Lincoln University Digital Thesis

Copyright Statement

Bank Efficiency and Bank Competition:

Empirical Evidence from Ghana's Banking Industry

A thesis
submitted in partial fulfilment
of the requirements for the Degree of
Doctor of Philosophy in Finance

at
Lincoln University
by
Kofi Adjei-Frimpong

Lincoln University
2013

Abstract of a thesis submitted in partial fulfilment of the requirements for the Degree of Doctor of Philosophy in Finance.

Abstract

Bank Efficiency and Bank Competition: Empirical Evidence from Ghana's Banking Industry

by

Kofi Adjei-Frimpong

The Ghanaian banking industry has undergone considerably transformation since 1988 as a result of the gradual but steady implementation of financial service reforms. The main purpose of implementing the financial reforms is to build competitive and stable banking industry to enhance banks' efficiency and ultimately stimulate economic growth and development.

Using annual data spanning from 2001 to 2010, this study investigates the level of bank efficiency and the degree of bank competition and their determinants in Ghana. In addititon, the study also examines the causal relationship between bank efficiency and competition.

The results suggest that Ghana's banks are, on average, inefficient and competitively weak, but the level of efficiency has increased significantly from 2001 to 2010. This study also reveals that well-capitalized banks in Ghana are pure technically efficient and competitve but are cost inefficient. In addition, bank size influences bank pure technical efficiency suggesting that larger banks are pure technically efficient but have no influence on cost efficiency and competition. There is no indication that fee income has an impact on bank competition. The findings also exhibit that loan loss provision ratio has no effect on bank efficiency and competition in Ghana. Furthermore, this study finds GDP growth negatively influences bank cost efficiency while the rate of inflation positively affect bank pure technical efficiency, but has no impact on bank cost efficiency and bank competition. The results also reveal that lagged cost efficiency tends to persist from year to year.

Similarly, market power persistence exists in banking industry of Ghana. The findings also reveal that bank capitalization has a negative impact on bank market power.

There is evidence that cost efficiency positively Granger-causes market power and hence causality negatively runs from cost efficiency to competition indicating that bank cost efficiency precedes competition. However, the reverse causality running from competition to cost efficiency is not supported. The findings also indicate that there is no causal relationship between bank pure technical efficiency and competition in Ghana.

Keywords: Efficiency, Competition, Causality, Data Envelopment Analysis, Lerner Index.

Acknowledgements

My sincere thanks and praise to the Almighty God for giving me the opportunity to pursue my PhD studies and for guiding and protecting me.

I wish to thank my main supervisor Professor Christopher Gan for his incredible support and insightful comments and guidance that helped foster the successful completion of this work. I undoubtedly also recognise the priceless comments offered by my associate supervisor Dr. Baiding Hu. Furthermore, many thanks to both of you for your patience and understanding relating not only to my academic work but also my family matters.

Special thanks and sincere appreciation to my beloved late mother Ama Tawiah and late sister Abena Bukura for assisting me even when it was impossible to do so. I dedicate this thesis to you as well as the late Margaret Scanlan, the Godmother of my firstborn. May Almighty God be with you all.

I truly appreciate the valuable suggestions from David Roodman at Center for Global Development, Washington, DC, USA (who developed Stata module Xtabond2 used for the GMM estimations) and Professor Mark Holmes at Waikato University.

Furthermore, to all my friends in Auckland particularly Rev. Monsignor Paul Farmer, Rev. Father Bernard Dennehy, Joseph Folau and Michael Wong and those in Lincoln, Canterbury especially, Rev. Father Frank Kelly, Michael and Claire Walker, Jack O'Donnell and Madam Shirley (Tai Tapu), thank you all for your prayers, services and encouragement.

Finally, I wish to express my sincere gratitude to my children; Adjei-Asaah Frimpong, Kwabena Owusu-Frimpong, Kwaku Frimpong, Nana Ayensua Frimpong and my wife Naana Adjei-Frimpong. Thanks to you all for your patience and unwavering support.

Table of Contents

List of Tables

List of Figures

ABBREVIATIONS

ABL	Amalgamated Bank Limited
ACH	Automated Clearing House
ADB	Agricultural Development Bank
ATM	Automatic Teller Machines
BBG	Barclays Bank (Ghana) Limited
BOG	Bank of Ghana
BSIC	Banque Sahélo-Saharienne I'Investissement et le Commerce Limited
CAL	CAL Bank Limited
CAP	Capitalization
CCC	Cheque Codeline Clearing
DEA	Data Envelopment Analysis
EBG	Ecobank (Ghana) Limited
FAMBL	First Atlantic Merchant Bank Limited
FBL	Fidelity Bank Limited
GCB	Ghana Commercial Bank
GDP	Gross Domestic Product
GIPSS	Ghana Interbank Payments and Settlement System
GTB	Guaranty Trust Bank (Ghana) Limited
HFC	HFC Bank (Ghana) Limited
HHI	Herfindahl-Hirschman index
IBG	Intercontinental Bank (Ghana) Limited
ICB	International Commercial Bank Limited
IFRS	International Financial Reporting Standards
IMF	International Monetary Fund
INF	Inflation rate
LERNER	Lerner index of market power
LLP	Loan loss provisions

MBG	Merchant Bank (Ghana) Limited
NIB	National Investment Bank Limited
OECD	Organisation for Economic Co-operation and Development
PBL	Prudential Bank Limited
PwC	PricewaterhouseCoopers (Ghana) Limited
ROA	Return on assets
ROE	Return on equity
RTGS	Real Time Gross Settlement System
SCB	Standard Chartered Bank (Ghana) Limited
SG-SSB	SG-SSB Bank Limited
Stanbic	Stanbic Bank (Ghana) Limited
SWIFT	Society for Worldwide Interbank Financial Telecommunication
TTB	The Trust Bank Limited
UGL	UniBank (Ghana) Limited
UTB	UT Bank Limited
ZBL	Zenith Bank (Ghana) Limited

Chapter 1
Introduction

1.1 Introduction

The banking industry in Ghana has changed considerably since 1988 as a result of the gradual and steady implementation of financial services deregulation, globalisation and the emergence of communication and information technologies. The financial deregulation was undertaken as part of the structural economic adjustment and stabilisation programme launched in 1983 with the assistance of the International Monetary Fund and World Bank. These financial sector reforms are aimed at increasing banks competitiveness, efficiency and performance in the Ghanaian banking system that could contribute in greater measure to stimulate economic growth and ensure financial stability. The changes are still an ongoing process.

Bank competition and efficiency are vital for economic development. Competition should compel banks to reduce their costs and therefore increase their cost efficiency, leading to more efficient allocation of financial resources and consequently increasing investment to stimulate economic growth. Thus, competitive environment stimulates banks to become more efficient by reducing overhead costs, enhancing overall bank management, improving risk management, and providing new banking products and services (Denizer et al., 2000). In addition, bank competition reduces bank market power and therefore should reduce prices of financial services effecting welfare gains for their customers.

However, Keeley (1990) emphasises that too much competition among banks could foster insolvency of some banks and instability of the entire banking system. Thus, excessive competition emerging from financial reforms may encourage banks to pursue riskier policies in taking on more credit risk in their loan portfolio (which could eventually generate bank failure) so as to maintain their former profit level. For instance, increased competition contributed to weaker lending standards in the recent subprime lending market in US that caused systemic financial problems across the world. Boyd & Nicolo (2005), on the other hand, argue that reducing loan rates as a result of bank competition assists borrowers to repay loans contributing to lower default risk.

Furthermore, increased competition will improve efficiency by creating incentives to managers to reduce costs in order to remain profitable (Casu & Girardone, 2006). In contrast, recent research by Claessen & Leaven (2004) has remarked that the perceived view of competition as undoubtedly good is more naïve in banking than in other industries. Casu & Girardone (2009) have recently commented that the relationship between competition and bank performance might be more complex. Similarly, Fecher & Pestieau (1993) notice in their study of OECD financial services that competition fostered efficiency, but indicate that it is not clear in the process of deregulating the economy that increasing competitiveness always enhances efficiency. Financial sector reforms might not always improve efficiency and this may depend on the conditions before financial reforms and other incentives may intervene (Berger & Humphrey, 1997). Indeed, in some countries, financial sector reform has increased branch network, fostered asset growth, increase bankruptcies, and reduced efficiency (Berger & Humphrey, 1997).

Findings of various studies have revealed inconsistencies regarding the relationship between financial reforms and efficiency. For instance, studies on bank efficiency by Ataullah et al. (2004) on India and Pakistan banks, Casu & Molyneax (2003) on Italy and Spain banks, Gilbert & Wilson (1998) on Korean banks and Hermes & Nhung (2010) on four Latin America and six Asian banks and Kumbhakar & Lozano-Vivas (2004) on Spanish savings banks, Leightner and Lovell (1998) on Thai banks and Mukherjee et al. (2001) on US banks have documented some positive impact of financial sector reforms on bank efficiency. On the other hand, studies by Grabowski et al. (1994) and Wheelock & Wilson (1999) on U.S banks, Sturm & Williams (2004) on Australian banks, Ariff & Can (2008) on Chinese bank, Bhattacharyya et al. (1997) and Sathye (2003) on Indian banks, Casu & Molyneax (2003) on French and German banks and Fries & Taci (2005) on 15 East European countries banks have reported inefficiencies in the banking sector.

In the context of Ghana's banking sector, Acquah (2006) points out that Bank of Ghana distinctively advocates that the entry of new banks be selective, well-managed, and paced over time. In addition, clear exit rules and prudential supervision are strongly enforced to ensure systemic stability and also to avoid decline in banks' franchise value. While the entry of new banks would increase competition, excessive numbers within the system could reduce the franchise value of banks and increase instability.

During the pre-reform era, Ghana's banking system was dominated by the state-owned banks and totally controlled by the government. The state-owned banks had a monopoly over the banking sector in regard to their operations and were directed to allocate essential component of their total loan portfolio to selected sectors in the economy. Hence, the government essentially became the biggest borrower. As highlighted in Huang et al.'s (2011) study on China's banks, the lending decisions of Ghana's banks were basically directed by the government and were not based on the borrowers' credibility and viability of the project. In such an economic environment, banks may be less inclined to improve their performance by reducing operating costs, increasing the mobilisation of deposits and enhancing the efficient allocation of loans. All the seven state-owned banks in Ghana were insolvent before the financial reforms. The banks in the entire banking system that were unaffected by the financial insolvency as a result of non-performing loans and bad investments are Barclays and Standard Chartered banks.

In 1987, Ghana's economic performance declined and its banking system was in distress. Banks were characterised by inefficiency, inadequate capital, insufficient loans loss provisions, high operating costs due to inefficient operations, a large portfolio of nonperforming loans and endured enormous political influence (International Monetary Fund, 1999; World Bank, 1989). The financial system was distorted by interest rate controls and selective credit policies, lack of competition, and weak supervision by the Bank of Ghana (World Bank, 1989).

The government decided to undertake economic and financial reforms. As a result of the financial reforms, most restrictions on foreign banks entry, interest rates and exchange rates were removed and direct government intervention diminished to entice foreign banks to enter the banking and financial markets. The results have increased the capacity of financial institutions to mobilise domestic savings, enhanced competition and efficiency among banks, and strengthened economic growth.

The Ghanaian banking sector has shown considerable improvements in communication and computing information technology, as banks have modernised their distribution networks and introduced new banking services such as Automated Teller Machines **(**ATMs), telephone banking, mobile banking and internet banking which are prevalent in

all cities. The central bank has set up payments system infrastructure and appropriate measures that facilitate a competitive and efficient banking sector.

Since 2000, the financial sector has been built on a strong regulatory and supervisory framework, and modern payments and settlement infrastructure. This encouraged the development of the Ghanaian banking sector that is reasonably efficient, financially innovative, competitive, profitable, and growing quite quickly (Acquah, 2009). The sector has seen some structural changes with reduced concentration and strong competition for market shares, increase in branch network and provision of various new banking products in Ghana. For example, the number of banks actively operating in Ghana has grown from 10 in 1987 to 27 in 2010. Most of the new entrants were foreign banks. During the same period, the number of foreign banks in Ghana increased from 3 to 15. As of 2010, with twenty-seven banks in operation in Ghana, the number of foreign-owned banks is more than domestic banks. The number of bank branches also increased from 309 in 2002 to 776 in 2010. The bank concentration based on the Herfindahl-Hirschman index (HHI) has dropped considerably from 1,413.7 points in 2000 to 600.0 points in 2010 (Bank of Ghana, February 2010, February 2011) representing a decrease in market concentration of 30.2 percent, as a result of the increase of the number of banks. Furthermore, the five-bank concentration ratio in terms of total assets also decreased from 78.2 percent in 2001 to 46 percent in 2010 (PricewaterhouseCoopers, 2006, International Monetary Fund, 2011). These developments reflect the intense competitive environment in Ghana's banking sector. Bank of Ghana (February 2009) also reported that the banking sector has produced strong asset growth and enhanced profitability over the years. The growth in total assets was driven mostly by the relatively new banks in the system.

1.2 Importance of the Study

Banking efficiency and competition are major issues for financial stability and economic development, because banks play essential roles in the provision of credit, payment system, and the transmission of monetary policy. The degree of competition in the financial sector is important for the efficiency of the production of financial services, the quality of financial products, and innovation in the sector (Claessens, 2009). Competition in banking is very important since bank failure or anti-competitive bank behaviour could have wider implications for bank efficiency, growth and welfare throughout the economy

(Wilson et al., 2010). In addition, bank competition has important implications for competition policy, financial stability, and for the effective regulation and supervision of the banking industry. Improvements in efficiency may reduce the cost of intermediation, which directly affects the intermediation margin in the market. Thus, improvements in efficiency in the banking industry are a vital requirement for providing a more efficient system of asset allocation in the financial system. Thus, when banks efficiently mobilise and allocate funds, this lowers the cost of capital to firms and accelerates capital accumulation and productivity growth (McKinnon, 1973).

The financial reform in Ghana is an ongoing process, therefore a detailed study of efficiency and competition could be of a great assistance in the formulation and evaluation of policy to enhance the performance of the banking sector. Thus, empirical analysis of efficiency and competition is very important requirement for further policy changes relating to competition and efficiency in the financial market. This study may help bank regulator, policymakers and bankers to understand how regulatory changes may affect banks' efficiency, competition, financial stability and bank performance. It would also assist bank managers to identify the sources of efficiency or inefficiency within their banks. This study would help various interest groups such as investors and depositors to understand the competitiveness of Ghana's banking system.

The recent developments of the mortgage crises involving major banks in the US such as Citibank, IndyMac Bank and Bear Stearns which have affected many banking systems across the world make the detail examination of the efficiency of Ghana's banks more important. Many policymakers and bank regulators across the world have been asking questions relating to the competitiveness, efficiency and stability of their various banking systems. Moreover, the findings of this research could offer some lessons learnt and policy recommendations to other developing countries, particularly other African countries that have embarked on similar financial sector reforms.

In addition, previous studies on bank efficiency and competition have mostly used static panel data models to evaluate the determinants of efficiency and competition. However, many financial processes exhibit dynamic adjustment over time so failing to consider the dynamic aspect of the data process can lead to serious model misspecification and estimation biases. As De Jonghe & Vennet (2008) highlighted that most banking studies

failed to consider the time it takes for the impacts of competition and efficiency to materialize. Only Ataullah & Le (2006), Fiordelisi et al. (2011), Goddard et al. (2012) and Staub et al. (2010) have applied the dynamic model in their assessment of bank efficiency and competition.

Furthermore, there is no study on the relation between competition and efficiency on Ghana's banking industry and neither has a dynamic method been employed to assess the determinants of bank competition and efficiency. Hence, this research attempts to fill the gap in the literature by providing empirical evidence to the existing literature on efficiency and competition in Ghana's banking industry.

1.3 Research Questions

This study seeks to answer the following research questions:

1. How efficient are Ghana's banks and what role have bank-specific and macroeconomic factors played in the variation of efficiency across Ghana's banks?
2. How competitive are Ghana's banks and what are the determinants of competition (or market power) within the industry?
3. Does bank competition (or market power) influence bank efficiency and vice versa?

1.4 Objectives of the Study

This research empirically investigates the impact of financial sector reforms on efficiency and competition of the banking sector in Ghana over the period 2001 to 2010 using panel data.

More specifically, the objectives of this study are:

1. To determine whether deregulation has improved bank efficiency and competition of Ghana's banking sector.
2. To examine the determinants of bank efficiency and bank competition in Ghana
3. To investigate the causal relationship between bank competition and bank efficiency in Ghana.

4. To identify the policy implications of the financial sector reforms in term of competition and efficiency in Ghana's banking industry.

1.5 Organisation of the Study

The rest of this study is structured into six chapters: Chapter 2 discusses the evolution of the Ghanaian Banking sector. Chapter 3 describes the data used throughout the study and discusses the fixed effect model and a two-step system generalised method of moment (system GMM) estimators that are used to explore the determinants of bank efficiency and competition as well as the causality between bank efficiency and bank competition. Chapter 4 provides the analysis of the level and determinant of bank efficiency. Chapter 5 presents the degree and determinant of bank competition. Chapter 6 presents the causal relationship between bank efficiency and bank competition. Chapter 7 provides the conclusion and policy implications of the study.

Chapter 2
The Banking Industry in Ghana

2.1 Introduction

The banking industry in Ghana has witnessed significant reforms in the financial sector initiated in 1988. The implementation of these reforms has been gradual and steady aimed at enhancing bank competition, bank efficiency and bank stability. It is expected that these reforms would foster economic growth and development of the country. The emphasis is on banks because they dominate Ghana's financial system.

The chapter is divided into five sections. Section 2.2 presents the historical development of the banking sector in Ghana relating to the pre-deregulation era. Section 2.3 discusses the structure of banking industry in Ghana. Section 2.4 presents the pre-reforms banking policies and their impact on Ghana's financial service industry, and Section 2.5 examines the banking reforms that have taken place since 1988. Section 2.6 reviews the performance of the Ghana's banking sector. Section 2.7 provides summary of the chapter.

2.2 Historical Background of Ghana's Banking Industry

The Standard bank, Barclays bank and Bank of Gold Coast[1] were operating in Ghana under the colonial rule to provide commercial banking services. Their main business was to offer trade finance and mainly served the expatriate community. In 1953, the first indigenous bank, Ghana Commercial Bank, was opened to offer credit services to the indigenous Ghanaians as well. After independence in 1957, the Bank of Ghana was set-up to replace the West African Currency Board established in 1912 by the colonial British rule to oversee the banks in Ghana, Gambia, Nigeria and Sierra Leone. It became the central bank of Ghana. It replicated the functions of the West African Currency Board. Between the period 1957 and 1988, three state-owned development banks were set-up, namely National Investment Bank, Agricultural Development and Bank for Housing and Construction to offer long-term credit facilities; Merchant Bank for merchant banking services; Cooperative Bank to consolidate cooperative banking and the Social Security

[1] Bank of Gold Coast became Ghana Commercial Bank.

Bank to offer banking services to workers (World Bank, 1994). The ultimate aim of establishing Cooperative Bank and Social Security Bank was to help encourage savings. In addition, the government of Ghana acquired a large minority shares in both Standard Bank and Barclay Bank. The entry into Ghana's banking market was restricted. Standard Bank, Barclay Bank and Bank for Credit and Commerce[2] were the only foreign banks operating in Ghana before the financial reforms. Seven state banks were operating in Ghana in addition to the three foreign banks. The state-owned banks dominated the banking industry and financial sector as well. The most interesting event in the history of Ghana's banking was the frozen of bank deposits accounts of 50 thousand cedis (currency of Ghana) or more by the government in 1981 (World Bank, 1988). Thus, depositors with 50 thousand cedis or more in the bank were asked to explain where they obtained their money from. The government also demonetised 50 cedi note in 1982 (the highest denomination of Ghana's currency in 1982). These actions by the government undermined the confidence of the public in the Ghanaian banking system (World Bank, 1988). Table 2.1 shows the establishment of Ghana's banks between the period 1896 and 1988.

Table 2.1 Pre-Reforms Banks in Ghana Between 1896 and 1988

Bank	Year established	Ownership
Standard Bank	1896	Private: foreign
Barclay Bank	1917	Private: foreign
Ghana Commercial Bank	1953	State
National Investment Bank	1963	State
Agricultural Development	1965	State
Bank for Housing and Construction	1972	State
Merchant Bank	1972	State
Ghana Cooperative Bank	1975	State
Social Security Bank	1977	State
Bank for Credit and Commerce	1978	Private: foreign

Source: Bank of Ghana Annual Reports and International Monetary Fund Country Reports

2.3 The Structure of Banking Sector in Ghana

The Bank of Ghana, the central bank, was established in 1957 to oversee all the banks in Ghana. It supervises and regulates all the banks operating in Ghana. At the time of

[2] The operations of Bank for Credit and Commerce International in Ghana were closed in May 2000 following the collapsed of the Bank for Credit and Commerce International world-wide.

independence, the banking industry consisted of three banks: Barclays Bank, Standard Bank and Bank of Gold Coast.

