group: min =         1
Wald chi2(28) =   6980.07                                      avg =      7.22
Prob > chi2   =     0.000                                      max =        10
------------------------------------------------------------------------------
             |              Corrected
        lmsa |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lmsa |
         L1. |   .8756762   .0383872    22.81   0.000     .8004387    .9509137
             |
        leff |   .1454218   .6360844     0.23   0.819    -1.101281    1.392124
      bden10 |   .0190698   .0069023     2.76   0.006     .0055416    .0325979
         dzs |   .0245805   .0199514     1.23   0.218    -.0145236    .0636846
         deq |  -.0092229   .0030562    -3.02   0.003     -.015213   -.0032329
    foreign9 |   .0688434   .0430629     1.60   0.110    -.0155583    .1532451
        lpop |    .153104   .2026691     0.76   0.450    -.2441202    .5503282
       lgdpc |  -.0580044   .0517141    -1.12   0.262    -.1593621    .0433534
          eu |   .0484716    .030058     1.61   0.107    -.0104409    .1073841
         oar |    .056671   .0624452     0.91   0.364    -.0657193    .1790613
     oarrisk |   .0041668   .0023079     1.81   0.071    -.0003566    .0086902
     ospower |  -.0086711   .0188471    -0.46   0.645    -.0456107    .0282685
 ospowerrisk |  -.0031206   .0010719    -2.91   0.004    -.0052214   -.0010197
     crindex |  -.0281949   .0241457    -1.17   0.243    -.0755195    .0191298
 crindexrisk |  -.0027923   .0012592    -2.22   0.027    -.0052603   -.0003244
      moralh |  -.0143072   .0512301    -0.28   0.780    -.1147164    .0861019
  moralhrisk |   .0076984   .0036329     2.12   0.034     .0005781    .0148188
     pmindex |  -.0406303   .0200732    -2.02   0.043    -.0799731   -.0012875
 pmindexrisk |  -.0022021   .0018171    -1.21   0.226    -.0057636    .0013593
         y04 |  -.0128501   .0219021    -0.59   0.557    -.0557775    .0300773
         y05 |  -.0092885   .0284692    -0.33   0.744    -.0650871    .0465101
         y06 |  -.0518922   .0283549    -1.83   0.067    -.1074667    .0036824
         y07 |  -.0843747   .0330778    -2.55   0.011     -.149206   -.0195433
         y08 |  -.1464798   .0813053    -1.80   0.072    -.3058352    .0128755
         y09 |  -.1843078   .0835477    -2.21   0.027    -.3480582   -.0205574
         y10 |  -.1501583   .0812784    -1.85   0.065     -.309461    .0091445
         y11 |  -.1761175    .085131    -2.07   0.039    -.3429712   -.0092638
         y12 |  -.1908724   .0844121    -2.26   0.024    -.3563171   -.0254278
       _cons |  -.6502145   2.747609    -0.24   0.813    -6.035429       4.735
```

```
------------------------------------------------------------------------------
Instruments for orthogonal deviations equation
  Standard
    FOD.(y04 y05 y06 y07 y08 y09 y10 y11 y12)
    FOD.(oar ospower crindex moralh pmindex)
    FOD.(foreign9 lpop lgdpc eu)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(3/5).pmindexrisk collapsed
    L(3/10).moralhrisk collapsed
    L(3/6).crindexrisk collapsed
    L(3/6).ospowerrisk collapsed
    L(2/3).oarrisk collapsed
    L3.deq collapsed
    L(2/3).dzs collapsed
    L(2/3).bden10 collapsed
    L2.leff collapsed
    L(3/4).L.lmsa collapsed
Instruments for levels equation
  Standard
    y04 y05 y06 y07 y08 y09 y10 y11 y12
    oar ospower crindex moralh pmindex
    foreign9 lpop lgdpc eu
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL2.pmindexrisk collapsed
    DL2.moralhrisk collapsed
    DL2.crindexrisk collapsed
    DL2.ospowerrisk collapsed
    DL.oarrisk collapsed
    DL2.deq collapsed
    DL.dzs collapsed
    DL.bden10 collapsed
    DL.leff collapsed
    DL2.L.lmsa collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -3.38  Pr > z =  0.001
Arellano-Bond test for AR(2) in first differences: z =  -0.72  Pr > z =  0.470
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(29)   =  19.15  Prob > chi2 =  0.917
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(29)   =  25.81  Prob > chi2 =  0.636
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(19)   =  19.15  Prob > chi2 =  0.447
    Difference (null H = exogenous): chi2(10)   =   6.66  Prob > chi2 =  0.758
  gmm(L.lmsa, collapse lag(3 4))
    Hansen test excluding group:     chi2(26)   =  21.25  Prob > chi2 =  0.729
    Difference (null H = exogenous): chi2(3)    =   4.56  Prob > chi2 =  0.207
  gmm(leff, collapse lag(2 2))
    Hansen test excluding group:     chi2(27)   =  25.38  Prob > chi2 =  0.553
    Difference (null H = exogenous): chi2(2)    =   0.42  Prob > chi2 =  0.809
  gmm(bden10, collapse lag(2 3))
    Hansen test excluding group:     chi2(26)   =  24.00  Prob > chi2 =  0.576
    Difference (null H = exogenous): chi2(3)    =   1.80  Prob > chi2 =  0.614
  gmm(dzs, collapse lag(2 3))
    Hansen test excluding group:     chi2(26)   =  23.37  Prob > chi2 =  0.612
    Difference (null H = exogenous): chi2(3)    =   2.43  Prob > chi2 =  0.488
  gmm(deq, collapse lag(3 3))
    Hansen test excluding group:     chi2(27)   =  24.07  Prob > chi2 =  0.626
    Difference (null H = exogenous): chi2(2)    =   1.73  Prob > chi2 =  0.420
  gmm(oarrisk, collapse lag(2 3))
```

```
  Hansen test excluding group:     chi2(26)   =  23.75  Prob > chi2 =  0.590
  Difference (null H = exogenous): chi2(3)    =   2.05  Prob > chi2 =  0.561
gmm(ospowerrisk, collapse lag(3 6))
  Hansen test excluding group:     chi2(24)   =  21.39  Prob > chi2 =  0.616
  Difference (null H = exogenous): chi2(5)    =   4.42  Prob > chi2 =  0.491
gmm(crindexrisk, collapse lag(3 6))
  Hansen test excluding group:     chi2(24)   =  21.70  Prob > chi2 =  0.597
  Difference (null H = exogenous): chi2(5)    =   4.10  Prob > chi2 =  0.535
gmm(moralhrisk, collapse lag(3 .))
  Hansen test excluding group:     chi2(20)   =  17.29  Prob > chi2 =  0.634
  Difference (null H = exogenous): chi2(9)    =   8.52  Prob > chi2 =  0.483
gmm(pmindexrisk, collapse lag(3 5))
  Hansen test excluding group:     chi2(25)   =  24.68  Prob > chi2 =  0.480
  Difference (null H = exogenous): chi2(4)    =   1.12  Prob > chi2 =  0.891
iv(foreign9 lpop lgdpc eu)
  Hansen test excluding group:     chi2(25)   =  21.96  Prob > chi2 =  0.638
  Difference (null H = exogenous): chi2(4)    =   3.85  Prob > chi2 =  0.427
iv(oar ospower crindex moralh pmindex)
  Hansen test excluding group:     chi2(24)   =  22.15  Prob > chi2 =  0.570
  Difference (null H = exogenous): chi2(5)    =   3.66  Prob > chi2 =  0.600
iv(y04 y05 y06 y07 y08 y09 y10 y11 y12)
  Hansen test excluding group:     chi2(20)   =  15.11  Prob > chi2 =  0.770
  Difference (null H = exogenous): chi2(9)    =  10.70  Prob > chi2 =  0.297
```

MARGINAL EFFECTS

OAR

```
. margins oar, at (dzs=( -32 (38) 545)) force vsquish noestimcheck
(note: default prediction is a function of possibly stochastic quantities other than e(b))

Predictive margins                                Number of obs   =       1069
Model VCE    : Corrected

Expression   : Fitted Values, predict()
1._at        : dzs             =         -32
2._at        : dzs             =           6
3._at        : dzs             =          44
4._at        : dzs             =          82
5._at        : dzs             =         120
6._at        : dzs             =         158
7._at        : dzs             =         196
8._at        : dzs             =         234
9._at        : dzs             =         272
10._at       : dzs             =         310
11._at       : dzs             =         348
12._at       : dzs             =         386
13._at       : dzs             =         424
14._at       : dzs             =         462
15._at       : dzs             =         500
16._at       : dzs             =         538