In addition to the seven banks, the government also acquired significant minority holdings in private banks namely, Barclays Bank, Standard Bank and Bank for Credit and Commerce (Ghana). In terms of operations, all the banks regardless development or commercial offered almost the same banking services and operated under the same regulatory and supervisory requirements. The structure of Ghana's banking system has changed considerably. Table 2.2 exhibits the structure of the banking industry in Ghana for the period 2001 to 2010.

Table 2.2 Structure of the Banking Industry in Ghana

Banks	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Universal Banks	0	0	3	6	8	16	23	25	26	27
Commercial Banks	9	9	9	8	7	4	0	0	0	0
Development Banks	3	3	3	3	3	3	0	0	0	0
Merchant Banks	5	5	3	2	2	0	0	0	0	0
No. of major banks	17	17	18	19	20	23	23	25	26	27
Bank Branches	NA	309	295	360	392	450	595	640	706	776
Ownership:										
Domestic	9	9	10	11	11	13	13	13	13	12
Foreign	8	8	8	8	9	10	10	12	13	15
Rural Banks	115	115	NA[3]	120	121	122	126	129	134	135

Source: Bank of Ghana Annual Reports and International Monetary Fund Country Reports.

Banks in Ghana still dominate the financial system. In 2010, there were 27 major banks operating in Ghana (Appendix E). This number consists of 12 domestic and 15 foreign banks and all are universal banks (PricewaterhouseCoopers, 2011; Bank of Ghana, 2010).

The most significant changes in the structure of Ghana's banking sector are the increase in the foreign banks operating in Ghana, the adoption of the universal banking and to some extent the introduction of rural banks (unit banks) which has only 2.7 percent of the total assets of Ghana's financial system in 2010. The major banks (excluding the rural banks), on the other hand, have 75.1 percent of the total assets of Ghana's financial system in 2010 (International Monetary Fund, 2011). This undoubtedly demonstrates the dominance of the

[3] NA means not available

banks in Ghana's financial system. More remarkable is that 38.3 percent of the assets of Ghana's financial system are owned by the foreign banks (International Monetary Fund, 2011). In term of Ghana's banking system, foreign-owned banks domination account for 51 percent of the total assets. The state banks, however, dominate the domestic part of the banking system (28.9 percent), one of the highest in the Sub-Saharan Africa region (International Monetary Fund, 2011). In addition, total bank branches have increased from 315 in 1998 to 776 in 2010.

Furthermore, concentration has declined in the banking industry mainly as a result of the entry of many new banks. The market share of the five largest banks fell from 65.6 percent in 2000 to 46 percent in 2010 reflecting the intense competitive environment under which the banks are operating in Ghana (Bank of Ghana, 2008; International Monetary Fund, 2011).

2.4 Policies during Ghana's Pre-Banking Reforms Era

During the pre-reform period, the state owned banks dominated Ghana's banking system and utterly controlled by the government. The various governments of Ghana pursued a policy of intervention in economic activity to ensure rapid industrialisation, modernisation of agriculture and general welfare of the people of Ghana. As a result, the governments prioritised some sectors that were perceived as strategic. The state-owned banks had a monopoly over the banking sector in regard to their operations and were directed to allocate essential component of their total loan portfolio to selected sectors in the economy (World Bank, 1988). Policies pursued by the governments of Ghana were structured to deal with the weaknesses inherent in the colonial banking system. As a result of the policies, there was excessive concentration of risks in certain sectors, or to certain individuals which did not depend on the viability of the project or creditworthiness of the borrowers. The excessive borrowing by the government crowded the finances for the private sector (Bank of Ghana, 2004).

The governments also placed restrictions on foreign banks entry. The interest rates and exchange rates were set administratively by the Bank of Ghana and not market-based. The results were high rates of inflation, negative real interest rates and low rate of savings. The negative real interest rates, for example, generated huge banks' non-performing loan

portfolios. Banks had little or no motivation to mobilise extra savings or reduce operating costs. The banks were unduly inefficient (International Monetary Fund, 1999).

2.5 Banking Reforms in Ghana since 1988

2.5.1 Reasons for the Banking Reforms

In 1987, the banks in Ghana were in distress, especially the state-owned banks. For instance, nonperforming loans reached 41 percent of the total credits (International Monetary Fund, 1999). The World Bank study of the Ghanaian banking sector (1988) concluded that the banking sector was characterised by:

i. high operating costs due to inefficiencies,
ii. huge non-performing loan portfolios,
iii. insufficient provisions for loan losses,
iv. insolvency of the banking system,
v. capital inadequacy, and
vi. reported inflated profits.

The World Bank (1988) study indicated that the banking sector had slumped because of the general economic decline during the 1970s and early 1980s. The Ghanaian economy was in a very bad shape. The economic and financial reforms were imminent as the Ghanaian economic situation was in profound crisis in 1987, precisely on the verge of collapse. Their ability to mobilise savings and supply credit even to the important sectors was non-existent.

The financial system was distorted by interest rate controls and selective credit policies, lack of competition, and weak supervision by the Bank of Ghana (World Bank, 1989). Many of the banks were highly exposed to foreign exchange risk (World Bank, 1989). From 1988, Ghana implemented financial sector reforms as part of economic adjustment program aimed at rehabilitating its financial system.

2.5.2 Main Stages of the Banking Reforms

Table 2.3 shows the main stages of the banking reforms in Ghana.

Table 2.3 Ghana's Banking Industry Reforms from 1988-2010

Year	Reforms
1988	Private banks are authorised to operate. Decontrolled the minimum banks savings rate. Removed of sectoral credit controls except for agriculture. Established foreign exchange bureaus.
1989	Enacted new banking law to strengthen the regulatory environment and supervisory authority of the Bank of Ghana in the following areas: minimum capital requirement, disclosure, and prudential lending guidelines.
1990	Liberalisation of commercial banks interest rates and bank charges. Abolition of credit controls including credit allocation by sector. Non-performing loans of state enterprises in three financially distressed state-owned banks are replaced by Bank of Ghana bonds. Abolition of lending targets for the agriculture sector. Non-performing loans of private sector in three financially distressed state-owned banks are replaced by Bank of Ghana bonds. Restructuring of six financially distressed banks
1991	Non-performing loans of private sector in four sound[4] banks are replaced by Bank of Ghana bonds.
1992	New Bank of Ghana law is enacted to offer stronger supervisory and regulatory powers to the Bank of Ghana.
1995	Sale of 30 percent of government shares in Social Security Bank after merging with National Savings and Credit Bank: only 21 percent was subscribed. Placement of 60 percent of the capital of the Social Security Bank through the Ghana Stock Exchange.
1996	Sale of 30 percent of government shares in Ghana Commercial Bank through the Ghana Stock Exchange; after oversubscription the public offer was raised to 42 percent.
1998	Government sold three quarters of the remaining 40 percent shares it held in Barclays Bank.
2000	Closure of three insolvent banks: Bank for Housing and Construction, Cooperative Bank and Bank of Credit and Commerce and transfer of guaranteed deposits.
2002	Bank of Ghana Act (2002) was passed to give independence to the central bank, Bank of Ghana, making price and financial stability as its primary function. Introduction of Real Time Gross Settlement (RTGS) System also known as the Ghana Interbank Settlement System.
2003	The universal banking license was introduced and as a result Bank of Ghana issued a directive requiring all banks to increase their minimum stated capital requirements to GH¢7million by the end of 2006 from GH¢20 thousand. Maintenance, transaction, and transfer fees charges by commercial banks were abolished. The Payment System Act (2003) gave explicit powers to the Bank of Ghana to oversee payments system.

[4] These four banks were not distressed.

Table 2.3 Ghana's Banking Industry Reforms from 1988-2010 (continued)

Year	Reforms
2004	Banking Act 2004 replaced the Banking Law 1989. Bank of Ghana began to strengthen its risk based prudential supervision policies. In addition, the minimum capital adequacy ratio was increased from 6% to 10%. Bank of Ghana introduced a paper-based credit clearing system.
2006	Foreign Exchange Act 2006 - to liberalise inflows of foreign exchange into Ghana for foreign direct investment purposes. Abolition of secondary deposits reserves requirement (15%) by banks.
2007	Banking Amendment Act 2007 – to allow Offshore banking; to enable establishment of international financial services in Ghana. The Credit Reporting Act (Act 726) was enacted to establish credit reference bureaux to offer a legal and regulatory framework for credit reporting in Ghana. The International Financial Reporting Standards (IFRS) was introduced and all banks were to report their financial position and performance in accordance with IFRS[5]. Implementation of risk-based supervision of banks.
2008	The Anti-Money Laundering Act, 2007 (Act 749) enacted to provide structure for criminalising money laundering. The Borrowers and Lenders Act (2008) was enacted to provide a framework for full disclosure in creditor and borrower relations and in particular the role of collateral in the delivery of credit. Operation of a common electronic platform, the National Switch (e-zwich) and a biometric smartcard.
2009	The Cheque Codeline Clearing (CCC) was introduced which reduced the cheque clearing period from 5–8 days to 2 days throughout the country. Minimum capital requirement was increased from 7 million cedis to 60 million cedis in order to strengthen the capital base of the banks to enable them assume greater levels of risk. Mobile payment services were authorised and launched.
2010	Commencement of electronic direct credit transfer system a component of the Automated Clearing House project.

Sources: Bank of Ghana Annual Reports, Kapur, Hadjimichael, Hilbers, Schiff and Szymczac (1991), Ghana Banking Survey and International Monetary Fund Country Reports.

The discussion of the banking reforms has been categorised into regulatory and supervisory reforms and payments and settlements system reforms.

5. Insurance companies, securities brokers, pension funds and investment banks, and public institutions report in accordance with IFRS.

2.5.3 Regulatory and Supervisory Reforms

The regulatory and supervisory framework was strengthened with the passage of the following regulatory polices:

In 1989, a new banking law was passed providing regulatory structure for the banking system: minimum capital requirements, capital adequacy ratios, prudential lending ratios, exposure limits, accounting and auditing regulations (World Bank, 1989; International Monetary Fund, 1999). For instance, commercial banks with at least 60 percent of Ghanaian ownership were required to obtain a minimum paid-up capital of 20 thousand cedis, while minimum paid-up capital for foreign banks was 50 thousand cedis. In addition, development banks were asked to obtain a minimum paid-up capital of 100 thousand cedis. The Banking Act also prescribed a minimum capital adequacy ratio of 6 percent which is lower than the Basle prescription. These were implemented because financial liberalisation places strong demand on prudential regulation and supervision. Therefore, insufficient regulatory and supervisory framework would hamper effective financial liberalisation.

In the previous year, new private banks including foreign banks were granted permission to enter into the Ghanaian banking sector besides the three foreign banks: Barclays Bank, Standard Bank and Bank of Credit and Commerce. During 1990, bank interest rates and charges were liberalised and credit controls abolished (International Monetary Fund, 2003). In addition, the requirement that banks lend to agriculture sector was also removed. However, the banking sector reforms were implemented at a cost. For instance, during the years 1990 and 1991, most nonperforming loans of banks were swapped for government-guaranteed interest-bearing bonds totalling 4.75 million cedis and set to mature in two to five years and earning 7 percent to 9 percent in interest (World Bank, 1994). In total, 6.2 million cedis nonperforming loans were removed from banks' portfolios at an estimated cost of 6 percent of GDP (International Monetary Fund, 1999). The difference was offset against liabilities to the government or Bank of Ghana. These policies were pursued in order to assist the banks to revive the Ghanaian economy. This was necessary because banks play important roles in the provision of credit, payment system and the transmission of monetary policy and as result are vital to Ghana's financial stability and economic development. In addition to reviving the banking system, these policies were also pursued, in part, to preserve confidence and avoid a flight from deposit. Ghana had no policy of

deposit insurance, but distressed banks could hinder the access to credit for credible borrowers and sound investment project (World Bank, 1989).

A new Bank of Ghana law was passed in 1992 to offer stronger supervisory and regulatory powers to the Bank of Ghana, while in 1995, 21 percent of government shares in Social Security Bank and National Savings and Credit Bank were sold after merging through a public offer (International Monetary Fund, 1999). In 1996, 42 percent shares of Ghana Commercial Bank were sold. Initially, the government intended to issue 30 percent shares but the initial offer was oversubscribed so the government increased it to 42 percent (International Monetary Fund, 1999). The oversubscription could be due to the fact that Ghana Commercial Bank is the largest commercial bank in Ghana. Similarly, the government sold 75 percent of its 40 percent shares in Barclays Bank in 1998 (International Monetary Fund, 1999). These sales were issued in order to promote efficiency and competition in the banking system.

Two state-owned banks: Bank for Housing and Construction and Cooperative Bank were liquidated in 2000 without disrupting banking activities in Ghana. The cost relating to the closure was about 6 million cedis and the government issued treasury bills to cover the liabilities to depositors and guaranteed deposits were transferred to solvent banks. In the same year, a private bank, Bank of Credit and Commerce was also closed. This occurred when the parent bank, Bank of Credit and Commerce was liquidated. As a result of these liquidations, paid-up capital of the banking industry declined by 0.246 million cedis (Bank of Ghana, 2000).

In 2002, a banking law was passed to give independence to the central bank (Bank of Ghana) in formulating monetary and financial policies and supervising the financial system and making it more transparent and accountable. The law also empowered Bank of Ghana to strengthen supervision and modernise regulatory practices. These were aimed at ensuring price and financial stability and providing favourable economic environment for sustainable economic growth.

To enhance competition in the banking industry, the Bank of Ghana introduced universal banking in 2003 to permit banks to enter into commercial, development, investment or merchant banking with no requirement for separate licences (Bank of Ghana, 2007a).

Banks were allowed to undertake retail banking, corporate banking, etc. Universal banking was intended to give banks the ability to take on higher level of intermediation needed to support growth in an expanding economy. Bank of Ghana issued a directive requiring all banks to increase their minimum stated capital requirements from GH¢20 thousand to GH¢7million by the end of 2006.

The Foreign Exchange Act (Act 723) announced in 2006 offered a new statutory structure for foreign exchange payments and transactions. Bank of Ghana, instead of controlling as occurred during the repressive era, monitored foreign exchange transactions for balance of payments and other purposes in uniform with international best practice (Bank of Ghana, 2006). The banks, in turn, would submit reports on all transactions in foreign exchange to the Bank of Ghana. The objective of this law was to entice inflows of foreign exchange into Ghana for foreign direct investment purposes. It also established that resident did not need Bank of Ghana approval to obtain loans (Bank of Ghana, 2006).

Further, as part of the financial reforms, in 2007 Credit Reporting Act (Act 726) was enacted. XDS Data limited became the first credit reference bureau in Ghana to offer credible information on prospective borrowers (Bank of Ghana, 2008, 2009a). In addition, in 2011 Hudson Price Data Solutions was given licence to operate in Ghana while Dun and Bradstreet was given a provisional approval (PricewaterhouseCoopers, 2012). All banks were supposed to provide credit details to the bureau. This was an effort to reduce the information asymmetry that had characterised the lending function in Ghana. This is because no borrowers (individuals or firms) will willingly submit unfavourable information relating to themselves or their businesses. The problem of information asymmetry puts the financial system at greater risks. Credit reporting would ensure better and faster credit evaluation which could improve transparency and reduce lending risks (International Monetary Fund, 2007; Bank of Ghana, 2008). Having credible information about bank borrowers will help the banking industry to improve its credit risk management. In addition, this law protects and enforces creditor rights and help to establish confidence in the banking system (International Monetary Fund, 2007). In addition, Bank of Ghana has established a collateral registry to prevent a borrower from using the same collateral to secure more than one loan.

To prevent money laundering, the Anti-Money Laundering Act, 2007 (Act 749) was set up to offer the structure for criminalising money laundering. A Financial Intelligence Centre was then set up to identify and monitor money-laundering activities and report to the investigating authorities any information obtained (Bank of Ghana, 2007b). Under the Anti-money Laundering Act, a person commits the offence of money laundering if they knowingly convert, conceal, disguise, transfer, take possession of, or use property forming part of the proceeds of unlawful activity (PricewaterhouseCoopers, 2009).

Furthermore, the Bank of Ghana started the risk-based supervision (RBS) of banks in 2007. The banks complied by setting up risk management departments with well trained personnel. The Bank obtained technical assistance from the Office of the Superintendent of Financial Institutions of Canada in the form of advice and review of the RBS process. The RBS process involves critical identification, measurement, continuous monitoring, management of risks associated with the operations of banks such as new technologies, branch expansion, product innovation, size, linkages and interdependence of banks. The risk management systems are intended to improve the overall efficiency and effectiveness of the supervision process (Bank of Ghana, 2007b).

In line with the international regulatory standards, the Bank of Ghana requested all banks in Ghana to report their financial position and performance in line with International Financial Reporting Standards (IFRS) by end December 2008. Most of the banks complied with the Bank's directive by December 2007 (Bank of Ghana, 2008). The change is to improve transparency and facilitate comparison of reported financial results with banks operating in Ghana and international banks.

Gradual but steady, Ghana's financial reforms process continued. In 2008, the Borrowers and Lenders Act (2008) came into force to ensure full disclosure of information by borrowers and lenders and disallow certain credit practices. It also indicated the role of collateral in granting credit. It set up a collateral registry for charges and collateral credited by borrowers. It gave lenders the authority to take ownership of collateral security after a borrower was given 30-day notice of default without appealing to the court (International Monetary Fund, 2011). Thus, the Borrowers and Lenders Act provides the lending conditions and rights and obligations of lenders and borrowers (PricewaterhouseCoopers, 2009).

In 2009, Bank of Ghana set the minimum capital requirement at 60 million cedis from 7 million cedis. The foreign-owned banks were required to meet the new minimum capitalization of 60 million cedis by 2010. Domestic (local) banks were to attain a capitalization of at least 25 million cedis by 2010 and 60 million cedis by 2012 (Bank of Ghana, 2008, 2009a). The aim is to strengthen the capital base of the banks to enable them assume greater levels of risk, particularly, at a time when banks are allowed to engage in universal banking.

2.5.4 Payments and Settlements Reforms

The Bank of Ghana in an effort to reform payment and settlement system set up the Ghana Interbank Payments and Settlement System (GIPSS)[6] a subsidiary of the Bank which would implement and manage Ghana's payment and settlement infrastructures. The following infrastructures were implemented (Bank of Ghana, 2008, 2009b, 2010):

i. Real Time Gross Settlement System (RTGS),
ii. National Switch – e-zwich (the Common Platform) and Biometric Smart Card
iii. Cheque Clearing
iv. Cheque Codeline Clearing (CCC)
v. Automated Clearing House (ACH) - electronic direct credits transfer system
vi. Branchless Banking

The infrastructures have created an environment for safe, efficient, secure and timely payments. The Bank of Ghana implemented the infrastructures to bring Ghana's banking sector up to international standard and to ensure the efficiency of the payment and settlement system.

The Bank of Ghana is determined to modernise Ghana's payments and settlement system infrastructure. Consequently, the Bank implemented the RTGS for high-value payments in 2002. The RTGS provided good environment for safe, sound, secure, and timely payments (Bank of Ghana, 2007b). In addition, it reduced systemic payments and settlement risks

[6] All banks in the banking sector are expected to be members of GIPSS either directly or access the system through member banks.

because transactions are settled almost instantaneously. To complement the RTGS, the Bank of Ghana also introduced a paper-based credit clearing system to ensure the settlement of low-value payments in 2004 (Bank of Ghana, 2007c).

A common electronic platform, the National Switch (also known as e-zwich) for all payments transactions was set up by Bank of Ghana in 2008. This common platform links all banking institutions at significantly reduced costs. Further, it connects all ATMs and the settlement of payments transactions by customers of different banks at Points of Sale (POS). The National Switch enables transactions to be undertaken on online and offline. To include all segments of the population, Bank of Ghana also introduced a biometric smartcard (e-zwich smartcard). The e-zwich smartcard is mainly used for cash deposits and withdrawals, transfer of e-money, point of sale purchases, card to bank, loading and withdrawal of wages and salaries. It also has the following characteristics: low transaction costs, limited infrastructure needs, personal safety, security, convenience and simplicity. This has helped deposit-based financial intermediation. This card has more functions than the debit card (Bank of Ghana, 2007a).

In addition to the National Switch and Smartcard, the Bank of Ghana also introduced Cheque Codeline Clearing (CCC) with cheque truncation system in 2009. CCC has reduced the clearing cycle nation-wide from 5-8 days to 2 days throughout the country (Bank of Ghana, 2010; International Monetary Fund, 2011).

In 2009, the Bank of Ghana introduced a branchless banking that allowed mobile phones to be used to provide financial services. It is fast, convenient and secure method mobile phone users could use to transfer money. The services provided are deposits and withdrawals of funds, account balance enquiry, bills payments and funds transfer. The mobile money service providers aim to offer mobile phone users the chance to use banking services without having bank accounts. Therefore, it would assist both the banked and unbanked to transfer money. In 2010, two more telecommunication firms: Airtel and Globacom Ghana Limited joined Scancom Limited, Afric Express Ghana Limited and E-transact Ghana Limited to offer mobile phone financial services (Bank of Ghana, 2009b, 2010).

Furthermore, in December 2010 an electronic direct credits transfer system started operation. This retail payment system operates on the Automated Clearing House (ACH) platform and facilitates large electronic credit transfer of funds into the accounts of bank customers. Thus, it accelerates the clearing of funds into the accounts of bank customers. The system replaced the paper credit clearing system which ended operations after CCC system was introduced in 2009 (Bank of Ghana, 2010).

The objective of the Bank of Ghana's programme of modernising and improving the payments, clearing and settlement systems is to lower over-dependence on cash based transactions.

2.6 Performance of Ghana's Banking Industry

The evaluation of the performance of the banking industry in Ghana focused on the following indicators: profitability, solvency, loan portfolio quality and liquidity. These indicators appear to be relatively strong. However, the level of non-performing loans in the banking industry continued to be a cause of concern to the banking industry.

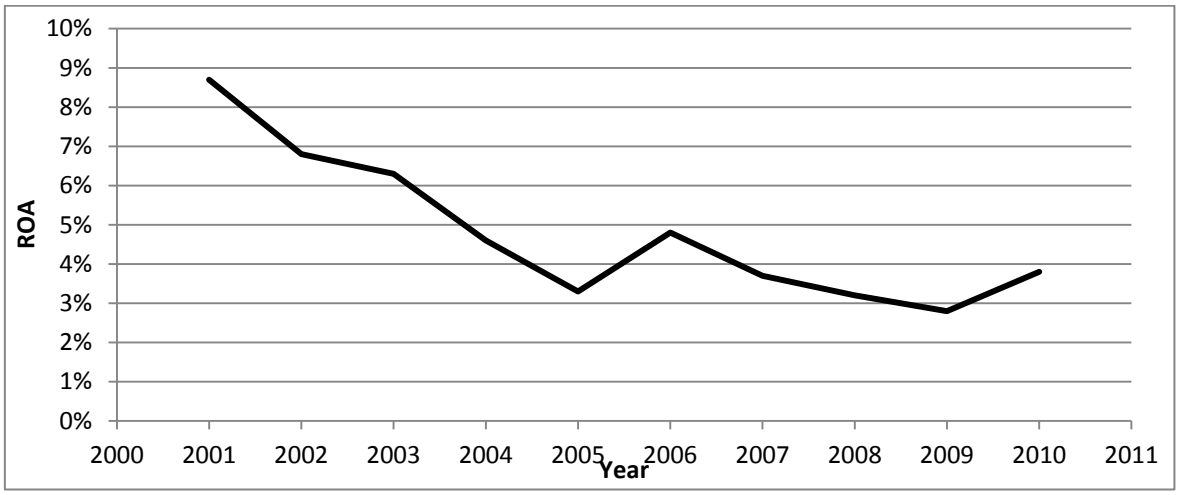
2.6.1 Profitability Indicators

Two profitability ratios namely, return on assets and return on equity are employed to discuss the profitability of Ghana's banking industry

2.6.1.1 Return on Assets

Increased competition as a result of new banks entry into the banking sector has generated a reduction in the banking industry's return on assets (ROA). Figure 2.1 shows the ROA deteriorates for the five successive years, reflecting the effect of declining rates of interest; improves in 2006 and then reverses to the downward trend but improves in 2010. Thus, the continuous decline in the banking industry's ROA from the periods 2001 to 2005 and 2006 to 2009 were the result of increased in average total assets against declined in profit levels due to fall in net interest spreads (see Appendix I). ROA improved from 2.8% in 2009 to 3.8% in 2010 because of increased in profits which was caused by significant fall in cost of funds (Bank of Ghana, 2010).

Figure 2.1 Return on Assets of Ghana's Banking Industry

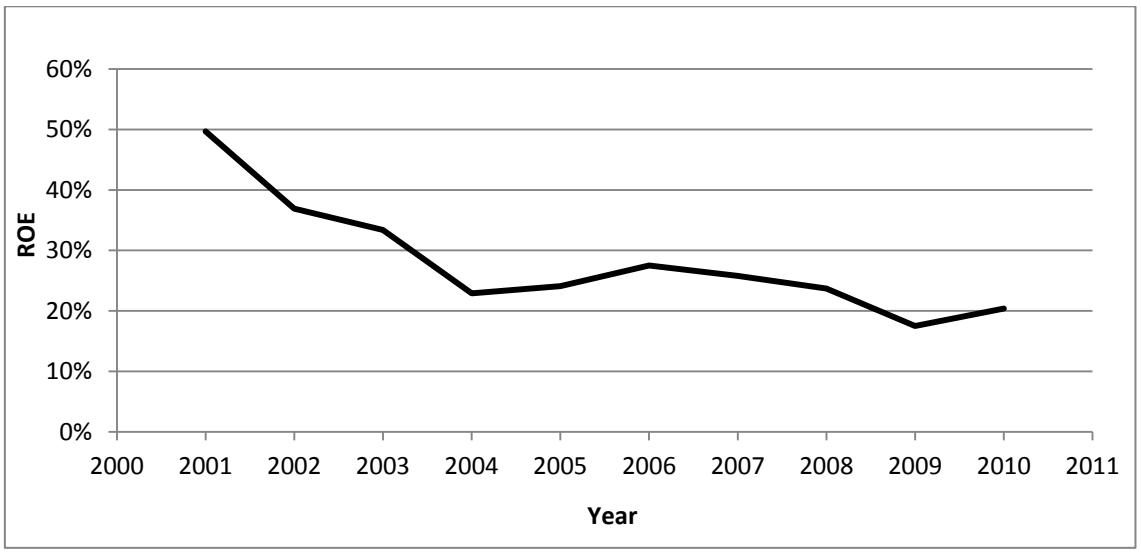


Source: Bank of Ghana

2.6.1.2 Return on Equity

The sharp and continuous decline in the industry's return on equity (ROE) reflects the increase of shareholders' capital over the period 2001 to 2004 and the corresponding fall in banks' profits. Figure 2.2 shows a decreasing trend in ROE from 2001 to 2004. However, ROE increased modestly in two successive years but resumed its downward trend until 2010 where it started to show an increasing trend. The industry's ROE increased from 17.5% in 2009 to 20.4% in 2010 (Bank of Ghana, 2010).

Figure 2.2 Return on Equity of Ghana's Banking Industry



Source: Bank of Ghana

The banking industry's returns on equity have fallen faster over most of the period under study due to the build-up of shareholders' capital (International Monetary Fund, 2007). The increase in ROE was the result of the capital injection in the two years by local banks to meet the minimum capital as well as retained earnings to meet statutory reserve requirements. This capital injection facilitated cheaper funds to finance banks' operating assets and improved their earning capacity. This led to improvement in the industry's net interest margin (PricewaterhouseCoopers, 2011). The banking industry's net interest margin[7] increased from 10.8 percent in 2009 to 12.4 percent in 2010 (Bank of Ghana, 2010).

The banking industry's ROA and ROE improved in 2010, a reversal of the continuous decline. The enhancement could be attributed to considerable decline in cost of funds due to fall in interest on loans and advances. However, the fall in earnings performance is attributed to the expenditure by the banks on information and communication technology (ICT) re-engineering (Bank of Ghana, 2007b). Despite the long successive trend of decline, the banks were generally profitable.

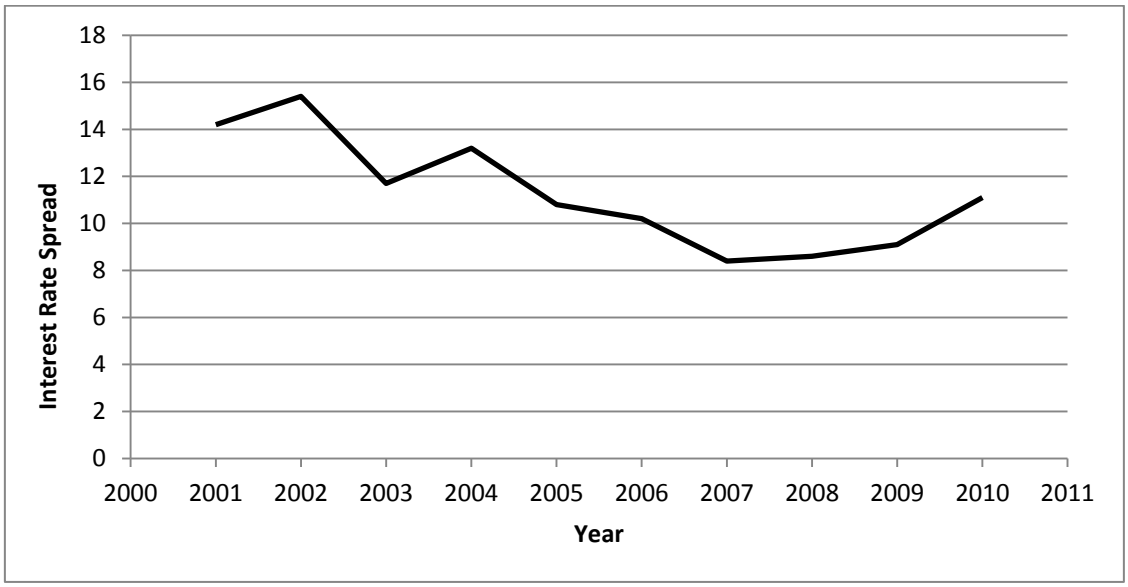
2.6.1.3 Interest Rate Spread

Interest rate spreads indicate the difference between lending and borrowing rates. The Ghana's banking system recorded a spread of 9.1 percent in 2009 compared with 11.1 percent in 2010 suggesting an increase in spread. The lowest interest rate spread of 8.4 percent was recorded in 2007 and highest spread of 15.4 percent in 2002 (see Appendix I). Figure 2.3 presents the trend of the banking industry's interest rate spread between 2001 and 2010.

The size of the interest rate spread is an indication of a number of factors including inefficiencies in the banking system. These high interest rate spreads may discourage savings and are also indicative of high transaction costs.

[7] The reserve requirement ratio in Ghana is 9 percent.

Figure 2.3 Interest Rate Spread of Ghana's Banking Industry

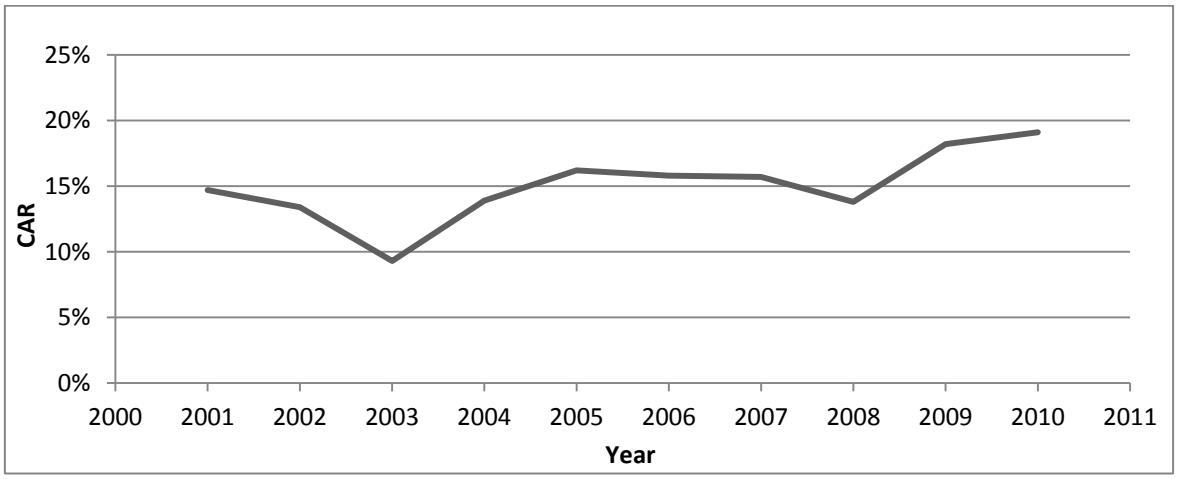


Source: Bank of Ghana

2.6.2 Solvency Indicator

The capital adequacy ratio (CAR) measures banks' solvency. The industry's CAR is defined as the ratio of risk weighted capital to risk-weighted assets. The capital adequacy ratio determines the capacity of the banking system to absorb losses or risks. The aim is to protect depositors and other lenders and promote the stability and efficiency of the financial systems (Bank of Ghana, 2007b). Figure 2.4 shows the trend of the banking industry's capital adequacy ratio between 2001 and 2010.

Figure 2.4 Capital Adequacy Ratio of Ghana's Banking Industry



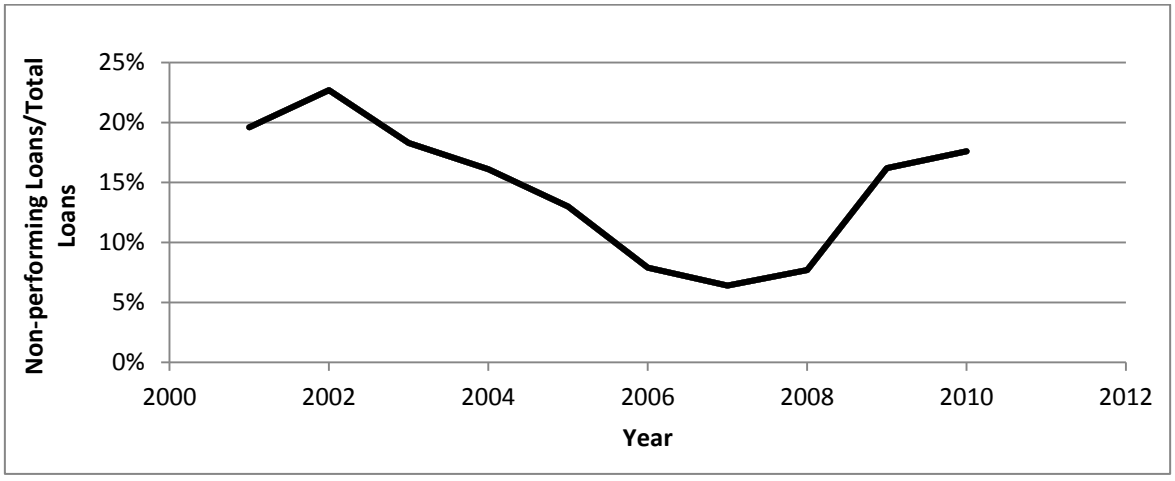
Sources: Bank of Ghana

Figure 2.4 shows in most cases, CAR exceeds the minimum requirement by the Bank of Ghana. The capital adequacy ratio shows a sharp fall in 2003. It was the only time that the CAR was below 10%, however, the required capital adequacy ratio was 6% (PricewaterhouseCoopers, 2006). Over the years, the banking industry has maintained high capital levels mostly reflecting the recent increase in minimum capital requirements and the increasing share of risk-free treasury securities. It continues to maintain its solvency with all banks complying with the required minimum capital adequacy ratio of 10.0 percent. For instance, the industry average was 19.1 per cent in 2010 which is far higher than the prudential limit of 10 percent suggesting a solvent and well capitalized banking industry (Bank of Ghana, December 2010). Thus, the injection of extra capital to meet the new minimum requirement level in 2006 and 2009 has further strengthened the solvency of Ghana's banking industry.

2.6.3 Asset Quality Indicator

Non-performing loans (NPL) ratio is used as asset quality indicator. Non-performing loans in Ghana include loans that are 90 days or more past due. Loan asset quality of Ghana's banking industry deteriorated as the ratio of non-performing loans to total loans showed rapid increasing trend from 2001 to 2002 (see Figure 2.5). Following this, the banking industry experienced a long and significant improvement in the loan quality for a period of time extending from 2002 to 2007. The NPL in the total bank credit portfolio declined to

Figure 2.5 Non-Performing Loans Ratio of Ghana's Banking Industry



Source: Bank of Ghana

6.4 percent in 2007 from as high as 22.7 percent in 2002. The improvement was attributed to better loan recovery and most of the new loans are active loans (International Monetary Fund, 2007).

However, the global financial crisis reversed the trend. The financial crisis affected the Ghanaian economy significantly resulting in a substantial decline in the quality of loans. The result following the financial crisis was a large reduction in Ghana's GDP growth, fall in inflows from portfolio capital and remittances and significant depreciation in the exchange rate (International Monetary Fund, 2011). The government could not make payments to contractors and other service providers, and therefore created NPLs across the banking system (International Monetary Fund, 2011). The NPL ratio in 2010 was 17.6 percent[8] and many banks reported high NPL ratios across the banking industry in the range of 20-40 percent including important domestic banks and subsidiaries of reputable international banks (International Monetary Fund, 2011). The upsurge in default is due to the low asset quality in previous years which generated non-performing loans in recent years. The Ghanaian banking industry's ability to withstand possible future deterioration of asset quality was improved by the increase in the minimum capital requirement for banks in 2009. Commerce and finance, manufacturing and service sectors exhibited the highest default rate in Ghana, 31.2 percent, 17.4 percent and 16.7 percent respectively. Apparently, Ghana banks have high non-performing loans in their books. Appendix G shows the comparison of banks' non-performing loans in Ghana with that of U.S, U.K, Germany, Canada and Australia. (TheGlobaleconomy.com, 2013).

Bad debt is a major problem for the banks in Ghana. However, the banks write off the debts when the borrowers are unable to pay. For example, GCB, the largest bank in Ghana, wrote off 64 million cedis of bad debts in 2010 (PricewaterhouseCoopers, 2011). In order to mitigate credit risk, the banking sector has intensified credit risk management process from origination to monitoring of credit. The introduction of the credit reference bureau (e.g. XDS Data Ghana limited, Hudson Price Data and Dun and Bradstreet) has enabled the banks to include credit checks into their management processes (PricewaterhouseCoopers, 2012). In addition, banks in Ghana have also instituted Credit

[8] The data used in the study on NPL seem unusually high. They were based on Bank of Ghana Statistics.

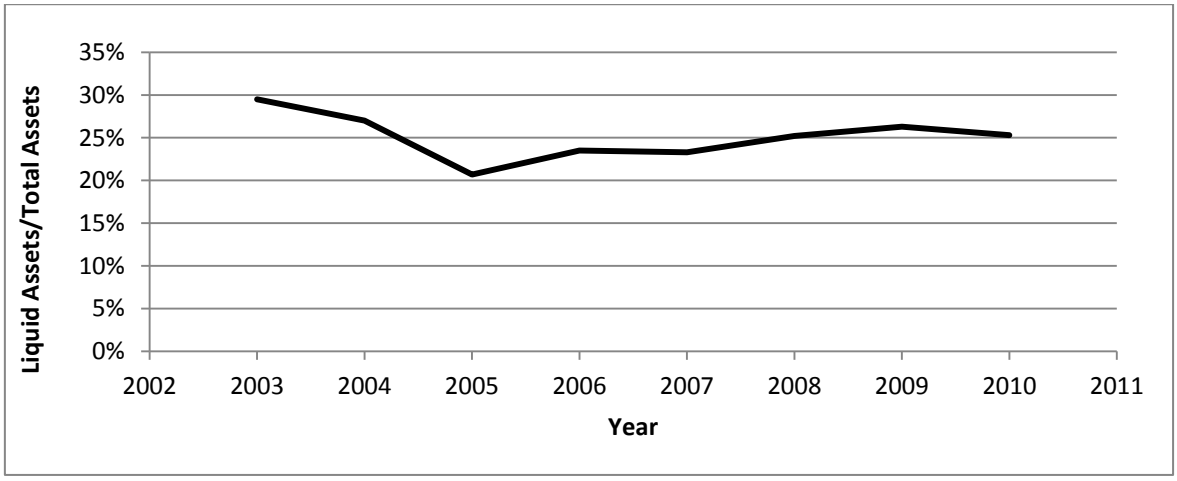
Committee Board that serves as the ultimate loan decision-makers instead of leaving it to the immediate credit officer.