------------------------------------------------------------------------------
             |            Delta-method
             |     Margin   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     _at#oar |
        1 6  |  -1.295854   1.035412    -1.25   0.211    -3.325223    .7335158
        1 7  |  -1.226577    1.59428    -0.77   0.442    -4.351308    1.898154
        1 8  |   -1.41478   1.040256    -1.36   0.174    -3.453645    .6240849
        2 6  |   .7260781   .1034217     7.02   0.000     .5233752    .9287809
        2 7  |   .8970316   .1896884     4.73   0.000     .5252491    1.268814
        2 8  |   .9225874   .0796129    11.59   0.000      .766549    1.078626
        3 6  |    2.74801   .9188491     2.99   0.003     .9470985    4.548921
        3 7  |    3.02064   1.829001     1.65   0.099    -.5641358    6.605416
        3 8  |   3.259955   1.091614     2.99   0.003      1.12043    5.399479
        4 6  |   4.769941   1.890196     2.52   0.012     1.065226    8.474657
        4 7  |   5.144248    3.53122     1.46   0.145    -1.776816    12.06531
        4 8  |   5.597322   2.153598     2.60   0.009     1.376348    9.818296
        5 6  |   6.791873   2.862929     2.37   0.018     1.180634    12.40311
        5 7  |   7.267857   5.235341     1.39   0.165    -2.993223    17.52894
        5 8  |   7.934689    3.21643     2.47   0.014     1.630602    14.23878
        6 6  |   8.813804   3.835995     2.30   0.022     1.295392    16.33222
        6 7  |   9.391465   6.939963     1.35   0.176    -4.210612    22.99354
        6 8  |   10.27206   4.279479     2.40   0.016     1.884432    18.65968
        7 6  |   10.83574   4.809191     2.25   0.024     1.409894    20.26158
        7 7  |   11.51507   8.644789     1.33   0.183    -5.428402    28.45855
        7 8  |   12.60942   5.342615     2.36   0.018      2.13809    23.08076
        8 6  |   12.85767   5.782452     2.22   0.026      1.52427    24.19107
        8 7  |   13.63868   10.34972     1.32   0.188    -6.646395    33.92376
        8 8  |   14.94679   6.405795     2.33   0.020     2.391663    27.50192
        9 6  |    14.8796   6.755749     2.20   0.028     1.638573    28.12062
        9 7  |   15.76229   12.05471     1.31   0.191    -7.864505    39.38909
        9 8  |   17.28416      7.469     2.31   0.021     2.645187    31.92313
       10 6  |   16.90153    7.72907     2.19   0.029     1.752832    32.05023
       10 7  |    17.8859   13.75974     1.30   0.194    -9.082688    44.85449
       10 8  |   19.62153   8.532221     2.30   0.021      2.89868    36.34437
```

11 6	18.92346	8.702405	2.17	0.030	1.867062	35.97986
11 7	20.00951	15.46479	1.29	0.196	-10.30092	50.31994
11 8	21.95889	9.595452	2.29	0.022	3.152152	40.76563
12 6	20.94539	9.675751	2.16	0.030	1.98127	39.90952
12 7	22.13312	17.16986	1.29	0.197	-11.51919	55.78542
12 8	24.29626	10.65869	2.28	0.023	3.40561	45.18691
13 6	22.96733	10.6491	2.16	0.031	2.095463	43.83919
13 7	24.25672	18.87494	1.29	0.199	-12.73748	61.25093
13 8	26.63363	11.72193	2.27	0.023	3.659057	49.6082
14 6	24.98926	11.62246	2.15	0.032	2.209645	47.76887
14 7	26.38033	20.58003	1.28	0.200	-13.95579	66.71645
14 8	28.97099	12.78518	2.27	0.023	3.912497	54.02949
15 6	27.01119	12.59583	2.14	0.032	2.323819	51.69856
15 7	28.50394	22.28513	1.28	0.201	-15.17411	72.182
15 8	31.30836	13.84843	2.26	0.024	4.16593	58.45079
16 6	29.03312	13.5692	2.14	0.032	2.437986	55.62825
16 7	30.62755	23.99024	1.28	0.202	-16.39245	77.64755
16 8	33.64573	14.91169	2.26	0.024	4.419359	62.8721

OSPOWERRISK

```
. margins, dydx(ospower) at (dzs=( -32 (38) 545)) force vsquish noestimcheck
(note: default prediction is a function of possibly stochastic quantities other than e(b))

Average marginal effects                          Number of obs   =       1069
Model VCE    : Corrected

Expression   : Fitted Values, predict()
dy/dx w.r.t. : ospower
1._at        : dzs             =         -32
2._at        : dzs             =           6
3._at        : dzs             =          44
4._at        : dzs             =          82
5._at        : dzs             =         120
6._at        : dzs             =         158
7._at        : dzs             =         196
8._at        : dzs             =         234
9._at        : dzs             =         272
10._at       : dzs             =         310
11._at       : dzs             =         348
12._at       : dzs             =         386
13._at       : dzs             =         424
14._at       : dzs             =         462
15._at       : dzs             =         500
16._at       : dzs             =         538

------------------------------------------------------------------------------
             |            Delta-method
             |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ospower      |
         _at |
          1  |   .0911874   .0365412     2.50   0.013     .0195679    .1628069
          2  |  -.0273945   .0208185    -1.32   0.188     -.068198    .0134089
          3  |  -.1459765   .0533823    -2.73   0.006    -.2506038   -.0413492
          4  |  -.2645584     .09265    -2.86   0.004    -.4461491   -.0829677
          5  |  -.3831403   .1328025    -2.89   0.004    -.6434284   -.1228523
          6  |  -.5017223   .1732255    -2.90   0.004     -.841238   -.1622065
          7  |  -.6203042   .2137657    -2.90   0.004    -1.039277   -.2013312
          8  |  -.7388861    .254367    -2.90   0.004    -1.237436   -.2403361
          9  |  -.8574681   .2950042    -2.91   0.004    -1.435666   -.2792706
         10  |    -.97605   .3356642    -2.91   0.004     -1.63394   -.3181603
         11  |  -1.094632   .3763397    -2.91   0.004    -1.832244   -.3570197
         12  |  -1.213214   .4170261    -2.91   0.004     -2.03057   -.3958577
         13  |  -1.331796   .4577206    -2.91   0.004    -2.228912     -.43468
         14  |  -1.450378   .4984211    -2.91   0.004    -2.427265   -.4734904
         15  |   -1.56896   .5391262    -2.91   0.004    -2.625628   -.5122917
         16  |  -1.687542   .5798351    -2.91   0.004    -2.823998   -.5510857
------------------------------------------------------------------------------
```

CRINDEXRISK

```
. margins, dydx(crindex) at (dzs=( -32 (38) 545)) force vsquish noestimcheck
(note: default prediction is a function of possibly stochastic quantities other than e(b))

Average marginal effects                          Number of obs   =       1069
Model VCE    : Corrected

Expression   : Fitted Values, predict()
dy/dx w.r.t. : crindex
1._at        : dzs             =         -32
2._at        : dzs             =           6
3._at        : dzs             =          44
4._at        : dzs             =          82
5._at        : dzs             =         120
6._at        : dzs             =         158
7._at        : dzs             =         196
8._at        : dzs             =         234
9._at        : dzs             =         272
10._at       : dzs             =         310
11._at       : dzs             =         348
12._at       : dzs             =         386
13._at       : dzs             =         424
14._at       : dzs             =         462
15._at       : dzs             =         500
16._at       : dzs             =         538