2.6.4 Liquidity Indicator

Liquidity is defined as assets that can be converted into cash quickly without much loss in value. It is measured by the ratio of liquid assets to total assets. Figure 2.6 shows a sharp decline in liquidity between 2003 and 2005 because banks held more funds in less risky assets and the government reduced its domestic borrowing to reduce interest rates (Bank of Ghana, 2004). The aim of the government was to reduce inflationary pressures. However, the liquidity position of the banking industry appeared to be satisfactory. The rising trend in liquidity started from 2006 was due to the abolition of the secondary reserves requirement in August 2006 which increased banks liquidity (International Monetary Fund, 2007). Figure 2.6 illustrates the trend of liquidity in the banking industry between 2003 and 2010.

The decline in liquidity in 2010 is attributed to the reduction in the government borrowing which generated a fall in interest on government securities (PricewaterhouseCoopers, 2011).

Figure 2.6 Liquid Assets to Total Assets of Ghana's Banking Industry



Source: Bank of Ghana

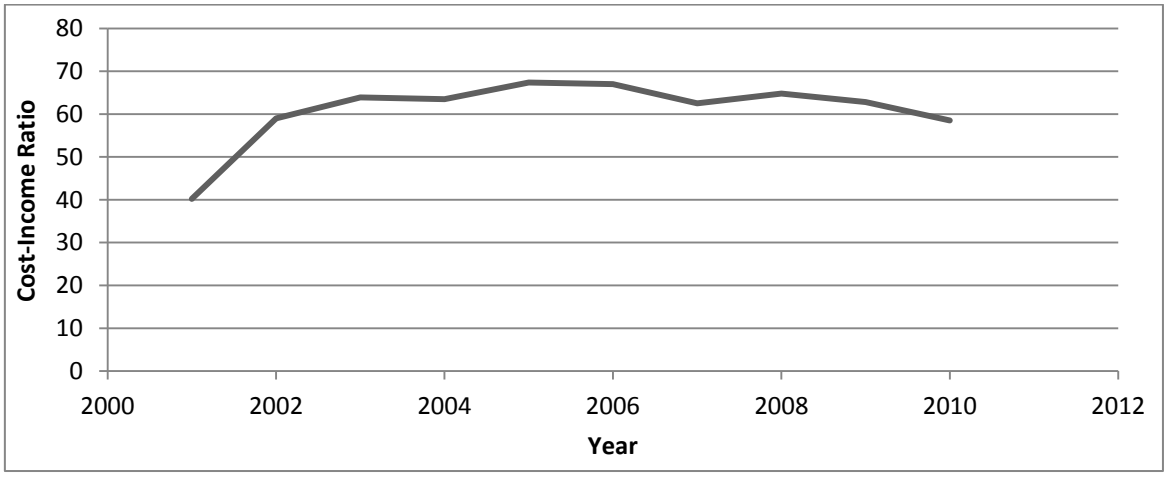
Nevertheless, the banking industry of Ghana is still liquid and within prudential limits. Increase in banks' deposit mobilisation, government expenditures and foreign inflows

especially foreign direct investment, remittances, and portfolio capital flows are the factors that have maintained significant liquidity in the Ghanaian banking sector over the years (International Monetary Fund, 2011). However, the International Monetary Fund (2011) warned that high liquidity in the banking system could promote greater risk taking by banks as a result of the recent increase in minimum capital requirements.

2.6.5 Efficiency Indicators

Cost to income ratio is defined as non-interest operating expenses divided by operating income. This ratio has been high throughout the study period 2001-2010. It recorded its lowest ratio of 40.2 percent in 2001 and the highest ratio of 67.4 percent in 2005 (see Appendix J). The cost to income ratio has been very high but started to decline from 2008 to 2010 (see Figure 2.7). The cost to income is high in Ghana because of the operating costs and rigidities in the banks cost structure that rigidities reduce flexibility of the banks to respond to macroeconomic impact leading to high lending rates (International Monetary Fund, 2011). Overhead costs are high and

Figure 2.7 Cost-Income Ratio of Ghana's Banking Industry



Source: Bank of Ghana

primarily consist of staff-related expenses (50-55 percent) and expanding administrative cost ranging between 25 and 30 percent (International Monetary Fund, 2011). The high administrative costs are partly due to the growing banks' branch networks. The rapid expansion of branch networks helps banks to compete for market share and to mobilise lower cost deposits. In addition, lack of qualified bank personnel leads to demand

exceeding supply placing upward pressure on staff costs. The lack of scale economies as result of the small banking system and small average bank size are contributors to the high cost of overhead cost in Ghana (International Monetary Fund, 2011).

2.7 Summary

Ghana's financial system is dominated by both domestic and foreign banks. Most remarkably, foreign banks hold 51 percent of the total assets of Ghana's banking industry. Ghana banking system is small and banks sizes are small on average. The amount of total assets of the Ghanaian banking sector in 2012 was 27,237.7 million cedis[9] (Bank of Ghana, February 2013). The amount of total deposits in 2012 was 19,581.1 million cedis representing 71.9 percent (the main source of bank funding) of total liabilities whereas the total borrowings in 2012 amounted to 2,262.7 million (8.3 percent as percentage of total liabilities) (Bank of Ghana, February 2013).

Between 1988 and 2010, the entry of foreign banks and more market-oriented policies have fostered competition and efficiency in the banking system. The repressive policies have either been removed or diminished. The removal of restrictions on foreign bank entry, interest rates and exchange rates and decreased in direct government intervention have entice foreign banks to enter Ghana's banking and financial markets.

The quality of bank services to their customers has been immensely enhanced. The banks have provided innovative products such as electronic-banking, telephone banking, internet banking and ATM facilities. The Bank of Ghana has also introduced the necessary reforms regarding payments and settlements and supervision and prudential regulations.

However, the strong competition and increased liquidity has caused bank management to take on higher risk ventures. Over the last three years (2008-2010), non-performing loans have deteriorated and continue to be a major problem in Ghana's banking industry. However, Ghana's banking industry is adequately capitalized, liquid and profitable[10].

[9] For 27 banks.
[10] Ghana's banks financial data may seem usual but this is the true reflection of the banking system in Ghana.

Chapter 3
Data and Econometric Methods

3.1 Introduction

The chapter is divided into two sections. Section 3.2 describes the data used in this study and Section 3.3 discusses the estimation procedure of the fixed effect regression estimator for the static panel models and the two-step system generalised method of moment estimator for dynamic panel models used in this study.

3.2 Data

The study covers Ghanaian banks during the period 2001 to 2010. The data used in this study depend on the amount of information available for each bank involved. The data exclude banks which have data available covering less than three years of operation during the entire study period. There were very few mergers and acquisitions and exit during the period. The data are analysed for inconsistencies, reporting errors, and outliers. In addition, the years with zero or missing values on input and output variables are omitted. With these restrictions, the sample data for this study is an unbalanced panel data of 25 banks with 211 annual observations, which accounts for more than 99% of bank assets in the time period under consideration. The choice of an unbalanced panel is due mostly to entry during the study period. The number of banks in each year varied between 14 and 25. The data are based on the balance sheets and income statements of the banks' annual reports. The data are obtained from PricewaterhouseCoopers. All 25 banks used the same accounting standards namely, International Financial Reporting Standards (IFRS). The macroeconomic variables are obtained from International Monetary Fund's World Economic Outlook. The 25 banks used in this study are listed in Appendix F. These 25 banks consist of 3 state-owned banks, 9 domestic private banks, and 13 foreign-owned banks. A bank is identified as foreign-owned in Ghana if the foreign ownership share of assets exceeds 50%.

3.3 Econometric Method

Many studies have employed a censored Tobit regression method to determine factors affecting efficiency because the efficiency scores (dependent variable) are bounded between 0 and 1 making the dependent variable a limited dependent variable (e.g., Maudos et al., 2002; Casu & Molyneux, 2003; Weill, 2003). Some researchers have argued that non-censored methods provide biased and inconsistent estimates. However, recently Hoff (2007), Banker & Natarajan (2008) and McDonald (2009) documented that the use of a two-stage procedure involving the DEA followed by ordinary least square (OLS) regression yields consistent estimates. Banker & Natarajan (2008) indicate that input variables may be correlated with each other and the efficiency factor variables may be correlated with each other. Therefore, the factor variables affecting efficiency must be independent of the stage one the DEA input variables. However, the Chang et al. (2008), Sufian & Habibullah (2009) and Saranga & Phani (2009) estimated their second stage regressions using the DEA as dependent variable (without any transformation) and applied OLS method, while Fiordelisi et al. (2011), Casu & Girardone (2009) and Stuab et al. (2010) used a two-step system GMM with the DEA (without any transformation) as the dependent variable. Murthy et al. (2009), Denizer et al. (2007), Bozec & Dia (2007) and Lovell et al. (1994), on the other hand, used logarithm of the DEA efficiency as their dependent variable and estimated their regression using OLS. Simar & Wilson (2007) argue that the conventional methods of statistical inference are invalid in the second stage regression. To address these problems, the authors propose the use of a bootstrap method to correct for the small sample bias and serial correlation of the DEA efficiency estimates. Hoff (2007) and McDonlad (2009) argue that the DEA efficiency scores cannot be considered as censored but rather a fractional data. Accordingly, one of the methods used to estimate fractional dependent variable is to transform the dependent variable into a log-odds ratio (logit transformation). Ataullah & Le (2006) and Maudos & Fernandez de Guevara (2007) among others have also argued against the censored Tobit regression method. They transformed the efficiency scores using a log-odds ratio. Maudos & Fernandez de Guevara (2007) used logistic regression while Ataullah & Le (2006) and Staub et al. (2010) applied the system GMM estimator to identify the factors influencing bank efficiency after transforming the DEA efficiency using logit transformation. This study uses modified logit transformation to transform the DEA efficiency and applies the fixed effect estimator for static model and the system GMM estimator for dynamic model.

This study employs fixed effect estimator for static model and the system GMM estimator for dynamic model.

3.3.1 Fixed Effect Estimator for Static Panel Models

Static equation implies instantaneous impact. It is likely that the unobserved individual bank heterogeneity (such as management style and strategy, managerial ability and willingness to risk) and the explanatory variables are not correlated. In such situation, the fixed-effect estimator which is based on deviations of the observations can be consistent (Arellano & Bover, 1995). The fixed effects model unlike the random effect model, assumes that the unobserved effects are constant within individual banks, but changes across banks (assuming heterogeneity across banks) for a given point in time. Unlike Tobit and ordinary least squares (OLS) models, the fixed effect regression model controls for unobserved heterogeneity[11].

In this study, the fixed effect regression model (static model) is used to assess the determinants of bank efficiency and bank competition. Thus, equation can be represented by the following regression:

$$y_{it} = \beta_0 + X_{it}\beta' + \eta_i + \mu_{i,t} \qquad (3.1)$$

where

i represents the individual bank and *t* denotes time,

y_{it} = dependent variable,

X_{it} = explanatory variables,

η_i = unobserved individual effect (such as managerial ability, strategy or historical factors),

μ_{it} = error term,

[11] In the absence of correlation between unobserved individual bank heterogeneity and the explanatory variables, random effect estimator is more appropriate. Otherwise treating the individual heterogeneity as a random error component can provide biased and inconsistent estimates.

3.3.1.1 Estimation Methods for Fixed Effect Estimator

A fixed effect regression estimator consists of subtracting the time mean from each variable in the model and the OLS method is applied to the transformed model in order to estimate β. The above model (3.1) is transformed as follows:

$$y_{it} - \bar{y}_i = (X_{it} - \bar{X}_i)\beta' + (\mu_{it} - \bar{\mu}_i) \qquad (3.2)$$

where

$$\bar{X}_i = \frac{1}{T}\sum_{t=1}^{T} X_{it} \quad \text{and} \quad \bar{\mu}_i = \frac{1}{T}\sum_{t=1}^{T} \mu_{it}$$

$$\hat{x}_{it} = (X_{it} - \bar{X}_i) \quad \text{and} \quad \hat{y}_{it} = (y_{it} - \bar{y}_i)$$

therefore

$$\hat{\beta}_{FE} = \left(\sum_{i,t}^{T} \hat{x}'_{it}\,\hat{x}_{it}\right)^{-1} \sum_{i,t}^{T} \hat{x}'_{it}\,\hat{y}_{it}$$

The fixed effect (FE) estimator uses the within transformation to eliminate the unobserved individual effect η_i and consistently estimate β.

3.3.2 Two-Step System GMM Estimator for Dynamic Models

The dynamic approach is applied in this study because there is no guarantee that all the explanatory variables (especially bank-specific variables) are strictly exogenous, since banks may manage their assets and liability structures over a period of time indicating that the lagged explanatory variables are not strictly exogenous (Goderis et al., 2007). Thus, some explanatory variables may be exogenous, predetermined or endogenous.

This study uses the two step system GMM estimator instead of difference GMM estimator for the following reasons:

Blundell & Bond (1998) demonstrated that the system GMM estimator reduces the potential biases and inaccuracies associated with the first-difference GMM estimator

especially for small samples, unbalanced panel data and when the explanatory variables are persistent.

System GMM estimator is chosen because it is asymptotically more efficient and robust to heteroskedasticity (and second order autocorrelation) relative to difference GMM, but its standard error is largely downward biased in small samples (Arellano & Bond, 1991; Blundell & Bond, 1998). Therefore, Windemeijer's (2005) correction for small sample is applied to rectify the standard error bias. Consequently, the two-step GMM estimator provides more accurate estimates than the robust one-step GMM estimator, especially for the system GMM (Roodman, 2003).

In addition, Roodman (2006, 2009) also suggests the avoidance of employing difference GMM estimator when using an unbalanced panel, simply because it has a weakness of magnifying gaps in unbalanced panels. For instance, if some y_{it} is missing, then both Δy_{it} and $\Delta y_{i,t+1}$ are missing in the transformed data. Arellano & Bover, (1995) and Roodman (2006, p.20; 2009, p.104) recommend the use of forward orthogonal deviation in place of first-differencing. Forward orthogonal deviations approach subtracts the mean of all future available observations of a variable instead of subtracting the past value of observations of a variable. Only the last data for each individual variable is not computable and therefore it minimises data loss (Roodman, 2009). This approach preserves sample size in panels with gaps (Arellano & Bover, 1995; Roodman, 2009). Simulation results show that the GMM estimator with forward orthogonal deviation transformation works better than that transformed by the first difference (Hayakawa, 2009).

3.3.3 Estimation Method for System GMM Estimator

Equation (3.1) can be represented by the following dynamic regression:

$$y_{i,t} = \propto y_{i,t-1} + \beta' x_{i,t} + \varepsilon_{it} \qquad i = 1, 2, \dots N \text{ and } t = 1, 2, \dots T \tag{3.3}$$

$$\varepsilon_{it} = \eta_i + \mu_{it} \tag{3.4}$$

$$E(\eta_i) = 0, \;\; E(\mu_{it}) = 0, \;\; E(\eta_i \mu_{it}) = 0 \;\; \text{for all i = 1,2,...N and t = 1, 2,...T} \tag{3.5}$$

where

i represents the individual bank and *t* denotes time,

$y_{i,t}$ = dependent variable for the bank *i* at period t,

$x_{i,t}$ = set of independent variables (observed heterogeneity)

η_i = unobserved heterogeneity,

$\mu_{i,t}$ = an error term,

$\varepsilon_{it} = \eta_i + \mu_{it}$ is the fixed effects decomposition of the error term.

3.3.3.1 First Difference GMM Estimator

The presence of the lagged dependent variable as an explanatory variable does not allow the use of conventional techniques to estimate α and β in equation (3.3). Arellano & Bond (1991) propose first-differencing the variables in equation (3.3) to eliminate any potential bias that may arise from unobserved bank specific effect (unobserved heterogeneity). This is because unobserved heterogeneity does not vary with time. This removes the correlation between banks' unobserved heterogeneity (error term) and lagged dependent variable. Thus, taking first difference of equation (5.9) yields the following specification:

$$y_{i,t} - y_{i,t-1} = \propto (y_{i,t-1} - y_{i,t-2}) + \beta'(x_{i,t} - x_{i,t-1}) + (\varepsilon_{i,t} - \varepsilon_{i,t-1}) \qquad (3.6)$$

However, the lagged dependent variable is still potentially endogenous, because $y_{i,t-1}$ term in $y_{i,t-1} - y_{i,t-2}$ correlates with $\varepsilon_{i,t-1}$ in $\varepsilon_{it} - \varepsilon_{i,t-1}$. In addition, any explanatory variables in x that are weakly exogenous could be potentially endogenous because they too may be correlated with $\varepsilon_{i,t-1}$. Therefore, we need to employ instrumental variables to address this problem of endogeneity. Arellano & Bond (1991) suggest using the lagged levels of explanatory variables (including the lagged dependent variable) as instruments for the equations in first difference. This is valid under the assumption that the error term is not correlated with the lagged explanatory variables. This implies that the following moment conditions for each endogenous variable have to be satisfied for equation (3.6) to be estimated using first difference GMM (Arellano & Bond, 1991):

$$E[y_{i,t-s}(\Delta\varepsilon_i)] = 0 \qquad \text{for } s \geq 2,\ t = 3, \dots, T \qquad (3.7)$$

$$E[x_{i,t-s}(\Delta\varepsilon_i)] = 0 \qquad \text{for } s \geq 2,\ t = 3, \dots, T \qquad (3.8)$$

where $x_{i,t-s}$ and $y_{i,t-s}$ represent the instruments set used in the first difference GMM.

Thus, the moment conditions in equations (3.7) and (3.8) can be written compactly as follows:

$$E[Z'_{di}\Delta\varepsilon_i] = 0 \qquad i = 1, \dots, N \tag{3.9}$$

where Z_{di} is the (T-2) x (T-1)(T-2) matrix of instruments of the individual *i* (in this case the bank) given as follows:

$$Z_{di} = \begin{bmatrix} y_{i1}x_{i1} & 0 & \cdots & 0 \\ 0 & y_{i1}y_{i2}x_{i1}x_{i2} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & y_{i1}\cdots y_{iT-2}x_{i1}\cdots x_{iT-2} \end{bmatrix} \qquad \Delta\varepsilon_i = \begin{bmatrix} \Delta\varepsilon_{i3} \\ \Delta\varepsilon_{i4} \\ \vdots \\ \Delta\varepsilon_{iT} \end{bmatrix} \tag{3.10}$$

Then the matrix with all the instruments in the model is represented as $Z_d = (Z'_{d1}, Z'_{d2}, \dots, Z'_{dN})'$. Therefore the first difference GMM estimator for $\widehat{\Phi}_d = (\alpha, \beta)'$ in equation (3.6) based on the moment conditions in equations (3.7) and (3.8) or (3.9) are as follows:

$$\widehat{\Phi}_d = (\Delta X' Z_d A_d Z'_d \Delta X)^{-1} \Delta X' Z_d A_d Z'_d \Delta Y \tag{3.11}$$

where

matrix **X** is formed by the stacked matrices $X_i = ((y_{i2}, x_{i3})', (y_{i3}, x_{i4})', \dots, (y_{iT-1}, x_{iT})')'$ including lagged explanatory variables and matrix Y is formed by stacked vector $Y_i = (y_{i3}, y_{i4}, \dots, y_{iT})'$ is the vector of dependent variable.

However, the first-difference GMM estimator may suffer from the weaknesses of its instruments as the lagged levels of persistent explanatory variables are weak instruments for the equation in first-difference (Blundell & Bond, 1998). This implies that past levels provide little information about future changes (the first-differencing procedure may dispose much of the available information in the data).

3.3.3.2 System GMM Estimator

To address this potential bias and imprecision associated with the use of first difference GMM estimator, Arellano & Bover (1995) and Blundell & Bond (1998) developed a

system GMM estimator that combines both equations in levels (equation 3.3) and equations in differences (equation 3.6) simultaneously. This assists to retain some of the information in the levels equation. This system GMM estimator (considered as an extension of the first-difference GMM estimator) reduces the potential biases and inaccuracies associated with the first-difference GMM estimator especially for small samples and with persistent data.