------------------------------------------------------------------------------
             |            Delta-method
             |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
crindex      |
         _at |
          1  |   .0611593   .0453472     1.35   0.177    -.0277197    .1500383
          2  |  -.0449488   .0258508    -1.74   0.082    -.0956154    .0057179
          3  |  -.1510568   .0621227    -2.43   0.015    -.2728151   -.0292986
          4  |  -.2571649   .1078391    -2.38   0.017    -.4685256   -.0458042
          5  |  -.3632729   .1548495    -2.35   0.019    -.6667724   -.0597734
          6  |   -.469381   .2022537    -2.32   0.020     -.865791    -.072971
          7  |   -.575489   .2498276    -2.30   0.021    -1.065142    -.085836
          8  |  -.6815971   .2974897    -2.29   0.022    -1.264666   -.0985279
          9  |  -.7877052   .3452036    -2.28   0.022    -1.464292   -.1111185
         10  |  -.8938132   .3929504    -2.27   0.023    -1.663982   -.1236446
         11  |  -.9999213   .4407194    -2.27   0.023    -1.863715   -.1361272
         12  |  -1.106029    .488504    -2.26   0.024     -2.06348    -.148579
         13  |  -1.212137   .5363002    -2.26   0.024    -2.263266   -.1610084
         14  |  -1.318245    .584105    -2.26   0.024     -2.46307   -.1734207
         15  |  -1.424353   .6319165    -2.25   0.024    -2.662887   -.1858199
         16  |  -1.530462   .6797333    -2.25   0.024    -2.862714   -.1982087
```

MORALH

```
. margins moralh, at (dzs=( -32 (38) 545)) force vsquish noestimcheck
(note: default prediction is a function of possibly stochastic quantities other than e(b))

Predictive margins                                Number of obs   =       1069
Model VCE    : Corrected

Expression   : Fitted Values, predict()
1._at        : dzs             =         -32
2._at        : dzs             =           6
3._at        : dzs             =          44
4._at        : dzs             =          82
5._at        : dzs             =         120
6._at        : dzs             =         158
7._at        : dzs             =         196
8._at        : dzs             =         234
9._at        : dzs             =         272
10._at       : dzs             =         310
11._at       : dzs             =         348
12._at       : dzs             =         386
13._at       : dzs             =         424
14._at       : dzs             =         462
15._at       : dzs             =         500
16._at       : dzs             =         538

------------------------------------------------------------------------------
             |            Delta-method
             |     Margin   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  _at#moralh |
        1 0  |  -.4339251   .9838082    -0.44   0.659    -2.362154    1.494304
        1 1  |  -.5416805   .9434972    -0.57   0.566    -2.390901     1.30754
        1 2  |  -.8296209   1.077745    -0.77   0.441    -2.941961     1.28272
        2 0  |   .8186692   .0824243     9.93   0.000     .6571205    .9802179
        2 1  |   .8233246   .0364839    22.57   0.000     .7518175    .8948316
        2 2  |   .8617646   .0396609    21.73   0.000     .7840307    .9394984
        3 0  |   2.071264   .9943813     2.08   0.037     .1223119    4.020215
        3 1  |    2.18833   .8903689     2.46   0.014     .4432386    3.933421
        3 2  |    2.55315   1.039395     2.46   0.014     .5159728    4.590327
        4 0  |   3.323858   1.978353     1.68   0.093    -.5536425    7.201358
        4 1  |   3.553335   1.806783     1.97   0.049     .0121055    7.094564
        4 2  |   4.244535   2.097103     2.02   0.043     .1342888    8.354782
        5 0  |   4.576452   2.963453     1.54   0.123    -1.231808    10.38471
        5 1  |    4.91834   2.723317     1.81   0.071    -.4192626    10.25594
        5 2  |   5.935921   3.155007     1.88   0.060    -.2477797    12.11962
        6 0  |   5.829047   3.948836     1.48   0.140     -1.91053    13.56862
        6 1  |   6.283345    3.63988     1.73   0.084    -.8506881    13.41738
        6 2  |   7.627306    4.21296     1.81   0.070    -.6299429    15.88456
        7 0  |   7.081641   4.934334     1.44   0.151    -2.589475    16.75276
        7 1  |    7.64835   4.556454     1.68   0.093    -1.282136    16.57884
        7 2  |   9.318692   5.270931     1.77   0.077    -1.012144    19.64953
        8 0  |   8.334235   5.919888     1.41   0.159    -3.268532      19.937
        8 1  |   9.013355   5.473035     1.65   0.100    -1.713596    19.74031
        8 2  |   11.01008   6.328913     1.74   0.082    -1.394364    23.41452
        9 0  |    9.58683   6.905475     1.39   0.165    -3.947653    23.12131
        9 1  |   10.37836   6.389618     1.62   0.104    -2.145062    22.90178
        9 2  |   12.70146     7.3869     1.72   0.086    -1.776594    27.17952
       10 0  |   10.83942   7.891083     1.37   0.170    -4.626814    26.30566
       10 1  |   11.74336   7.306204     1.61   0.108    -2.576532    26.06326
       10 2  |   14.39285    8.44489     1.70   0.088    -2.158832    30.94453
       11 0  |   12.09202   8.876704     1.36   0.173    -5.306001    29.49004
       11 1  |   13.10837   8.222791     1.59   0.111    -3.008005    29.22475
```

11 2	16.08423	9.502882	1.69	0.091	-2.541073	34.70954
12 0	13.34461	9.862334	1.35	0.176	-5.985207	32.67443
12 1	14.47338	9.13938	1.58	0.113	-3.43948	32.38623
12 2	17.77562	10.56088	1.68	0.092	-2.923318	38.47456
13 0	14.59721	10.84797	1.35	0.178	-6.664427	35.85884
13 1	15.83838	10.05597	1.58	0.115	-3.870956	35.54772
13 2	19.467	11.61887	1.68	0.094	-3.305565	42.23957
14 0	15.8498	11.83361	1.34	0.180	-7.343657	39.04326
14 1	17.20339	10.97256	1.57	0.117	-4.302433	38.7092
14 2	21.15839	12.67687	1.67	0.095	-3.687814	46.00459
15 0	17.1024	12.81926	1.33	0.182	-8.022894	42.22769
15 1	18.56839	11.88915	1.56	0.118	-4.733911	41.87069
15 2	22.84978	13.73486	1.66	0.096	-4.070064	49.76962
16 0	18.35499	13.80491	1.33	0.184	-8.702138	45.41212
16 1	19.9334	12.80574	1.56	0.120	-5.165389	45.03218
16 2	24.54116	14.79286	1.66	0.097	-4.452315	53.53464

6.6 CEHCK FOR ROBUSTNESS (PRITNOUTS)

Table A.6.12: Printout of dynamic panel system GMM estimation for the bank's market share determinants in SEECs, 2002-2012 (Dependent variable MSA)(check for robustness using ETR2T)

```
xtabond2 lmsa l.lmsa leff2 bden10 dzs deq foreign9 lpop lgdpc eu oar ospower crindex moralh
pmindex y04 y05 y06 y07 y08 y09 y10 y11 y12, gmm(l.lmsa, lag(3 3)coll) gmm(leff2, lag(2
3)coll) gmm(bden10, lag(2 2)coll) gmm(dzs, lag(4 .)coll) gmm(deq, lag(2 2)coll) iv(foreign9
lpop lgdpc eu) iv(oar ospower crindex moralh pmindex) iv(y04 y05 y06 y07 y08 y09 y10 y11 y12)
two robust orthogonal
Favoring space over speed. To switch, type or click on mata: mata set matafavor speed, perm.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      1069
Time variable : year                            Number of groups   =       148
Number of instruments = 36                      Obs per group: min =         1
Wald chi2(23) =   4465.78                                      avg =      7.22
Prob > chi2   =     0.000                                      max =        10
------------------------------------------------------------------------------
             |              Corrected
        lmsa |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lmsa |
         L1. |   .8642398   .0406795    21.25   0.000     .7845094    .9439701
             |
       leff2 |   .1376973    .527293     0.26   0.794    -.8957779    1.171173
      bden10 |   .0178559   .0074431     2.40   0.016     .0032677    .0324441
         dzs |  -.0014618   .0005163    -2.83   0.005    -.0024738   -.0004499
         deq |  -.0094209   .0033732    -2.79   0.005    -.0160323   -.0028095
    foreign9 |   .0351244   .0634741     0.55   0.580    -.0892826    .1595315
        lpop |   .0730514   .0915525     0.80   0.425    -.1063881    .2524909
       lgdpc |  -.0572502   .0496902    -1.15   0.249    -.1546411    .0401408
          eu |   .0411709   .0370655     1.11   0.267    -.0314761    .1138179
         oar |    .101176   .0424338     2.38   0.017     .0180072    .1843448
     ospower |  -.0257987   .0124894    -2.07   0.039    -.0502775   -.0013199
     crindex |  -.0396488   .0145628    -2.72   0.006    -.0681915   -.0111062
      moralh |  -.0301292    .056957    -0.53   0.597    -.1417629    .0815046
     pmindex |  -.0342256     .02014    -1.70   0.089    -.0736993     .005248
         y04 |   .0148812   .0223029     0.67   0.505    -.0288316    .0585941
         y05 |   .0034304   .0278881     0.12   0.902    -.0512292      .05809
         y06 |  -.0336503   .0283212    -1.19   0.235    -.0891588    .0218582
         y07 |  -.0564649   .0309301    -1.83   0.068    -.1170868     .004157
         y08 |  -.1509271   .0730421    -2.07   0.039     -.294087   -.0077673
         y09 |  -.1740292   .0737463    -2.36   0.018    -.3185694   -.0294891
         y10 |  -.1505984   .0716676    -2.10   0.036    -.2910644   -.0101324
         y11 |  -.1803395   .0707529    -2.55   0.011    -.3190125   -.0416664
         y12 |  -.1922001   .0708973    -2.71   0.007    -.3311563   -.0532439
       _cons |  -.2780708   2.293656    -0.12   0.904    -4.773554    4.217413
------------------------------------------------------------------------------
Instruments for orthogonal deviations equation
  Standard
    FOD.(y04 y05 y06 y07 y08 y09 y10 y11 y12)
    FOD.(oar ospower crindex moralh pmindex)
    FOD.(foreign9 lpop lgdpc eu)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L2.deq collapsed
    L(4/10).dzs collapsed
```