However, the system GMM estimator still includes unobserved heterogeneity therefore Blundell & Bond (1998) suggested differencing the instruments to make them exogenous to the fixed effects (instead of transforming the explanatory variables). This is valid provided the first-difference variables are not correlated with unobserved fixed effects in order for the first differences to be valid instruments in the levels equation (see Arellano & Bover, 1995; Bond, 2002). In other words, this assumption is valid if any correlation between endogenous variables and the unobserved fixed effect is constant over the time period of the data set (Wintoki et al., 2012). This additional assumption leads to additional set of moment conditions (Arellano & Bover, 1995; Blundell & Bond, 1998; Bond, 2002) as follows:

$$\mathrm{E}\left[(\Delta \mathrm{y}_{\mathrm{i,t-s}})\varepsilon_{\mathrm{i,t}}\right] = 0 \qquad \text{for } \mathrm{s} = 1,\ \mathrm{t} = 3, \dots, \mathrm{T} \tag{3.12}$$

$$\mathrm{E}\left[(\Delta \mathrm{x}_{\mathrm{i,t-s}})\varepsilon_{\mathrm{i,t}}\right] = 0 \qquad \text{for } \mathrm{s} = 1,\ \mathrm{t} = 3, \dots, \mathrm{T} \tag{3.13}$$

These moment conditions allow the use of lagged first-differences of the endogenous variables as instruments for equations in levels as suggested by Arellano & Bover (1995). The level GMM estimator is obtained by using the moment conditions in equations (3.12) and (3.13) which can then be written compactly as:

$$\mathrm{E}[Z_{li}'\ \varepsilon_i] = 0 \tag{3.14}$$

Then the instruments for the equations in levels for each individual i are given by 2(T-2)(T - 2) matrix

$$\mathrm{Z_{li}} = \begin{bmatrix} \Delta \mathrm{y_{i2}} \Delta \mathrm{x_{i2}} & 0 & \cdots & 0 \\ 0 & \Delta \mathrm{y_{i3}} \Delta \mathrm{x_{i3}} & \cdots & 0 \\ \vdots & \vdots & \cdots & \vdots \\ 0 & 0 & \cdots & \Delta \mathrm{y_{iT-1}} \Delta \mathrm{x_{iT-1}} \end{bmatrix} \qquad \varepsilon_i = \begin{bmatrix} \varepsilon_{i3} \\ \varepsilon_{i4} \\ \vdots \\ \varepsilon_{iT} \end{bmatrix} \tag{3.15}$$

The matrix of all the instruments in the model is represented as follows: $Z_l = (\mathrm{Z}'_{\mathrm{l}1}, \mathrm{Z}'_{\mathrm{l}2}, \ldots, \mathrm{Z}'_{\mathrm{l}\mathrm{N}})'$.

The system GMM estimator adds set of equations in first-differences with lagged levels as instruments to the set of equations in levels with lagged first-differences as instruments. This is performed to improve the efficiency of the estimator. The system GMM estimator is obtained by using the moment conditions in equations (3.7), (3.8), (3.12) and (3.13) or (3.9) and (3.14) which can then be written compactly as:

$$\mathrm{E}[Z'_{si}\, p_i] = 0 \qquad (3.16)$$

Therefore the whole set of instruments used in the system GMM estimator is given by the 2N(T-2) (2(T-2+(T-1)(T-2)) matrix

$$Z_{si} = \begin{bmatrix} Z_{di} & 0 \\ 0 & Z_{li} \end{bmatrix} \qquad p_i = \begin{bmatrix} \Delta\varepsilon_i \\ \varepsilon_i \end{bmatrix} \qquad (3.17)$$

where $\mathrm{Z_d}$ as defined by equation (3.9) and $Z_s = (\mathrm{Z}'_{\mathrm{s}1}, \mathrm{Z}'_{\mathrm{s}2}, \ldots, \mathrm{Z}'_{\mathrm{s}\mathrm{N}})'$. Hence the system GMM estimator based on moment conditions in equation (3.16) is

$$\widehat{\Phi}_{\mathrm{s}} = (X'_s Z_s \mathrm{A_s} Z'_s X_s)^{-1} X'_s Z_s \mathrm{A_s} Z'_s Y_s \qquad (3.18)$$

where $\mathrm{X_s}$ is a stacked matrix of explanatory variables in differences and levels and $\mathrm{Y_s}$ is a stacked vector of the dependent variable in differences and levels.

3.3.3.3 One-Step and Two-Step GMM estimators

Each GMM estimator (difference GMM or system GMM) has two different choices namely; one-step or two-step estimator. For instance, the one-step system GMM estimator uses

$$\mathrm{A_s} = \left(\frac{1}{\mathrm{N}} \sum_{\mathrm{i}=1}^{\mathrm{N}} \mathrm{Z'_s H Z_s} \right)^{-1} \qquad (3.19)$$

where

$$H=\begin{bmatrix} 2 & -1 & 0 & \cdots & 0 \\ -1 & 2 & -1 & \cdots & 0 \\ 0 & -1 & 2 & \cdots & 0 \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ 0 & 0 & 0 & \cdots & 2 \end{bmatrix} \quad (3.20)$$

The two-step GMM estimator uses

$$A_s = \left(\frac{1}{N}\sum_{i=1}^{N} Z'_s \Delta\hat{\varepsilon}_i \Delta\hat{\varepsilon}'_i Z_s\right)^{-1} \quad (3.21)$$

The one-step GMM estimator uses a weighted matrix that does not rely on the estimated parameters and is only efficient under homoskedasticity and uncorrelated with error terms (Presbitero, 2005). On the contrary, the efficient two-step GMM estimator uses the residuals from the one-step estimate and applies a consistent estimate of the weighted matrix (Davidson & MacKinnon, 2004).

3.3.3.4 Some Rules of Thumb in GMM Estimation

i. the number of period (years) must always be smaller than the number of units (in this study, banks) in order to control for dynamic panel bias (e.g. Bond, 2002; Roodman, 2006, 2007; Baltagi, 2008).
ii. the number of instruments should not exceed the number of units (banks) (Roodman, 2006).

3.3.3.5 Choice of Lagged Variables as Instruments

The choice of lagged variables as instruments depends on the nature of the explanatory variables:

i. For the exogenous explanatory variables, their current values are used as valid instruments.
ii. For predetermined explanatory variables or lagged dependent variables (which are not correlated with future values of the error term), lagged values for at least one period can be used as valid instruments.

iii. For endogenous explanatory variables, only their lagged values for at least two periods can be used as valid instruments.

3.3.3.6 Issue with Excessive Instruments

The concern with the use of GMM with small sample is that the number of instrument could become large relative to the number of banks in the regression. This is to avoid the problem of too many instruments (overfitting endogenous variables) in the system GMM estimations since it weaken the specification tests and bias the results (Roodman, 2007, 2009). Thus, when the instrument count is high, the Hansen test of validity of the instruments weakens (Roodman, 2009). This could mean accepting a model as valid when the problem of endogeneity is partially solved.

To solve this issue, Roodman (2007, 2009) suggested the following techniques:

i. use less lags as instruments than all available lags for instruments. This approach caps number of instruments for each period, so the instrument count is linear in T.
ii. 'collapse' instruments in order to reduce the number of instruments without losing much information from the data. That is, combine instruments in small subsets. Specifically, group together columns of the instrument matrix that are for the same variable and lag distance and combine them to generate a smaller set of moment conditions. The instrument count is quadratic in T for both GMM estimators. Collapsing also makes the instrument count linear in T. Thus, it restricts all of the yearly moment conditions to be the same and, hence, reduces the instrument count.

Apply these techniques while examining the behaviour of the coefficient estimates and Hansen and difference-in-Hansen tests. The two techniques can be applied together. The application of these techniques reduces the number of instruments in GMM estimations in order to have more reliable estimations.

3.3.3.7 Testing the Validity of the Instruments and Structural Specification

The specification of the models and the validity of the instruments are tested. Arellano & Bond (1991) and Blundell & Bond (1998) suggest two tests:

i. Tests for the first-order and second-order serial correlation in the first differenced residuals. However, the second-order serial correlation test is the decisive test

because second-order serial correlation among the residuals would show any violation of the exclusion restrictions (given that first differencing induces first order serial correlation in the first differenced errors). The second-order serial correlation test assesses the null hypothesis that the errors in the first-difference regression have no second-order serial correlation. Failure to reject the null hypothesis gives support to the specification of the models.

ii. The dynamic panel GMM estimator uses multiple lags as instruments suggesting that the system is over-identified. The Hansen (1982) J-test of over-identifying restrictions is used to test for the validity of the instruments. The null hypothesis is that instruments are exogenous. The test is distributed χ^2 with J-K degrees of freedom, where J is the number of instruments and K is the number of regressors. Failure to reject the null hypothesis gives support to the model. It is an indication that the instruments are valid. The Hansen J- test performs well in the presence of heteroskedasticity and autocorrelation unlike the Sargan (1958) test, which over-rejects in the presence of heteroskedasticity and autocorrelation.

iii. The system GMM estimator makes an additional assumption that any correlation between endogenous variables and the unobserved (fixed) effect is constant over time. This assumption enables us to include the levels equations in the system GMM estimation and use lagged differences as instruments for these levels. This assumption can be tested directly using a difference-in-Hansen test of exogeneity (Bond et al., 2001). Difference-in-Hansen test of exogeneity is under the null hypothesis that the instruments used for the equations in levels are exogenous. This test also provides a J-statistic which is distributed $\chi 2$ under the null hypothesis that the additional subset of instruments used in the levels equations (system GMM) is exogenous. Failure to reject justifies the inclusion of the levels equations in the system GMM estimation.

These tests must be satisfied under the system GMM estimation. The Hansen (and difference-in-Hansen) tests of over-identifying restrictions should not be rejected implying that the instruments used in the system GMM estimation are valid. According to Roodman (2007), the p-value should exceed the conventional 0.05 or 0.10 significance levels, at least 0.25 to rule out specification problems. However, most researchers use the higher values

over the conventional level of significance (and ignore the “at least 0.25” recommended by Roodman). It is also expected that the p-values of the Hansen and difference-in-Hansen tests should not be equal to 1.00 (Roodman, 2007 pp.10). A p-value of Hansen test equal to one suggests model mis-specification because it is a classic sign of instrument proliferation weakening its ability to detect the problem (Roodman, 2007). Further, the p-values of the Hansen test closer to 1.00 are considered as worrisome. However, there is no stipulated range that is considered closer to 1.00. Nonetheless, any p-value of Hansen tests over 0.90 is viewed with concern. Moreover, it is imperative that the second order autocorrelation test under the null hypothesis of no second order autocorrelation is not rejected (by construction the model will exhibit first-order serial correlation). This leads to the conclusion that the original error term is serially uncorrelated.

Chapter 4
Bank Efficiency

4.1 Introduction

The chapter is divided into ten sections. Section 4.2 describes measurement of efficiency using DEA approach presented in Section 4.3. Literature review is provided in Section 4.4. Section 4.5 and Section 4.6 provide the methodology and variables measurement respectively. The issue of endogeneity is discussed in Section 4.7 and Section 4.8 offers the descriptive statistics and correlation analysis. Section 4.9 presents the results and Section 4.10 provides the summary of the chapter.

4.2 Measurement of Bank Efficiency

The measurement of bank efficiency mostly focuses on two key approaches: parametric and non-parametric methods. Parametric approaches take into account random errors and specify a particular functional form which shapes the form of the frontier such as Cobb-Douglas and translog. In contrast, nonparametric methods neither require specifying the functional form for the frontier nor consider random errors. The apparent differences between these two approaches are based on the shape of the efficient frontier and the assumptions about the distribution of the inefficiency (e.g. half-normal, truncated normal or exponential) and random error (Berger & Humphrey, 1997).

4.2.1 Choice of Frontier Efficiency Measurement Approach

There is no agreement on the accepted method for assessing the best-practice or efficient frontier against which relative efficiencies are measured (Berger & Humphrey, 1997). The choice of estimation approach is a subject of debate. Some researchers consider the parametric approach (Berger, 1993) as the appropriate method, while others prefer the non-parametric approach (Seiford & Thrall, 1990).

Three main parametric frontier approaches are employed to estimate efficiency:

1. Stochastic frontier approach (SFA) by Aigner et al. (1977) and Meeusen & van den Broeck (1977).

SFA is the most commonly used parametric approach. It defines a functional form for the cost, profit, or production relationship among inputs, outputs, and environmental factors and allows for error term (Berger & Humphrey, 1997). The main advantage of SFA is that it incorporates the error term in the efficiency estimation. SFA has a two-component error term: random errors (statistical noise) and inefficiency. The inefficiency is assumed to follow an asymmetric distribution, usually the half-normal distribution while random error term is commonly assumed to follow a symmetric distribution, such as the standard normal distribution (Berger & Humphrey, 1997). However, SFA models require a large sample size to make reliable estimations.

2. Distribution free approach (DFA) by Berger (1993)[12].
   DFA imposes no assumptions about the distribution of the inefficiency and the random errors, because it considers inefficiency as constant over time while random error tends to average out over time.

3. Thick frontier approach (TFA) by Berger & Humphrey (1991).
   TFA also requires a functional form. It measures separately the highest and lowest performance quartiles of the observations. It assumes that deviations in predicted performance values between the highest and lowest quartiles represent inefficiencies while the random error is the deviation within the lowest and highest performance quartile of observations (Berger & Humphrey, 1997).

An important drawback of the parametric approaches is that they impose a functional form which pre-specifies the shape of the frontier. If the functional form is misspecified, the efficiency estimate will be biased (Delis et al., 2009).

Two main non-parametric frontier approaches are:

1. Free disposable hull (FDH) by Deprins et al. (1984).
   FDH is a form of the DEA model in which the points on the lines connecting the DEA vertices are excluded from the frontier.
2. Data envelopment analysis by Charnes et al. (1978).

[12] Based on the earlier work of Schmidt and Sickles (1984)

DEA, a non-parametric approach, on the other hand, does not specify any functional form of the underlying production relationship (Berger & Humphrey, 1997). In addition, DEA does not take into account random errors. It uses linear programming method to estimate efficiency. The main drawback of the DEA approach is that it does not take into account the random error in the data. Consequently, the approach assigns the following factors to inefficiencies:

i. measurement errors in constructing the frontier
ii. inaccuracies made by accounting rules (would make measured outputs and inputs deviate from the economic outputs and inputs)
iii. extreme data, that is, large outliers

DEA does not distinguish between inefficiency and random error. Thus, any deviation from the frontier is imputed to inefficiencies. For instance, if there is any shock that reduces the performance of a bank, it will be characterised as inefficient. This may result in overestimation of inefficiencies. In addition, it is not possible to conduct statistical hypothesis tests because DEA is a nonparametric method.

Nevertheless, DEA is used extensively in studies of the banking industry in developed and developing economies; for individual countries as well as cross-country comparisons (Aly et al., 1990; Chen, 1998; Sathye, 2001; Casu & Girardone, 2006; Moffat & Valadkhani, 2011). Similarly, SFA has been applied worldwide (Allen & Rai, 1996; Ashton, 2001; Shanmugam & Das, 2004; Girardone et al., 2004; Sun & Chang, 2011). Of the 122 frontier studies in financial institution efficiency reviewed by Berger & Humphrey (1997), 69 applications used the nonparametric techniques and 60 used parametric approaches. Of the 69 nonparametric applications, 62 were DEA and out of the 60 parametric applications, 24 used SFA.

Sherman & Zhu (2006) remark that using DEA can help to identify:

i. efficient units (in this study, banks) – banks using fewer inputs to produce products and services (best-practice units).
ii. inefficient units - banks using more inputs than the best-practice units to produce products and services.
iii. targets for improvement in the inefficient units by adopting best practices.

Following Aly et al. (1990), Chen (1998), Sathye, (2001), Casu & Girardone (2006), and Tecles & Tabak (2010) among others, a non-parametric DEA is used in our study to estimate bank efficiency in Ghana. This choice is based on following factors:

i. DEA does not require knowledge of the functional form of the frontier, error and inefficiency structures
ii. DEA can handle multiple inputs and multiple outputs
iii. DEA is relatively less data demanding and as a result it works well with a small sample size. This is very important because of the small number of banks in our study.

4.3 Data Envelopment Analysis

The concept of DEA was first developed by Charnes et al. (1978) based on the concept of efficiency as proposed by Farrell (1957). The authors' model also employed input orientation and assumed constant return to scale. They extended Farrell's (1957) single input and single output efficiency measure to multiple inputs and multiple outputs. Subsequently, Banker et al. (1984) proposed variable return to scale model. These are the two main DEA models which have been widely used in the banking literature.

DEA is a linear programming based technique for measuring the relative efficiency of a fairly homogeneous set of decision making units (DMUs), which are banks in our study. DEA uses multiple inputs and outputs to determine efficiency scores that can be used to evaluate decision making units. DEA forms surface frontier over the data points to determine the efficiency of each firm relative to the frontier. DEA constructs the frontier as a discrete piecewise linear combination of the most efficient units. This provides a convex production possibilities set that envelops all observations. Thus, DEA sets up an efficient frontier based on observed best performances and evaluates the efficiency of each DMU relative to the frontier. This implies that the best-practice or efficient unit defines the efficient reference DMU. The efficiency of the other DMUs under study is computed relative to this reference DMU. DMUs that lie on the frontier are efficient. Firms that are not on the frontier are inefficient (Das & Ghosh, 2006, 2009). DEA quantifies the distance to the efficient frontier for each DMU. Thus, this method provides a measure of relative efficiency.

DEA can be employed to estimate technical (pure technical and scale), cost, revenue, and profit efficiency for any units. However, this study focuses on pure technical and cost efficiency to estimate how efficient Ghanaian banks are in reducing input wastes or cutting costs in this era of financial sector reforms. Pure technical efficiency refers to the bank's managerial skills in using its inputs to ensure outputs maximization. This relates to managerial skills such as controlling operating expenses, effective screening and monitoring of borrowers, marketing activities focussing on attracting depositors, efficient risk management techniques, etc. The following are examples of previous studies that have estimated banks technical efficiency: Isik & Hassan, 2002; Ataullah & Le, 2006; Havrylchyk, 2006; Pasiouras et al., 2007, and that of cost efficiency: Isik & Hassan, 2002; Williams, 2004; Ariff & Can, 2008; Ray & Das, 2010.

4.3.1 Various Alternative DEA Models

There are other DEA models occasionally used to estimate bank efficiency. Table 4.1 shows other forms of DEA models.

Table 4.1 Other Forms of DEA Models

Model	Authors	Year	Main Characteristics
Additive DEA Model	Charnes et al.	1985	Has the same envelopment surface as the VRS model. Projects the inefficient units onto the efficient frontier by reducing their inputs and increasing their outputs at the same time.
Multiplicative DEA Model	Charnes et al.	1982	A multiplicative combination is used to obtain virtual outputs and inputs instead of additive combination. Has a piecewise log-linear frontier.
Stochastic DEA Model	Sengupta	2000	Includes random error in the input-output data.
Cross-Efficiency DEA Model	Sexton et al.	1986	Identify good overall units. Effectively rank DMUs.
Super- Efficiency DEA Model	Andersen & Petersen	1993	Permits ranking of efficient DMUs.
Assurance Region DEA Model	Thompson et al.	1986, 1990	Restricts weight values in order to limit the range of acceptable efficient input-output levels.
Cone-ratio DEA model	Charnes et al.	1990	Links the DEA with multi-criteria analysis.

4.3.2 Input and Output Orientations

In order to construct DEA frontier and estimate efficiency, the production unit is expected to specify its objective regarding input/cost minimisation or output/revenue maximisation. The choice of input or output orientation is based on the objective of production units subject to production and management constraints. DEA permits the choice between two main orientations: input and output. The input orientation measures efficiency by minimising inputs. An input-oriented measure quantifies the input reduction without reduction in output. The input-oriented approach identifies the input waste (or excess capacity) in the production process. Similarly, by maximising outputs an output-oriented measure quantifies the output expansion, assuming the inputs are fixed. The orientation used to measure efficiency may influence the efficiency scores estimated.

The majority of the banking studies in the literature using DEA models have applied input orientation (Delis et al., 2009). However, Coelli et al. (2005) indicate that choosing an appropriate orientation is important when using econometric approaches because it could suffer from statistical problems but linear programming approaches have no such problems. DEA is not subjected to statistical tests. Coelli & Perelman (1996), on the other hand, suggest that, in many instances, the choice of orientation has only a small impact on the efficiency scores estimated. Previous studies have applied the input-oriented efficiency measures because the input quantities are considered the primary decision variables, but this reason may not be valid in all industries (Casu & Molyneux, 2003).

The choice of orientation, undoubtedly, has both practical and theoretical implications. However, the theoretical literature has not been able to choose the appropriate alternative orientations of measurement (Casu & Molyneux, 2003). In some previous studies, the choice of the orientation was straightforward; for example, in industries where cost-control is considered essential, input orientation has been the ultimate choice (Ferrier & Valdmanis, 1996, Casu & Molyneux, 2003). Many studies in the banking literature have based their choice of orientation on the quantities (inputs or outputs) the managers have most control over. Further, when a bank (firm) has a fixed quantity of resources and is required to produce as much output as possible, then the appropriate model is the output-oriented model (see Coelli et al., 1998).

However, there are other measures such as the non-oriented models. Non-orientation is used to compute efficiency by changing both inputs and outputs at the same time. Specifically, non-oriented models use a mix of input reduction and output increase to estimate efficiency. In spite of this measure, input or output orientation is mostly used in the banking literature involving DEA model.