```
    L2.bden10 collapsed
    L(2/3).leff2 collapsed
    L3.L.lmsa collapsed
Instruments for levels equation
  Standard
    y04 y05 y06 y07 y08 y09 y10 y11 y12
    oar ospower crindex moralh pmindex
    foreign9 lpop lgdpc eu
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.deq collapsed
    DL3.dzs collapsed
    DL.bden10 collapsed
    DL.leff2 collapsed
    DL2.L.lmsa collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -4.15  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -0.66  Pr > z =  0.511
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(12)   =   5.74  Prob > chi2 =  0.928
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(12)   =   9.81  Prob > chi2 =  0.633
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(7)    =   6.13  Prob > chi2 =  0.524
    Difference (null H = exogenous): chi2(5)    =   3.67  Prob > chi2 =  0.597
  gmm(L.lmsa, collapse lag(3 3))
    Hansen test excluding group:     chi2(10)   =   8.31  Prob > chi2 =  0.599
    Difference (null H = exogenous): chi2(2)    =   1.50  Prob > chi2 =  0.473
  gmm(leff2, collapse lag(2 3))
    Hansen test excluding group:     chi2(9)    =   8.42  Prob > chi2 =  0.492
    Difference (null H = exogenous): chi2(3)    =   1.38  Prob > chi2 =  0.710
  gmm(bden10, collapse lag(2 2))
    Hansen test excluding group:     chi2(10)   =   7.05  Prob > chi2 =  0.720
    Difference (null H = exogenous): chi2(2)    =   2.75  Prob > chi2 =  0.253
  gmm(dzs, collapse lag(4 .))
    Hansen test excluding group:     chi2(4)    =   0.85  Prob > chi2 =  0.932
    Difference (null H = exogenous): chi2(8)    =   8.96  Prob > chi2 =  0.346
  gmm(deq, collapse lag(2 2))
    Hansen test excluding group:     chi2(10)   =   7.74  Prob > chi2 =  0.655
    Difference (null H = exogenous): chi2(2)    =   2.07  Prob > chi2 =  0.355
  iv(foreign9 lpop lgdpc eu)
    Hansen test excluding group:     chi2(8)    =   2.44  Prob > chi2 =  0.964
    Difference (null H = exogenous): chi2(4)    =   7.36  Prob > chi2 =  0.118
  iv(oar ospower crindex moralh pmindex)
    Hansen test excluding group:     chi2(7)    =   4.93  Prob > chi2 =  0.668
    Difference (null H = exogenous): chi2(5)    =   4.87  Prob > chi2 =  0.432
  iv(y04 y05 y06 y07 y08 y09 y10 y11 y12)
    Hansen test excluding group:     chi2(3)    =   2.22  Prob > chi2 =  0.527
    Difference (null H = exogenous): chi2(9)    =   7.58  Prob > chi2 =  0.577
```

Table A.6.13: Printout of dynamic panel system GMM estimation for the bank's market share determinants in SEECs, 2002-2012 (Dependent variable MSA)(check for robustness using EBC2T)

```
. xtabond2 lmsa l.lmsa leffbc2 bden10 dzs deq foreign9 lpop lgdpc eu oar ospower crindex
moralh pmindex y04 y05 y06 y07 y08 y09 y10 y11 y12, gmm(l.lmsa, lag(3 3)coll) gmm(leffbc2,
lag(2 3)coll) gmm(bden10, lag(2 2)coll) gmm(dzs, lag(4 .)coll) gmm(deq, lag(2 2)coll)
iv(foreign9 lpop lgdpc eu) iv(oar ospower crindex moralh pmindex) iv(y04 y05 y06 y07 y08 y09
y10 y11 y12) two robust orthogonal
Favoring space over speed. To switch, type or click on mata: mata set matafavor speed, perm.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      1069
Time variable : year                            Number of groups   =       148
Number of instruments = 36                      Obs per group: min =         1
Wald chi2(23) =   4952.71                                      avg =      7.22
Prob > chi2   =     0.000                                      max =        10
------------------------------------------------------------------------------
             |              Corrected
        lmsa |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lmsa |
         L1. |   .8698131   .0444167    19.58   0.000      .782758    .9568682
             |
     leffbc2 |   .2599135   1.367617     0.19   0.849    -2.420566    2.940393
      bden10 |   .0182439   .0087088     2.09   0.036      .001175    .0353128
         dzs |  -.0013551   .0006003    -2.26   0.024    -.0025317   -.0001785
         deq |  -.0098124   .0031435    -3.12   0.002    -.0159736   -.0036513
    foreign9 |   .0265142   .0954383     0.28   0.781    -.1605415    .2135699
        lpop |   .0965325   .1232375     0.78   0.433    -.1450087    .3380736
       lgdpc |  -.0578305   .0839735    -0.69   0.491    -.2224155    .1067545
          eu |   .0380898   .0410872     0.93   0.354    -.0424396    .1186192
         oar |   .0981984   .0496066     1.98   0.048     .0009712    .1954255
     ospower |  -.0271474   .0159389    -1.70   0.089     -.058387    .0040923
     crindex |  -.0381951   .0237511    -1.61   0.108    -.0847465    .0083562
      moralh |  -.0291089   .0610393    -0.48   0.633    -.1487438     .090526
     pmindex |   -.032959    .027867    -1.18   0.237    -.0875773    .0216593
         y04 |   .0130498   .0229881     0.57   0.570    -.0320061    .0581056
         y05 |   .0065203   .0277892     0.23   0.814    -.0479456    .0609861
         y06 |  -.0311826   .0298394    -1.05   0.296    -.0896667    .0273016
         y07 |  -.0550578   .0355875    -1.55   0.122    -.1248081    .0146925
         y08 |  -.1494691   .0886777    -1.69   0.092    -.3232741     .024336
         y09 |  -.1734345   .0885181    -1.96   0.050    -.3469269    .0000578
         y10 |  -.1500465   .0858372    -1.75   0.080    -.3182844    .0181914
         y11 |  -.1777782   .0857644    -2.07   0.038    -.3458733    -.009683
         y12 |  -.1894059   .0830867    -2.28   0.023    -.3522529   -.0265589
       _cons |   -.895779   5.854676    -0.15   0.878    -12.37073    10.57917
------------------------------------------------------------------------------
Instruments for orthogonal deviations equation
  Standard
    FOD.(y04 y05 y06 y07 y08 y09 y10 y11 y12)
    FOD.(oar ospower crindex moralh pmindex)
    FOD.(foreign9 lpop lgdpc eu)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L2.deq collapsed
    L(4/10).dzs collapsed
    L2.bden10 collapsed
    L(2/3).leffbc2 collapsed
    L3.L.lmsa collapsed
Instruments for levels equation
```