4.3.3 Choice of Input or Output Orientation

A review of the banking literature revealed that output-oriented estimations are inappropriate for assessing bank efficiency in an industry that is reforming as in the case of the Ghanaian banking sector. Financial reforms have brought technological advances in information and communication and enhanced competition. The increased competition would compel banks to strategically focus on cutting costs, for instance, by introducing more cost effective innovative products. Therefore, it is anticipated that the relative efficiency would depend on the banks' capability or to be more precise the managements' capability in using their resources better than their competitors. Moreover, through input-oriented DEA, the sources of input waste (for not employing best practices) in the Ghanaian banking industry may be identified and some policy conclusions drawn from them. Furthermore, previous studies such as Elyasiani & Mehdian (1990), Drake (2001), Goddard et al. (2001) and Berger (2007) focused on the estimation of efficiency assuming that bank management has more control over costs rather than over outputs. Consequently, the adoption of an input-orientation is deemed fairly appropriate for our study.

4.3.4 Formulation of DEA Models

DEA models can assume either constant returns-to-scale (Charnes et al., 1978), or variable return-to-scale (Banker et al., 1984). The constant return-to-scale (CRS) assumption is acceptable when all banks in the sample are operating at optimal scale (minimum point on the long-run average cost function). It means that a proportionate increase in input leads to a proportionate increase in output. It indicates that all banks, small and large, are able to produce with the same input–output ratios. In contrast, the variable return-to-scale (VRS) is appropriate when firms or banks are not operating at optimal scale. It implies that a proportionate increase in input leads to a disproportionate change in output. Generally, imperfect competition, regulatory requirements and constraints on finance in practice suggest that most of the banks are not operating at

optimal scale (Coelli et al., 1998). DEA model uses linear programming to generalise the Farrell's (1957) single output and input idea of efficiency measure to the multiple output and input measure.

4.3.4.1 DEA Input-Oriented Model with Constant Returns to Scale

Consider the situation with K number of inputs, M number of outputs and N number of banks. For the *i*-th bank, x_i represents a vector of inputs and y_i a vector of outputs. The K×N input matrix X, and the M×N output matrix Y, represent the data of all N banks. The efficiency of a bank *i* is then determined as the ratio of all outputs over all inputs such as

$$\frac{u'y_i}{v'x_i} \tag{4.1}$$

where

v = K x 1 vector of input weights

u = M x 1 vector of output weights

v′ = transpose of the input weights matrix

u′ = transpose of the output weights matrix

To determine the optimal weights, the following mathematical programming problem is specified and solved for the i^{th} bank:

$$\begin{aligned} &\text{Maximise}_{uv} \quad u'y_i/v'x_i \\ &\text{subject to} \quad u'y_i/v'x_i \leq 1 \qquad j = 1,2,3,\dots,N \\ &\qquad\qquad u, v \geq 0 \end{aligned} \tag{4.2}$$

The objective function specified in equation (4.2) involves solving for the values of the optimal weights u and v, so that the efficiency of the i^{th} bank is maximised, subject to the constraint that all efficiency measures must be less than or equal to one. However, the above fractional problem is non-linear in nature and has infinite number of solutions for u and v. To avoid this problem, the fractional problem in equation (4.2) is converted into a linear programming by restricting the denominator (weighted inputs) of the objective function to unity, i.e. $v'x_i = 1$ and adding this as an additional constraint to the problem,

while maximising the numerator, the outputs (this becomes an input-oriented efficiency[13] measure which implies with given outputs, banks minimise the use of inputs). This transforms the above non-linear programming model into linear programming problem as follows:

$$\text{Maximise}_{\mu\upsilon} \quad (\mu' y_i) \tag{4.3}$$
$$\text{subject to} \quad \Psi' x_i = 1$$
$$\mu' y_i - \Psi' x_i \leq 0 \quad j = 1,2,3, \dots N$$
$$\mu, \Psi \geq 0$$

where the notation changes from u to μ and from v to Ψ reflects the transformations. This is known as the multiplier form of the DEA linear programming problem. However, corresponding to this multiplier form problem yields another linear problem called dual of the problem (dual problem). Therefore, one possible solution to the linear programming in equation (4.3) is to formulate a dual companion. By denoting the input weights of bank *i* by θ and the input and output weights of other banks in the sample by λ the dual form of the equation (4.3) is specified as follows:

$$\text{Minimise}_{\theta,\lambda} \ \theta, \tag{4.4}$$
$$\text{subject to} \quad -y_i + Y\lambda \geq 0$$
$$\theta x_i - X\lambda \geq 0$$
$$\lambda \geq 0$$

where θ is a scalar and is the efficiency score of the i^{th} bank and λ is a column matrix N x 1 is a vector of constants or weights attached to each of the efficient banks. Optimal solutions (θ, λ) are obtained for each of the banks being evaluated. The dual form involves fewer constraints than the multiplier or primal form and hence is generally the preferred form to solve. If θ=1, it indicates a technically efficient bank as it lies on the frontier. Banks with θ=1 are benchmark institutions, and their input-output mix lies on the efficient frontier. If θ<1, then the bank is inefficient and needs a 1-θ reduction in the input level to reach the efficient frontier. The linear programming in equation (4.7) is solved for N

[13] Output-oriented efficiency measure restricts the sum of the weighted output to unity, and minimises the inputs.

number of times, once for each bank in the sample, a value of θ is obtained for each bank representing its efficiency score. The DEA CRS measures the overall efficiency for each bank and thus, consists of pure technical efficiency and scale efficiency. Under the assumption of CRS any environment inefficiency may be attributed to the size of the bank or poor management.

4.3.4.2 DEA Input-Oriented Model with Variable Returns to Scale

The CRS assumption is unlikely to prevail if the banks operate in imperfect competitive environment or are subject to financial constraints and regulatory requirements (Coelli et al., 1998). One or combination of these factors might compel or cause the banks not to operate at optimal scale. Hence, in such a situation, estimating technical efficiency using the CRS model will be confounded by scale inefficiencies. Banker et al. (1984) introduce the VRS DEA model by including an additional convexity constraint $N1'\lambda = 1$ to account for VRS. The VRS model of DEA permits technical efficiency to be computed without the impact of scale efficiency. VRS offers a measure of pure technical efficiency. Thus, dual linear programming model CRS in equation (4.4) can be modified to VRS by adding a constraint $N1'\lambda = 1$ as follows:

$$\begin{aligned} &\text{Minimise}_{\theta,\lambda}\ \theta && (4.5)\\ &\text{subject to} \quad -y_i + Y\lambda \geq 0\\ &\qquad\qquad \theta x_i - X\lambda \geq 0\\ &\qquad\qquad NI'\lambda = 1\\ &\qquad\qquad \lambda \geq 0 \end{aligned}$$

where N1 is a N x 1 vector of ones. The convexity constraint ensures that a bank is compared only to banks of similar size and as a result, VRS envelopes the data more closely than CRS. Accordingly, the VRS technical efficiency score are greater than or equal to that of CRS. Once again θ is a scalar and is the efficiency score of the i^{th} bank. If $\theta = 1$, it shows that the bank is technically efficient. Hence, it lies on the efficient frontier. If $\theta < 1$, then the bank is technically inefficient. The DEA VRS measures only pure technical efficiency.

4.3.4.3 Estimation of Cost Efficiency

In order to calculate the DEA cost efficiency (CE), we assume that w_i is a 1×N vector of input prices for the i^{th} bank and solving the following cost minimization DEA (assuming VRS) yields:

$$\begin{aligned} \text{Minimise}_{\lambda, x_i^*} \quad & w_i' x_i^* \\ \text{Subject to} \quad & -y_i + Y\lambda \geq 0 \\ & x_i^* - X\lambda \geq 0 \\ & NI'\lambda = I \\ & \lambda \geq 0 \end{aligned} \tag{4.6}$$

x_i^* is the frontier or cost-minimising vector of input quantities for the *i*-th bank, given the prices of input w_i and the levels of output y_i. The bank *i* would have a frontier or minimum cost $w_i' x_i^*$ which, by definition, would be less than or equal to the observed or actual cost $w_i' x_i$. The optimal values x_i^* are found by solving the linear programming problem (equation 4.6), where matrix *X* and *Y* are the observed data of all the banks. The cost efficiency of the i^{th} bank is calculated as the ratio of minimum cost to actual cost. Thus:

$$CE = \frac{w_i' x_i^*}{w_i' x_i} \tag{4.7}$$

That is, cost efficiency measures how close a bank's cost is to the minimal cost (or best practice bank's cost) for producing a certain level of output with given input prices and technology. Thus, a cost efficiency value of CE indicates that it would be possible to produce the same vector of production with a saving cost of (1-CE) x100 percent. In other words, 1-CE represents the amount by which the bank could reduce its costs and still produce the same amount of output. The measure of cost efficiency is bounded between zero and one. Cost efficiency scores are also bounded between the value of zero and one (or 100 if the results are expressed as percentages). A cost efficiency score of one represents a cost efficient bank and is also known as best practice banks in the sample, whereas cost inefficient banks exhibit a value less than one. However, the cost inefficient banks with a value of zero are considered worst practice banks. A bank is cost efficient if it is technical and allocative efficient at the same time.

4.3.4.4 Choice between CRS and VRS DEA Models

Some recent studies advocate that DEA models can be estimated using only the assumption of VRS. Some researchers have found that banks face non-CRS (for example McAllister & McManus, 1993; Mitchell & Onvural, 1996; Sufian & Majid, 2007; Wheelock & Wilson, 1999). These studies advocate that CRS is only appropriate when all firms are operating at an optimal scale. In addition, VRS frontier, which is less restrictive than CRS, permits the best practice level of outputs to inputs to vary with the size of the banks in the sample (Halkos & Tzeremes, 2009). On the other hand, if the VRS model is employed where there is no inherent scale effects of the firms (that is, where there is no diversity in the size of the firms) being evaluated, small and large firms will tend to be over-rated in the efficiency evaluation (Dyson et al., 2001). In contrast, other studies have also advocated for the use of CRS (e.g. Ariff & Can, 2008; Avkiran, 1999; Noulas,1997; Pasiouras, et al., 2007) instead of VRS or expressed caution in using the VRS formulation (e.g. Dyson, et al., 2001; Soteriou & Zenios, 1999). Accordingly, many studies present their results under both CRS and VRS assumptions (e.g. Canhoto & Dermine, 2003; Casu & Molyneux, 2003) in order to avoid this controversy.

In this study, VRS is used because factors such as imperfect competition, finance constraints and regulatory requirements may cause a bank to operate less than optimal scale.

4.3.4.5 Specification of Inputs and Outputs

In order to analyse the efficiency of the banking industry, it is essential that input and output measures of bank activities are defined or specified. Selecting the appropriate specification of bank output is a vital issue for banks' efficiency investigations. The choice of inputs and outputs in DEA is a matter of long standing debate among researchers (Sathye, 2003). There is a consensus among researchers that the choice of input and output variables in efficiency studies can considerably impact the results.

Berger & Humphrey (1997) identify two main approaches for the selection of inputs and outputs as production and intermediation approaches and they are the most widely used to measure bank efficiency (see Berger & Humphrey, 1991; Hunter & Timme, 1995; Ray, 2007; Pasiouras et al., 2008; Berger et al., 2009). Most banking studies have applied either

the production approach (Sherman & Gold, 1985; Soteriou & Zenios, 1999; Sherman & Zhu, 2006) or the intermediation approach (Aly et al., 1990; Yue, 1992; Pasiouras et al., 2008; Staub et al., 2010) and sometimes both approaches are adopted to assess whether the results are affected by the choice of output (Ashton, 2001; Giokas, 2008). However, most of the DEA studies employ intermediation approach as opposed to production approach.

According to the production approach pioneered by Benston (1965), banks produce loan and deposit accounts using labour and capital as inputs. In other words, inputs are needed only to perform transactions and process financial documents (Vesala, 1995; Berger & Humphrey, 1997). On the other hand, outputs are measured by the number of accounts serviced (e.g. the number of deposit or loan accounts serviced) and transactions or documents processed for customers such as loan applications, credit reports, cheques or other payment instruments. This approach does not consider interest costs, it only considers physical inputs such as capital and labour and their costs (Berger & Humphrey, 1997).

Intermediation approach was originally developed by Sealy & Lindley (1977). According to this approach, banks act as financial intermediaries, transforming and transferring financial resources they borrow from depositors into credit and lent to the borrowers (Berger & Humphrey, 1997). Banks produce intermediation services through the collection of deposits and other liabilities and use them to generate interest-earning assets such as loans, securities and other investments. Hence, this approach uses deposits collected and funds borrowed from financial markets (i.e. bank liabilities) as inputs, whereas loans and other earning assets are considered to be the bank's outputs. Thus, the intermediation approach considers the input of funds and their interest cost because funds are the main raw material which is transformed in the financial intermediation process (Berger & Humphrey, 1997).

Elyasiani & Mehdian (1990) highlight the following advantages of the intermediation approach over the production approach:

i. intermediation approach includes total interest expenses which make up large proportion of banks' total costs, therefore excluding them may make the empirical results unreliable.

ii. intermediation approach views deposits as inputs because they are employed for making loans and investments, whereas production approach considers deposit as output.
iii. by using the currency value of the input-output data, the intermediation approach reduces the potential quality problems of input-output data.

Nevertheless, neither of these two approaches fully captures the entire role of financial institutions. According to Berger & Humphrey, (1997) the production approach may be appropriate for assessing the efficiencies of branches of financial institutions (in this case the banks), because most bank branches process customer documents for the entire bank and branch managers have no control over bank funding and investment decisions. On the other hand, they suggest that intermediation approach may be suitable for assessing the entire financial institutions because it includes interest expenses, which accounts for one-half to two-thirds of the total costs. Yildirim (2002) also indicates that intermediation approach takes into account the overall costs of banking and is preferred when studying the economic viability of banks. Thus, the intermediation approach may be better for assessing the profitability of the financial institution, since minimisation of total costs, not just production costs, is required to maximise profits. Furthermore, it is not easy to obtain detailed bank information relating to transactions and financial documents which are needed in the production approach. The intermediation approach is more preferred to production approach in the banking literature.

In addition to the two main approaches, Favero & Papi, (1995) identify three other approaches: asset approach, user-cost approach and value added approach. The asset approach is a variant of intermediation approach which considers the role of banks as financial intermediaries between depositors and final users of bank assets. Deposits and other liabilities, in addition to labour and capital are defined as inputs, whereas bank assets mainly loans are view as output. According to the value-added approach, the specification of inputs and outputs relies on the share of value added (Berger & Humphrey, 1992). Assets or liabilities are considered outputs if they add value to the bank (Berger et al., 1987) . For instance, demand and time deposits, loans and investments are considered as outputs because they contribute to large proportion of value added. On other hand, labour, capital expenses to fixed assets and interest expenses are viewed as inputs. Hancock (1985) first applied the user cost approach. The user cost approach identifies inputs and outputs

depending on their net contributions to banks' revenue. Most recently, Drake et al. (2006) proposed a variation of intermediation approach known as profit-oriented approach or operating approach in DEA where the banks' objective is solely to generate revenue from the total cost incurred for executing bank business. Consequently, total expenses such as interest and non-interest expenses are classified as inputs and total revenue such as interest and non-interest income are considered as outputs.

Despite the extensive studies on bank efficiency, there is no consensus on the exact definition and measurement of banks' inputs and outputs. The choice of the approach to input and output definition and the appropriate number of inputs and outputs utilised basically rest on the data availability.

4.3.4.6 Issue with the Classification of Deposits

Researchers encounter the problem of how to classify deposit; whether it should be considered as input or output. Deposits are considered as inputs to the production process (intermediation and asset approach), whereas production, value added and user cost approaches view deposits as outputs. This is because it creates value added (value added approach) and customers bear an opportunity cost (user cost approach). This shows the difficulties in the specification and measurement of the concept of bank output.

Some banking studies view deposits as inputs because interests paid on deposits are considered as costs and the rate paid is included as an input price and both are considered as inputs of the raw material of investible funds (Berger & Humphrey, 1997). However, those studies that consider deposits as outputs relate them to amount of liquidity, safekeeping, and payments services offered to depositors (Berger & Humphrey, 1991; Bauer et al., 1993; Berger & Humphrey, 1997). Since the classification of deposits in efficiency models can impact on the efficiency estimates, it is deemed as important issue. To resolve this issue, some bank efficiency studies have adopted a solution of first treating deposits as an input and then as an output (e.g. Tecles & Tabak, 2010).

4.3.4.7 Choice of the Number of Inputs and Outputs

In using DEA model, the choice of the number of inputs and outputs will always depend on the total number of DMUs in the sample, since the number of inputs and outputs selected can inhibit the discrimination power of the DEA among the units (Dyson et al.,

2001). This is because DEA permits the units to freely choose and apply weights to their inputs and outputs in order to assess them, so the greater the number of inputs and outputs included the lower the level of discrimination (Dyson et al., 2001). For instance, a large number of inputs and outputs may inhibit the discriminatory power of the DEA among the units, which may result in overestimation of efficiency. In contrast, a small number of inputs and outputs may result in underestimation of efficiency. Moreover, in using small sample size if a high number of inputs and outputs relative to the number of observations are chosen, the units or banks can be wrongly identified as efficient because too many constraints will be specified. Hence, a small sample size may restrict the number of input and output variables that can be used in order to maintain the DEA model's discriminatory power. On the contrary, arbitrarily limiting the number of inputs and outputs variables may also underestimate the relative efficiency score.

Accordingly, various solutions as to how to deal with the issue have been suggested. Nunamaker (1985) and Stern et al. (1994) suggest that the sample size should be at least three times greater than the sum of the number of inputs and outputs. On the other hand, and Cooper et al. (2000, pp.252) recommend that in order to discriminate effectively between efficient and inefficient banks, the sample size should be at least three times the sum of the number of input and output variables. However, a recent study by Dyson et al. (2001) advocates that for the DEA model to preserve its discriminatory power, the sample size should be at least two times the product of the number of inputs and outputs.

DEA is sensitive to the number of variables chosen. As the number of variables increases, the ability of DEA to discriminate between the inefficient and efficient units decreases. As a result, inefficient units can be identified as efficient (Smith, 1997).

4.4 Literature Review

For some years now banking efficiency has been the subject of many studies (see Ariff & Can, 2008; Berg et al., 1993; Das & Ghosh, 2006; Sherman & Gold, 1985; Staub et al., 2010). Many studies have used various methods to estimate bank efficiency as well as different econometric approaches to determine the factors that affect bank efficiency. Many of the previous studies on bank efficiency have been conducted on developed economies. However, the recent resurgence of economic and financial reforms across the

developing countries has also raised the awareness of the importance of bank efficiency. This section is categorised into three parts; evidence on bank efficiency in developed countries and in developing and emerging countries both based on individual-country studies and cross-country studies.

4.4.1 Evidence on Developed Countries

Sherman & Gold's (1985) study is the first to apply data envelopment analysis (DEA) method to examine the efficiency of 14 branches of US savings bank. They adopt the production approach using labour, office space and supply costs as input variables and 17 types of transactions processed by the bank branches as output variables. The authors find that six branches operate inefficiently out of the 14 branches. A similar study by Parkan (1987) examines 35 bank branches of a major Canadian chartered bank. The author also uses the DEA method but adopts the intermediation approach using six input variables namely, total authorised full-time employees, annual rent, quality of customer service space ranking, telephone and stationery expenses, number of online terminals and marketing activity ranking and six output variables namely, number of transactions, commercial account openings, retail account openings, number of loan applications, customer service survey rating and number of corrections. The author concludes that 11 out of the 35 branches are relatively inefficient. Aly et al. (1990) adopt the DEA method to investigate the differences in efficiency between unit and branch banking organisation in 322 US independent banks in 1986. The authors' model includes five outputs: real-estate loans, commercial and industrial loans, consumer loans, all other loans and demand deposits; and three inputs: labour, capital and loanable funds to compute technical, scale and allocative efficiencies. The authors attributed the main source of inefficiency to technical inefficiency, rather than allocative or scale inefficiencies.

However, Rangan et al.'s (1988) study consolidated banking institutions instead of bank branches employing a sample of 215 US banks in 1986. They also use the DEA method and adopt the intermediation approach using labour, capital and purchased funds as input and loans and deposits as output variables. Their study reveals the banks are inefficient and that scale inefficiencies of the banks are relatively small, identifying technical inefficiency as the key source of inefficiency. Yue (1992) similarly applies the DEA method to four input variables, namely, interest expenses, non-interest expenses, transaction deposits and

non-transaction deposits, and three output variables, namely, interest income, noninterest income and total loans to evaluate the efficiency of 60 commercial banks in Missouri, US, during the period 1984-1990. The author finds that pure technical inefficiency is the major source of the overall technical inefficiency rather than scale technical inefficiency. Interestingly, both studies find technical inefficiency as the major source of overall technical inefficiency. Miller & Noulas (1996) employ the DEA approach to estimate overall technical efficiency, pure technical efficiency and scale efficiency of 210 large banks operating in US for the period 1984-1990. The authors observe that the average scale and pure technical inefficiencies are small relative to previous studies. The authors also examine the determinants of efficiency. They report a significant positive impact of bank size on pure technical efficiency.