```
  Standard
    y04 y05 y06 y07 y08 y09 y10 y11 y12
    oar ospower crindex moralh pmindex
    foreign9 lpop lgdpc eu
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.deq collapsed
    DL3.dzs collapsed
    DL.bden10 collapsed
    DL.leffbc2 collapsed
    DL2.L.lmsa collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -4.02  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -0.63  Pr > z =  0.531
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(12)   =   7.93  Prob > chi2 =  0.790
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(12)   =   9.30  Prob > chi2 =  0.677
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(7)    =   6.67  Prob > chi2 =  0.464
    Difference (null H = exogenous): chi2(5)    =   2.64  Prob > chi2 =  0.756
  gmm(L.lmsa, collapse lag(3 3))
    Hansen test excluding group:     chi2(10)   =   7.84  Prob > chi2 =  0.644
    Difference (null H = exogenous): chi2(2)    =   1.46  Prob > chi2 =  0.481
  gmm(leffbc2, collapse lag(2 3))
    Hansen test excluding group:     chi2(9)    =   8.31  Prob > chi2 =  0.503
    Difference (null H = exogenous): chi2(3)    =   0.99  Prob > chi2 =  0.803
  gmm(bden10, collapse lag(2 2))
    Hansen test excluding group:     chi2(10)   =   6.67  Prob > chi2 =  0.756
    Difference (null H = exogenous): chi2(2)    =   2.64  Prob > chi2 =  0.268
  gmm(dzs, collapse lag(4 .))
    Hansen test excluding group:     chi2(4)    =   1.43  Prob > chi2 =  0.838
    Difference (null H = exogenous): chi2(8)    =   7.87  Prob > chi2 =  0.446
  gmm(deq, collapse lag(2 2))
    Hansen test excluding group:     chi2(10)   =   7.21  Prob > chi2 =  0.705
    Difference (null H = exogenous): chi2(2)    =   2.09  Prob > chi2 =  0.351
  iv(foreign9 lpop lgdpc eu)
    Hansen test excluding group:     chi2(8)    =   4.03  Prob > chi2 =  0.855
    Difference (null H = exogenous): chi2(4)    =   5.28  Prob > chi2 =  0.260
  iv(oar ospower crindex moralh pmindex)
    Hansen test excluding group:     chi2(7)    =   4.21  Prob > chi2 =  0.755
    Difference (null H = exogenous): chi2(5)    =   5.10  Prob > chi2 =  0.404
  iv(y04 y05 y06 y07 y08 y09 y10 y11 y12)
    Hansen test excluding group:     chi2(3)    =   1.73  Prob > chi2 =  0.631
    Difference (null H = exogenous): chi2(9)    =   7.58  Prob > chi2 =  0.577
```

Table A.6.14: Printout of dynamic panel system GMM estimation for the bank's market share determinants in SEECs, 2002-2012 (Dependent variable MSA)(check for robustness using LIC instead of Z-score)

```
. xtabond2 lmsa l.lmsa leff bden10 dliclp deq foreign9 lpop lgdpc eu oar ospower crindex
moralh pmindex y04 y05 y06 y07 y08 y09 y10 y11 y12, gmm(l.lmsa, lag(3 .)coll) gmm(leff, lag(2
2)coll) gmm(bden10, lag(2 3)coll) gmm(dliclp, lag(2 2)coll) gmm(deq, lag(2 3)coll) iv(foreign9
lpop lgdpc eu) iv(oar ospower crindex moralh pmindex) iv(y04 y05 y06 y07 y08 y09 y10 y11 y12)
two robust orthogonal
Favoring space over speed. To switch, type or click on mata: mata set matafavor speed, perm.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      1070
Time variable : year                            Number of groups   =       148
Number of instruments = 37                      Obs per group: min =         1
Wald chi2(23) =   4965.42                                      avg =      7.23
Prob > chi2   =     0.000                                      max =        10
------------------------------------------------------------------------------
             |              Corrected
        lmsa |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lmsa |
         L1. |   .8454914    .045291    18.67   0.000     .7567227    .9342601
             |
        leff |   .0799571   .6375991     0.13   0.900    -1.169714    1.329628
      bden10 |   .0166983   .0076275     2.19   0.029     .0017487     .031648
      dliclp |   .0020776   .0025687     0.81   0.419    -.0029569    .0071121
         deq |  -.0128114   .0029481    -4.35   0.000    -.0185897   -.0070332
    foreign9 |   .0711703   .0445578     1.60   0.110    -.0161613    .1585019
        lpop |   .1022337   .0842056     1.21   0.225    -.0628062    .2672735
       lgdpc |  -.0904822   .0447475    -2.02   0.043    -.1781857   -.0027787
          eu |   .0617683   .0310917     1.99   0.047     .0008297    .1227069
         oar |   .0870229   .0442248     1.97   0.049     .0003438     .173702
     ospower |  -.0229247   .0126236    -1.82   0.069    -.0476665    .0018171
     crindex |  -.0354949   .0166118    -2.14   0.033    -.0680534   -.0029363
      moralh |  -.0426995   .0496345    -0.86   0.390    -.1399814    .0545823
     pmindex |  -.0206744   .0204546    -1.01   0.312    -.0607647    .0194159
         y04 |   .0071731   .0248785     0.29   0.773     -.041588    .0559341
         y05 |    .006334   .0280583     0.23   0.821    -.0486592    .0613272
         y06 |  -.0281644   .0281687    -1.00   0.317    -.0833741    .0270453
         y07 |  -.0677375   .0313931    -2.16   0.031    -.1292668   -.0062082
         y08 |  -.1548493   .0659318    -2.35   0.019    -.2840732   -.0256255
         y09 |  -.1769243   .0707477    -2.50   0.012    -.3155873   -.0382614
         y10 |   -.160607   .0667336    -2.41   0.016    -.2914025   -.0298115
         y11 |   -.178703   .0691418    -2.58   0.010    -.3142185   -.0431874
         y12 |  -.1998111   .0687865    -2.90   0.004    -.3346302    -.064992
       _cons |   .1082122   2.735419     0.04   0.968     -5.25311    5.469534
------------------------------------------------------------------------------
Instruments for orthogonal deviations equation
  Standard
    FOD.(y04 y05 y06 y07 y08 y09 y10 y11 y12)
    FOD.(oar ospower crindex moralh pmindex)
    FOD.(foreign9 lpop lgdpc eu)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/3).deq collapsed
    L2.dliclp collapsed
    L(2/3).bden10 collapsed
    L2.leff collapsed
```

```
    L(3/10).L.lmsa collapsed
Instruments for levels equation
  Standard
    y04 y05 y06 y07 y08 y09 y10 y11 y12
    oar ospower crindex moralh pmindex
    foreign9 lpop lgdpc eu
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.deq collapsed
    DL.dliclp collapsed
    DL.bden10 collapsed
    DL.leff collapsed
    DL2.L.lmsa collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -3.98  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -0.58  Pr > z =  0.565
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(13)   =  18.02  Prob > chi2 =  0.157
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(13)   =  13.67  Prob > chi2 =  0.398
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(8)    =   9.93  Prob > chi2 =  0.270
    Difference (null H = exogenous): chi2(5)    =   3.74  Prob > chi2 =  0.588
  gmm(L.lmsa, collapse lag(3 .))
    Hansen test excluding group:     chi2(5)    =   4.48  Prob > chi2 =  0.482
    Difference (null H = exogenous): chi2(8)    =   9.18  Prob > chi2 =  0.327
  gmm(leff, collapse lag(2 2))
    Hansen test excluding group:     chi2(11)   =  12.93  Prob > chi2 =  0.298
    Difference (null H = exogenous): chi2(2)    =   0.74  Prob > chi2 =  0.692
  gmm(bden10, collapse lag(2 3))
    Hansen test excluding group:     chi2(10)   =  10.60  Prob > chi2 =  0.390
    Difference (null H = exogenous): chi2(3)    =   3.07  Prob > chi2 =  0.381
  gmm(dliclp, collapse lag(2 2))
    Hansen test excluding group:     chi2(11)   =  10.77  Prob > chi2 =  0.462
    Difference (null H = exogenous): chi2(2)    =   2.89  Prob > chi2 =  0.235
  gmm(deq, collapse lag(2 3))
    Hansen test excluding group:     chi2(10)   =  10.90  Prob > chi2 =  0.366
    Difference (null H = exogenous): chi2(3)    =   2.77  Prob > chi2 =  0.428
  iv(foreign9 lpop lgdpc eu)
    Hansen test excluding group:     chi2(9)    =  11.79  Prob > chi2 =  0.226
    Difference (null H = exogenous): chi2(4)    =   1.88  Prob > chi2 =  0.758
  iv(oar ospower crindex moralh pmindex)
    Hansen test excluding group:     chi2(8)    =   9.97  Prob > chi2 =  0.267
    Difference (null H = exogenous): chi2(5)    =   3.69  Prob > chi2 =  0.594
  iv(y04 y05 y06 y07 y08 y09 y10 y11 y12)
    Hansen test excluding group:     chi2(4)    =   3.95  Prob > chi2 =  0.413
    Difference (null H = exogenous): chi2(9)    =   9.72  Prob > chi2 =  0.374
```