Fukuyama (1993) applies the DEA approach to examine bank efficiency in 143 Japanese commercial banks in 1990 using labour, capital and funds from customers as input variables and income from loans and other business activities as output variables. The author finds the mean level of pure technical efficiency to be 0.8645 and scale efficiency around 0.9844 indicating that the major source of overall technical inefficiency is pure technical inefficiency. The author attributes the scale inefficiency mainly to increasing returns to scale. Scale efficiency has positive but weak effect on bank size. A more recent study by Loukoianova (2008) uses the DEA method to investigate the cost and revenue efficiency of Japanese banks for the period 2000-2006. The author's findings reveal enhancement in efficiency since 2001. Loukoianova findings show that City and Trust banks are more cost and revenue efficient than the regional banks. However, the banks in Japan are less profitable relative to banks in other developed countries.

In a broader set up, Yeh (1996) applies both DEA and financial ratio analysis to examine the efficiency of six commercial banks in Taiwan over the period 1981 to 1989. Yeh uses interest expenses, non-interest expenses, and total deposits as input variables and interest income, non-interest income, and total loans as output variables. The author's result shows that the banks with high DEA scores have higher ratios in capital adequacy, asset utilization and profitability and lower ratios in financial leverage and liquidity. The author then infers that it is possible to link the estimated efficiencies with banks' actual financial operating decisions. Similarly, Chen & Yeh (1998) assess efficiency of 34 commercial banks using the DEA approach and financial ratios analysis. They employ the following

two input variables: staff employed and interest expense and four output variables: loans, investment interest revenue, non-interest revenue and bank assets. Their results identify 15 out of the 34 commercial banks as efficient. The authors also find that the private-owned banks manage their resources more efficiently than public-owned banks. In contrast, Chen & Yeh (1998) indicate that the results from the DEA method are not consistent with those obtained from the financial ratios. A more recent study by Chen (2001) highlights a positive effect of the financial deregulation on banking efficiency in Taiwan.

Resti (1997) employs the DEA method to evaluate a panel of 270 Italian banks for the period 1988-1992. The author adopts the intermediation approach and use labour and capital as input variables and loans, deposits, and non-interest income as output variables. Resti observes no increase in efficiency but large differences in the efficiency scores. The result also reveals positive association between efficiency and assets quality. In another study by Girardone et al. (2004) on Italian banks over the period 1993–1996 the aftermath of the introduction of the EU's 1992 Single Market Programme, the authors find improvement in the overall cost efficiency of the Italian banking system. The study also examines the key factors explaining the Italian banks' cost efficiency and find evidence that there is no association between size and bank efficiency. In addition, Italian banks' cost efficiency is positively related to capital strength but negatively associated with the level of non-performing loans which is consistent with the findings of Mester (1993, 1996).

A study by Gilbert & Wilson (1998) on Korean financial deregulation programme in the period between 1980 and 1994 reports that most Korean banks experience efficiency gains. A recent study by Hao et al. (2001) analyse efficiency of 19 private Korean banks over the period 1985 to 1995, an era of financial deregulation. Their findings suggest that banks with faster growth rates, operating nationwide and employ core deposits in funding their assets appear most efficient. Moreover, banks with more nationwide branches emerge more efficient. However, their findings also indicate that financial deregulation has little or no effect on the level of bank efficiency in Korea. A more recent study by Sufian & Habibullah (2009) use the DEA approach to examine the effect of the 1997 Asian financial crisis on the efficiency of the Korean banking sector. The authors find high degree of

inefficiency in the Korean banking industry, which is more pronounced in the year after the Asian financial crisis.

To assess bank efficiency using Australian trading banks from 1986 to 1995, Avkiran (1999) applies two types of DEA model. In the first model, the author employs interest expense and non-interest expense as input variables and net interest income and noninterest income as output variables. However, in the second model, two input variables: deposits and staff numbers and two output variables: net loans and non-interest income are employed. The author reports increase in efficiencies during the post-deregulation period. Sathye (2001) examines the x-efficiency (technical and allocative) in 29 Australian banks in 1996 using the DEA method and finds that the Australian banks, on average, are less efficient relative to banks in US and the European countries. The author identifies technical inefficiency rather than allocative inefficiency as the source of the inefficiency. Consequently, the inefficiency is due to wasting of input resources rather than incorrect input combinations.

In another study, Pasiouras (2008) employs the DEA approach to assess the efficiency of the Greek commercial banking industry over the period 2000-2004 including Greek banks operating abroad. The study results show that banks operating abroad are more technical efficient than those operating at the national level. In order to investigate the determinants of efficiency, the author applies the Tobit analysis with technical and scale efficiency as dependent variables. The results indicate that higher capitalization and loan activity increase the efficiency of Greek commercial banks. Loan activity has positive and significant effect on bank efficiency and this result is consistent with Isik & Hassan (2003) study. The author reports that capital is significant and positively associated with bank efficiency. Therefore, well-capitalized banks are more efficient, both in terms of technical and scale efficiency. In this context, Pasiouras' results are consistent with Isik & Hassan (2003) study on Turkey, Casu & Girardone (2004) on Italy and Kwan & Eisenbeis (1997) on the US banks.

Contrary to the growing bank literature on static efficiency, Berger & De Young (1997) use Granger-causality method, a dynamic approach to examine the intertemporal relationships between problem loans, cost efficiency and capital for a sample of U.S. commercial banks between 1985 and 1994. The authors find that improvement in

nonperforming loans tends to be followed by the reduction in cost efficiency and decreases in cost efficiency precede increases in nonperforming loans indicating that the intertemporal relationships between loan quality and cost efficiency run in both directions. At the same time but contrary to Berger & De Young's (1997) finding, Kwan & Eisenbeis (1997) use a simultaneous equation framework to examine the interrelationships between bank risk, capitalization, and operating efficiency and find positive impact of inefficiency on both bank risk-taking and capitalization. Their study also reports that banks with more capital tend to operate more efficiently than less well-capitalized banks.

4.4.2 Evidence on Developing and Emerging Countries

To examine the impact of financial liberalization on the efficiency of Turkish commercial banks, Zaim (1995) employs the DEA method and finds positive effect on efficiency. The author's findings show that technical efficiency increased on average by 10 percent from 1981 to 1990. Another finding of the study indicates that technical efficiency differences between banks diminish during the study period. Further, pure technical inefficiency emerges as the key source of inefficiency in the Turkish banking sector. Interestingly, the result also shows that state banks are more efficient than privately owned banks in 1990 in term of overall and pure technical efficiency scores. On the other hand, state banks emerge as more prone to allocative inefficiency. In a broader set-up, Isik & Hassan (2002) analyse cost, allocative, technical, pure technical and scale efficiencies in the Turkish banking industry over the 1988–1996 period. They used both non-parametric and parametric approaches to estimate bank's efficiency and report that multinational domestic banks are superior to purely domestic banks in terms of all efficiency measures. The authors investigate the determinant of efficiency and find evidence of a strong negative association between bank size and efficiency. Yildirim (2002), expanding the study period from 1988 to 1999, assesses the efficiency of Turkish commercial banking sector. The study period is considered as the unstable macroeconomic conditions in Turkey. DEA method is applied to estimate technical and scale efficiencies of Turkish commercial banks. The author's results suggest that the sector suffers mainly from scale inefficiency, which is attributed to decreasing returns to scale. Both pure technical and scale efficiency scores report a large variation. Furthermore, the study examines the impact of profitability, asset quality and size on two types of efficiency. Yildirim reports that larger banks have positive relationship with pure technical efficiency in the Turkish banking industry. This positive

relationship is attributed to larger banks' market power and their ability to diversify credit risk in an uncertain macroeconomic environment. The trend in the performance levels over the period indicates that macroeconomic environment has considerable impact on the technical and scale efficiencies.

Among the earliest studies on bank efficiency in Thailand, Leightner & Lovell (1998) investigate the efficiency of 31 banks operating in the Thai banking sector from 1989 to 1994. Their results indicate that large domestic banks are most efficient, while the smaller domestic are seen as the least efficient. In addition, foreign-owned banks are found slightly more efficient than medium-sized domestic banks. More recently, Sufian & Habibullah (2010) investigate the efficiency of the Thai banking sector from 1999 to 2008. Their results show that inefficiency in the Thai banking sector emerges mainly from scale efficiency. Their findings indicate that small banks are most efficient contrary to the findings of Leightner & Lovell (1998), while medium-sized banks are found to be the least efficient banks. Interestingly, the domestic banks are comparatively more efficient than the foreign banks in Thailand. This result is attributed largely to a higher pure technical efficiency level. Furthermore, the authors use log-linear and OLS to identify factors that affect bank efficiency in Thailand. Their results suggest that banks with higher loans intensity and better capitalized tend to show higher efficiency levels. As expected, credit risk is negatively related to bank efficiency.

Ayadi et al. (1998) evaluates bank performance of ten Nigerian banks using the DEA method for the period 1991 to 1994. The authors employ an intermediation approach using interest paid on deposits, total expenses and total deposits as input variables and total loans, interest income and non-interest income as output variables. The authors find the existence of relatively efficient Nigerian banks. However, these are banks that have been operating for a long period of time in Nigeria. The authors also infer that poor management is the key factor that caused the weakness in the Nigeria banks and attributed it to poor loan quality, excessive credit risk, liquidity risk and their inability to generate capital internally.

Sathye (2003) investigates the efficiency of Indian banks after the economic and financial reforms. During the period 1997-1998, the author studies the efficiency of Indian banks applying the DEA method and finds several of the foreign owned banks efficient. The

author further observes that private owned domestic banks are less efficiency relative to the foreign and pubic owned banks. Sathye (2003) attributes the poor efficency score of the private sector banks to their expansion. On the other hand, a recent study by Ataullah & Le (2006) investigate the determinants of banks' efficiency in India. Ataullah & Le analyse the impact of fiscal reforms, financial reforms, and private investment liberalisation on technical efficiency of the Indian banking industry during 1992–1998. They first estimate the efficiency using the DEA method and find evidence of efficiency gain in the Indian banking industry during the post-economic reforms era. They then apply system generalized method of moments, a dynamic estimation technique, to estimate the determinants of efficiency and find a positive relationship between the level of competition and bank efficiency. They also notice that the efficiency of the previous year is significant and positively related to the current year efficiency. Another finding of their study is that bank size is positively related to efficiency. This relationship supports the perspective that attributes such association to larger banks' market power and their ability to diversity credit risk in uncertain macroeconomic conditions. At the same time, Das & Ghosh (2006) using more years (1992-2002), examine the performance of India commercial banking sector during the post reform and find high degree of inefficiency of some Indian banks which is inconsistent with the findings of Ataullah & Le (2006) which indicated efficiency gains. Most of the inefficiencies are attributed to poor use of resources as well as from current large scale of operations. In the second estimation stage, they regress efficiencies over a set of variables namely, bank size, ownership, capital adequacy ratio, non-performing loans and management quality using a multivariate analysis based on the Tobit model. Their results suggest that technical efficient banks have, on average, less nonperforming loans. A strong association is found between efficiency and capital adequacy ratio. Furthermore, Das & Ghosh (2006) link the differences in the efficiency performance of commercial banks with different ownership status, level of non-performing loans, size, asset quality, and management. For instance, it is found that banks with low-risk portfolios, as measured by a higher capital adequacy ratio are likely to be more efficient.

Havrychyk (2006) examines the efficiency of the Polish banking sector over the period 1997 to 2001. The author estimates cost, allocative, technical, pure technical and scale efficiencies using the DEA method. Havrychyk reports that foreign banks are more cost efficient than domestic banks. Contrary to expectation, the author finds evidence of

reduction in efficiency. The author used Tobit regression model to examine the factors that affect efficiency and finds that size has positive association with banks efficiency in Poland. Similar studies by Ataullah et al. (2004) and Chen et al. (2005) underpin this result.

Ariff & Can (2008) employ the DEA method to evaluate cost and profit efficiency of 28 Chinese commercial banks over period 1995–2004. The authors find that cost efficiency is greater than profit efficiency levels implying that inefficiencies are largely from the revenue side. The authors use the Tobit regression to identify the factors that influence the Chinese bank efficiency. The study reports negative and weak relationship between size and efficiency for large banks, but significantly positive association for medium-sized banks. Medium-sized banks are adjudged as the most cost and profit efficient and large banks the least efficient which is consistent with the findings of Berger et al. (2006), but inconsistent with that of Chen et al. (2005) on Chinese banking efficiency. The authors find negative effect of both credit risk and asset quality on bank efficiency suggesting that banks with higher credit risk and/or higher loan-loss provisions are less efficient. Another finding of the study suggests negative but weak relationship between bank capital level and efficiency. Fu & Heffernan (2005) adjudge the cause of this negative relationship to the recapitalization of four state-owned banks and loans provided by the Chinese government to the joint-stock banks since 1998. Ariff & Can (2008) suggest that such a policy by the Chinese government may avert bank capital risk. However, it may increase moral hazard incentives.

On the efficiency of the Brazilian banking industry over the post-privatization period of 2000–2007, Tecles & Tabak (2010) used both Bayesian stochastic frontier and DEA approaches reported that large banks are the most efficient banks. Their finding shows a lower level of bank cost efficiency in Brazil, with an average cost efficiency score of 0.66. On the determinants of bank efficiency based on a static model, their results report a positive effect of bank capitalization on efficiency. The authors also find no significant relation between non-performing loans and bank efficiency. In another study, Staub et al. (2010) estimate cost, technical and allocative efficiencies for Brazilian banks for the same period 2000–2007. The authors apply the DEA approach and find that banks in Brazil are inefficient. The inefficiency in the Brazilian banks is assigned mostly to technical inefficiency rather than allocative inefficiency. The authors explain that the higher

technical inefficiency is evidence that the Brazilian banks' managers selected the appropriate input mix given the prices, but use fewer inputs which could be attributed, for some banks, to the large interest expenses or capital, personnel expenses and a low production. On the other hand, between the period 2003-2007 technical efficiency is greater than allocative efficiency. They conclude that non-performing loans have effect on allocative efficiency. However, investigating the factors of bank efficiency by applying dynamic system GMM estimator, the study indicates that non-performing loans have insignificant and negative relationship with bank technical and cost efficiency. Bank capitalization and size also have no significant effect on technical and cost efficiency. In addition, the coefficient of the lagged efficiency (the persistence effect) is positive and significant.

4.4.3 Evidence on Cross-Countries

One of the earlier studies that use the DEA method to assess European banking sectors is Berg et al. (1994). The authors evaluate the efficiency of three Nordic countries' (Finland, Norway and Sweden) banking sectors during 1990. Input variables in the DEA method include labour and capital, whereas output variables consist of total loans to other financial institutions, total deposits from other financial institutions and number of branches. Their findings indicate that on average the Swedish banks are relatively more efficient than the Finnish or Norwegian banks.

Altunbas et al. (2001) examine a sample of banks from 15 European countries over the period 1989-1997. They provide evidence that Austria, Denmark, Germany and Italy have the most efficient banking systems, but on average they conclude English and Swedish banks are least efficient over the period 1989-1997. In addition, the authors find improvement in banks efficiency over the period under evaluation. The authors also find evidence indicating that increase in the effect of technological progress reduces bank costs with bank size.

Using banks from 17 transition European economies from 1995 to 1998, Griogorian & Manole (2002) find the banks in these countries to be inefficient. On the factors influencing the bank efficiency, the authors find that capitalization is positive and has

significant effect on bank efficiency. Their findings also show that inflation has insignificant effect on bank efficiency.

Casu & Molyneux (2003) use a sample of 530 banks from five European Union countries: France, Germany, Italy, Spain and the United Kingdom covering the period 1993 to 1997 to investigate existence and convergence of productive efficiency across the European banking markets since the introduction of the Single Internal Market. Their results show evidence of a small improvement in bank efficiency levels since the European Union's Single Market Programme, but a weak evidence of convergence. They also assess the determinants of European bank efficiency using the bootstrapping technique to DEA efficiency scores and Tobit regression model approach. Their results suggest that there is little evidence that the average capital has effect on bank efficiency levels.

Ataullah & Le (2004) offer a comparative analysis of the evolution of the technical efficiency of commercial banks in India and Pakistan during 1988–1998. The authors used the DEA approach and two kinds of input–output specifications to estimate technical efficiency. Ataullah & Le decomposed technical efficiency into two components, pure technical efficiency and scale efficiency. They reported evidence of very low overall technical efficiency in India and Pakistan banking industry over the study period and documented little improvement in efficiency until 1995. In both countries, the low overall technical efficiency was attributed mainly to low scale efficiency. In addition, the examination of the relationship between bank size and technical efficiency showed that the larger banks outperformed the smaller banks. However, this difference dwindled over the years. The result also showed that banks are relatively more efficient in generating earning assets than in generating income. This is attributed to the presence of high non-performing loans.

Cihak & Podpiera (2005) study on three East African countries (using 43 banks from Kenya, 23 banks from Tanzania and 17 banks from Uganda) financial service reforms find the banks in Kenya, Tanzania and Uganda to be inefficient. Using 137 commercial banks from 29 African countries, Kablan (2010) investigates the level and determinants of bank cost efficiency from 1998 to 2002. The author finds the banks to be cost efficient using stochastic frontier analysis. Applying dynamic system generalized method of moments, the

author reports a negative relationship between nonperforming loans and efficiency. In addition, bank capitalization is statistically significant and negatively related to bank efficiency.

Kasman & Yildirim's (2006) study documented weak efficiency gains on eight new members of the European Union from Central and Eastern European countries. Their results also reveal that capitalization and GDP growth are significant and negatively related to profit efficiency. As expected, inflation has a negative impact on profit efficiency. Using the stochastic frontier approach and the distribution-free approach, Yildirim & Philippatos (2007) investigate cost and profit efficiency of 12 transition economies of Central and Eastern Europe (CEE) banks from 1993 to 2000. Their findings show significant managerial inefficiencies in 12 CEE banking markets, with mean cost efficiency level 72% and 77% by the distribution free approach and the stochastic frontier approach, respectively. The results also suggest that foreign-owned banks are relatively more cost-efficient but less profit-efficient relative to state-owned and private domestic banks. According to their findings, banks in Poland and Slovenia are adjudged to be the most cost efficient whereas the Russian Federation, Lithuania, Latvia, and Estonia are found to have the least efficient banks. The authors investigate the determinants of efficiency employing generalised least squares fixed-effects estimators and conclude that market concentration is negatively associated with bank efficiency. Another finding of the study is that bank size is positive and significantly related to levels of bank efficiency. In addition, the level of equity capital has a positive impact on cost efficiency. This result is consistent with the findings of Berger & Mester (1997) study on U.S banks over the period 1990-1995. The authors find a negative and significant relationship between credit risk and bank efficiency. Furthermore, the degree of competition relates positively to cost efficiency. Similarly, economic growth has a positive association with cost efficiency but a negative relationship with profit efficiency showing that favourable economic conditions have stimulated competition in the CEE banking markets.

Staikouras et al. (2008) assess the cost efficiency of banks operating in six emerging South Eastern European (SEE) countries: Bosnia-Herzegovina, Bulgaria, Croatia, FYR of Macedonia, Romania and Serbia–Montenegro over the period 1998–2003. Using a stochastic frontier approach, the authors find existence of low level of cost efficiency, with significant inefficiency differences among countries. They observe that foreign banks and

banks with higher foreign bank ownership have the least inefficiency. In addition, they notice that cost inefficiency is negatively related to bank capitalization. However, they identify a positive but insignificant relationship between cost inefficiency and credit risk. GDP growth has a positive relationship with inefficiency which is inconsistent to Yidirim & Philippatos (2007) finding.

Turk-Ariss (2010) uses 821 commercial banks in 60 developing countries from five different regions, including Africa, East and South Asia and Pacific, Eastern Europe and Central Asia, Latin America and Caribbean, and the Middle East for the years 1999–2005. The author's aim is to assess the effect of a higher degree of market power on bank efficiency and stability. The author reports evidence of significant negative relationship between bank market power and cost efficiency and documents that market power is significant and positively associated with bank profit efficiency and overall stability.

Using Granger-causality techniques, Williams (2004) following Berger & De Young (1997) assesses the inter-temporal relationships among problem loans, cost efficiency, and bank capital in a sample of European savings banks over the period 1990-1998. The author identifies evidence of negative association between loan loss provision and efficiency suggesting that poorly managed banks tend to make more poor quality loans. William's finding also reveals that cost efficiency positively Granger-causes capital. In a later study, Altunbas et al. (2007) employ a static simultaneous equation model (Seemingly Unrelated Regression approach) to analyse the relationship between capital, loan provisions and cost inefficiency on banks operating in 15 European countries between 1992 and 2000 and document that cost efficiency and bank risk-taking are negatively related contrasting the finding of Williams (2004). Both bank size and capitalization have positive impact on cost inefficiency. The difference in their finding might be due to differences in the estimation method. It is also important to point out that Altunbas et al. (2007) study fails to account for the dynamic nature of capital and credit risks. In a recent study, Fiordelisi et al. (2011) employ commercial banks from 26 European Union countries between 1995 and 2007 and test for the causal relationship between cost efficiency, risk and capital. The authors find that increase in capital precedes increase in cost efficiency and vice versa. In addition, cost efficiency negatively Granger-causes bank risk.

Previous empirical studies on bank efficiency have mostly employed static panel data methods to analyse the determinants of bank efficiency. However, many financial processes exhibit dynamic adjustment over time so failing to incorporate dynamic aspect of the data can lead to serious misspecification biases in the estimation and results. De Jonghe & Vennet (2008) report that most banking studies failed to consider the time it takes for the impacts of bank competition and efficiency to materialize.

Similarly, static models are mostly used to estimate the factors that influence bank efficiency. These studies fail apparently to incorporate the dynamic nature of efficiency in the assessment of bank efficiency. According to Staub et al. (2010), the banks that are more efficient in a specific year tend to be efficient in the following year. On the other hand, Ataullah & Le (2006) describe lagged efficiency as an accumulation of knowledge and technological endowment that may help banks to produce higher outputs with their inputs or reduce cost by adapting relatively quickly to the financial reforms. Such persistence can only be modelled with dynamic models (Staub et al., 2010). The studies also do not account for endogeneity of some of the regressors such as the lagged efficiency, credit risk and bank capital. However, there is gradual awareness of the need to include lagged efficiency such as in the studies of Ataullah & Le (2006), Staub et al. (2010) and Fiordelisi et al. (2011).

4.5 Method

This section presents the DEA approach used to estimate the bank efficiency. The section also provides the bank efficiency models employed to assess the determinants of bank efficiency in the Ghanaian banking industry from the year 2001 to 2010. Stata software is used to estimate the determinants of bank efficiency. In this study, we use the fixed effect regression estimator to estimate the determinants of bank efficiency in Ghana, while the dynamic model is estimated using the two-step system GMM.

The fixed effect model (described in Chapter 3) is used to examine the determinants of bank efficiency (static model) because it controls for unobserved heterogeneity. To control for potential heteroskedasticity, the fixed effect model is estimated using White (1980) robust standard error test. This is because the banks in Ghana have different sizes which may contribute to different variations in the error terms (see Baltagi, 1995). The static

models do not include lagged dependent variables in the fixed effect models because the fixed effect estimators generate severe biases in the coefficient estimates with lagged dependent variables (Roodman, 2009).

System GMM (as described in Chapter 3) is used to investigate the determinants of bank efficiency because it accommodates unobserved heterogeneity, exogenous and endogenous variables (dynamic model). In the presence of dynamics and endogenous explanatory variables in panel estimation, the GMM estimator is more superior to fixed effect estimator which generates inconsistent estimates (Baltagi, 1995). To solve these problems a two-step system GMM is adopted. In addition, relative to ordinary least squares, the fixed effect model and first difference GMM estimators, the system GMM estimator provides the least bias in small samples (when employing Windmeijer (2005) standard error correction). To test for heteroskedasticity, Pagan and Hall heteroscadasticity test is used.

4.5.1 Estimation of Bank Efficiency in Ghana's Banking Industry

This section estimates the bank efficiency in Ghana using the DEA approach. A detailed description of the DEA models was presented in Section 4.2. DEA-Solver Pro software is used to compute the bank efficiency scores. The efficiency scores are used as the dependent variable in the estimation of the factors determining bank efficiency in Ghana.

4.5.2 Choice of Input and Output Variables for the Study

There is an agreement among researchers that the DEA is sensitive to the choice of input–output variables. This may be to the advantage of the DEA technique, since it indicates which of the input–output variables should be closely monitored by bank management to improve overall efficiency (Sathye, 2003). The role of banks to serve as the financial intermediaries between depositors and borrowers is seen as more reasonable even though it does not fully capture all the roles of the financial institutions.

Therefore, following Das & Ghosh (2006), Casu & Girardone (2006), Staub et al. (2010) and Moffat & Valadkhani (2011) studies, the specification of input and output used in our

study is a variation of the intermediation approach where deposits[14], labour (personnel expenses) and capital-related expenses (defined as operating expenses minus personnel expenses) are assumed as inputs for producing loans and other earning assets such as loans to special sectors, investment securities, equity investments and government securities such as treasury bills and bonds. Pure technical efficiency can now be estimated.

Deposits are the most important input resources for Ghanaian banks and are available to banks to perform their activities such as lending and investing. The choice of labour and capital expenses shows their importance as other input resources in the production process of the banks in Ghana. In the case of output, loans and other earning assets constitute the major activities of banks that channel their funds into investment or lending for profit motives. In Ghana, loans and other earning assets account for about two thirds of banking assets and are important generator of revenues.

In order to estimate cost efficiency, input prices must also be calculated. Table 4.2 shows the description of the variables used in the computation of bank efficiency.

Table 4.2 Variables used in the Computation of Bank Efficiency

Variable	Name	Description
Inputs:		
Deposits		Customers deposits
Labour		Personnel expenses of bank staff such as salaries, wages and benefits
Output:		
Loans		Total customers' loans
Other earning assets		Banks' investments in different types of securities (e.g. government securities, bonds, Treasury bill and equity investment)
Input prices:		
Price of deposits		Interest expenses divided by total deposits
Price of labour		Personnel expenses divided by the total assets
Price of capital		Capital-related expenses (operating expenses - personnel expenses) divided by total fixed assets.

[14] There is no consistent data on other funds with many missing values. Total deposit as a percentage of total liabilities was 72.5 percent in 2011 whereas total borrowing was 8.1 percent in the same year (Bank of Ghana, 2011).

However, these inputs prices are proxies since relevant data are not available (Maudos & Fernandez de Guevara, 2004).

4.5.3 Determinants of Bank efficiency in Ghana

4.5.4 Empirical Models

This section explores the underlying relationship between the estimated efficiency levels and bank specific factors namely size, capital and credit risk and macroeconomic factors such as inflation and GDP growth rate[15]. In the second stage, the DEA scores are regressed on bank-specific and macroeconomic factors. The determinants of bank efficiency is estimated using fixed effect estimator for the static model and two-step system GMM for the dynamic model as discussed in Chapter 3.

Many banking studies have examined the factors that affect the efficiency of banks. In the banking literature, some studies investigate only bank-specific factors while others assess both bank-specific and external factors. The widely used bank-specific factors are size, capitalization, loans to assets, and loan loss provision to total loans (see Casu & Molyneux, 2003; Casu & Girardone, 2004; Ataullah & Le, 2006; Ariff & Can, 2008). The inflation and real GDP growth rates are commonly used to control for the macroeconomic conditions (see Salas & Saurina, 2003; Girardone et al., 2004; Yildirim & Philippatos, 2007; Pasiouras, 2008).

4.5.4.1 Static Panel Model of Bank Efficiency

The static panel data model used to determine the bank-specific and macroeconomic factors that affect bank efficiency in Ghana is given as follows:

$$\mathrm{EFF}_{\mathrm{it}} = \alpha_1 \mathrm{CAP}_{\mathrm{it}} + \alpha_2 \mathrm{SIZE}_{\mathrm{it}} + \alpha_3 \mathrm{LLP}_{\mathrm{it}} + \alpha_4 \mathrm{INF}_{\mathrm{it}} + \alpha_5 \mathrm{GDPG}_{\mathrm{it}} + \eta_i + \mu_{\mathrm{it}} \qquad (4.8)$$

where

i represents the individual bank and *t* denotes time,

[15] The reason for the selection of small number of determinant factors for this study is to provide parsimonious models and to avoid excessive reduction in the degree of freedom. This is done to ensure meaningful system GMM results for the study. This procedure is used due to the small number of banks and observations used in this study.

α = parameters to be estimated,

η_i = individual bank specific-effect,

μ_{it} = error term,

EFF_{it} = bank efficiency (pure technical efficiency, PTE or cost efficiency, CE),

CAP_{it} = capitalization, and is measured as total equity divided by total assets,

$SIZE_{it}$ = bank size, and is measured as natural logarithm total assets,

LLP_{it} = loan loss provision ratio[16] proxy as credit risk, and is measured as loan loss provisions divided by total loans,

$GDPG_{it}$ = real gross domestic product growth rate,

INF_{it} = inflation rate, and is measured as change in consumer price index.

In this model, all the explanatory variables are assumed to be strictly exogenous.

4.5.4.2 Dynamic Panel Model of Bank Efficiency

A dynamic model is adopted by including one-year lagged efficiency among the explanatory variables to capture the dynamic nature of the efficiency of banks. This study attempts to find out whether bank efficiency tends to persist over time in the Ghanaian banking sector. According to Staub et al. (2010), the banks that are more efficient in a specific year tend to be efficient in the following year. On the other hand, Ataullah & Le (2006) suggest that the one-year lagged efficiency indicates accumulation of knowledge and technological endowment that may assist banks to produce higher outputs with their inputs by adjusting comparatively quickly to the financial reforms. Ataullah & Le (2006), Solis & Maudos (2008), and Staub et al. (2010) studies find significant and positive relationship between the efficiency of the previous year and that of the current year. Furthermore, many early banking studies have confirmed the persistence of efficiency over time (Berger & Humphrey, 1991; Kwan & Eisenbeis, 1997). The introduction of a lagged dependent variable complicates the estimation of the model since the lagged dependent variable correlates with the error term, even where the error terms are not correlated (Fiordelisi et al., 2011).

[16] Loan loss provision ratio is used as a proxy for credit risk because there was no consistent data on non-performing loans.

In addition, based on the banking literature, bank capitalization and loan loss provision are considered endogenous variables (see Section 4.6). This is because failure to address such reverse causality in efficiency equations will bias the estimates of the coefficients. This will also complicate the analysis of the results.

Following the procedure of Ataullah & Le (2006), Solis & Maudos, (2008) and Staub et al. (2010) the dynamic panel model specification for the determinants of bank efficiency in Ghana is given as follows:

$$EFF_{it} = \beta_1 EFF_{it-1} + \beta_2 CAP_{it} + \beta_3 SIZE_{it} + \beta_4 LLP_{it} + \beta_5 INF_{it} + \beta_6 GDPG_{it} + \eta_i + \epsilon_{it} \quad (4.9)$$

where

i represents the individual bank and *t* denotes time,

β are parameters to be estimated,

η_i = individual bank specific-effect,

ϵ_{it}= error term,

EFF_{it} = bank efficiency (pure technical efficiency, PTE or cost efficiency, CE),

$EFF_{i,t-1}$= one-year lagged bank efficiency

CAP_{it} = capitalization, and is measured as total equity divided by total assets,

$SIZE_{it}$ = bank size, and is measured as natural logarithm of total assets,

LLP_{it} = loan loss provision ratio proxy as credit risk, and is measured as loan loss provisions divided by total loans,

$GDPG_{it}$ = real gross domestic product growth rate,

INF_{it} = inflation rate, and is measured as change in consumer price index.

To estimate the dynamic models using the system GMM, this study combines two techniques to ensure that the number of instrument counts is less than or equal to the number of groups (banks). The first technique uses less lags as instruments instead of all available lags for the endogenous variables (for the levels and difference equations). In addition, the study uses the technique of "collapsing instruments" to constrain all of the yearly moment condition to be the same in order to decrease the instrument count. In the standard instrument matrix (without collapsing the instruments) each instrumenting

variable produces one column for each time period and lag available to that time period, whereas collapsing instruments put the instrument set into a single column to limit the instrument count. The use of these techniques allows us to considerably reduce the number of instrument counts to avoid over-fitting of the endogenous variables in order to have more reliable estimations. Collapsing the instruments is vital to the identification of the models because the study uses only 25 banks (Jallab, 2008). In addition, this study uses second and third lags of the lagged dependent variable, and loan loss provision and capitalization[17] as instruments (as opposed to using all available lags).

4.5.4.3 Logit Transformation of the DEA Efficiency as the Dependent Variable

Since the estimated values of the DEA efficiency (EFF_u) ranges from 0 to 1, logistic specification is used to transform the efficiency scores into natural log odds ratio as follows:

$$EFF_R = Ln\left(\frac{EFF_u}{1-EFF_u}\right)$$

which is linear and continuous. This is a monotonic transformation. It ranges from negative infinity to positive infinity. It follows the same general principles used in linear regression and hence can be estimated with the usual ordinary least square methods since the value of EFF_R is known (Gujarati, 1992).

However, EFF_R is undefined when the efficiency score, EFF_u is zero or one. This problem reduces the total observations by the number of undefined efficiency scores, causing some loss of the data. Consequently, as in Cox (1970 p.33), Voos & Mishel (1990), Campbell et al. (2008) and Kader et al. (2010), the logit transformation is modified by adding 1/2N to both the numerator and denominator, where N represents the number of observations for the efficiency. The advantage of this modified logit transformation is that there is no reduction or elimination of some of the observations when the efficiency score is equal to zero or one (Maddala, 1983 p.30). The transformed efficiency score (modified logit transformation), EFF, is employed as the dependent variable for the evaluation of the determinants of efficiency as well as for the investigation of the causal relationship between efficiency and competition. However, it is impossible to obtain directly the

[17] Capitalization and loan loss provision, in this study, are considered endogenous based since they have effect on efficiency or market power and vice versa as explained in sections 5.6.1 and 5.6.2.

marginal effects of the explanatory variables on efficiency. Nevertheless, the signs and statistical significance of each coefficient of the determinant factors of efficiency can be interpreted directly. In this study, only the signs and statistical significance of each coefficient of the factors are needed. The logit method has been used in recent studies on bank efficiency (see for example, Ataullah & Le, 2006; Maudos & Fernandez de Guevara, 2007; Solís & Maudos, 2008; Kader et al., 2010).

4.6 Variable Measurements

This section explains the measurements of the variables used in the determinants of bank efficiency. These variables are grouped into bank-specific and macroeconomic factors.

4.6.1 Bank-Specific Factors

The bank-specific variables considered are size, credit risk, bank capitalization and fee income.

4.6.1.1 Size

Bank size is measured by the natural logarithm of total assets and it is included in the model to investigate the impact on bank efficiency. It is essential to know which size optimises bank efficiency. The results of previous studies on the relationship between bank size and bank efficiency are inconsistent. Some studies have found a significantly positive impact of bank size on bank efficiency (e.g. Miller & Noulas, 1996; Ataullah & Le, 2006; Chen et al., 2005; Tecles & Tabak, 2010). In contrast, others studies have documented a significantly negative effect of bank size on bank efficiency (e.g., DeYoung & Nolle, 1996; Isik & Hassan, 2002; Girardone et al., 2004; Altunbas et al., 2007), while others observe insignificant influence of bank size on efficiency (e.g., Pi & Timme, 1993; Berger & Mester, 1997, Ariff & Can, 2008; Staub et al., 2010).

4.6.1.2 Credit Risk

Credit risk is measured as loans loss provision divided by total loans. This is included to control for the differences in efficiency across banks due to differences in credit risk. This is an important factor because poor asset quality (or higher credit risk) is seen as the most prominent cause of bank failures. The loans loss provision to total loan is an indicator of

asset quality. Banks which have a higher ratio of loan loss provisions to total loans have lower asset quality and tend to incur higher credit risk. Previous studies have shown that higher risk-taking banks are less efficient (e.g. Yildirim, 2002; Casu & Girardone, 2004; Ataullah et al., 2004; Chang & Chiu, 2006; Staikouras et al., 2008; Yildirim & Philippatos, 2007). Since efficient banks are likely to be better in monitoring and credit evaluation, these banks encounter lower default risk (lower loan loss provisions) and therefore a negative relationship is expected. However, Altunbas et al. (2007) find a positive association between loan loss provision and efficiency while Staub et al. (2010) have observed insignificant relationship.

4.6.1.3 Bank Capitalization

Bank capitalization is defined as shareholders' equity divided by total assets. Generally, lower capital ratios indicate higher risk leading to higher borrowing costs. Thus, the efficiency is expected to be higher in better-capitalized banks and hence a positive relationship is expected. However, the results on the effect of bank capital levels on bank efficiency are mixed. Many studies have reported banks with higher capital ratios to be more efficient (see Casu & Girardone, 2004; Carvallo & Kasman, 2005; Chang & Chiu, 2006; Pasiouras, 2008, Yildirim & Philipatos, 2007; Staikouras et al., 2008). On the other hand, Altunbas et al.'s (2004) study reported a negative relationship. A negative association can be attributed to the fact that financial capital influences costs through its use as a source of financing loans (Berger & Mester, 1997; Ariff & Can, 2008; Staikouras et al., 2008). Thus, raising capital that involves higher costs than taking deposits could generate a negative relationship between bank capitalization and efficiency. Negative relationship between bank capitalization and efficiency has also been reported by Altunbas et al. (2007) and Kwan & Eisenbeis (1997), while others such as Ariff & Can (2008), Casu & Molyneux, (2003) and Staub et al. (2010) find no significant impact of capitalization on efficiency.

4.6.2 Macroeconomic Factors

The gross domestic product (GDP) growth rate and rate of inflation are included to account for the impact of macroeconomic conditions on bank efficiency. This is because macroeconomic developments are likely to affect the quality of banks' assets (Soedarmono et al., 2011).

4.6.2.1 Gross Domestic Product Growth Rate

It is expected that higher GDP growth will positively influence bank efficiency. This is because economic growth contributes to the development of the banking industry as higher GDP growth influences positively on the demand and supply of banking services, and possibly improves bank efficiency as well as enhancing the banks' asset quality. However, as GDP growth slows down and in particular during recessions, credit quality tends to deteriorate and default rate increases, thus reducing bank efficiency. Previous studies on European countries by Maudos et al. (2002), Pasiouras et al. (2009), Delis & Papanikolaou (2009), Lozano-Vivas & Pasiouras (2010) and Yildirim & Philippatos (2007) report positive impact of real GDP growth rate on bank efficiency. However, Fries & Taci (2005) study on 15 East European countries find no significant effect of GDP growth on bank efficiency, likewise Di Patti & Hardy's (2005) study on Pakistan banks. On the other hand, Staikouras et al.'s (2008) study on six emerging South Eastern European countries finds a negative relationship between GDP growth and bank efficiency.

4.6.2.2 Inflation Rate

Inflation rate measured by annual growth rate of the consumer price index is hypothesized to negatively affect the bank efficiency, because inflation tends to increase cost and reduce cost efficiency. Inflation reflects potential inefficiencies due to price (high interest margin) and non-price (excessive branches) behaviour of banks a symptom of high inflationary conditions (Grigorian & Manole, 2002). High inflationary conditions are prevalent in Ghana. For example, Kasman & Yildirim (2006) documented that inflation increases cost and reduces profits as banks tend to compete through expanding branch networks. Therefore, inflation is expected to have a negative association with bank efficiency.

4.7 The Issue of Endogeneity

In this study, bank capitalization and loan loss provision (non-performing loans) are considered as endogenous. Many bank studies have considered the relationship between bank efficiency and non-performing loans as endogenous (Fiordelisi et al., 2011; Tabak et al., 2011; Kwan & Eisenbeis, 1997; Williams, 2004; Altunbas et al., 2007). Thus, an increase in non-performing loans is expected to lead to reduction in bank efficiency. This is because banks would not able to retrieve from borrowers all costs resulting from increase

in defaults. On the other hand, lower bank efficiency can increase the rate of default due to bank inefficiency resulting from high operational expenses and failure to monitor and appropriately control credit portfolios (Staub et al., 2010). In terms of bank capitalization, well-capitalized banks tend to be efficient. More efficient banks incur lower costs and eventually become well-capitalized (Fiordelisi et al., 2011).

4.8 Descriptive Statistics and Correlation Analysis

This section reports the descriptive statistics and correlation analysis of the explanatory variables used in determining bank efficiency in Ghana for the period 2001 to 2010.

Table 4.3 shows large variation across banks shown by the minimum and maximum values of the factors during the study period 2001 to 2010. The dispersion of bank specific factors (measured by standard deviation) is high. The dispersion is more apparent in CAP and LLP (see Appendix B). This suggests the Ghana's banks are heterogeneous. The introduction of universal banking policy in 2003 in Ghana could reduce the heterogeneity across banks.

The average GDP growth is 5.7 percent during the study period. Ghana economy has enjoyed a sustained economic growth from 2001 to 2010. However, the inflation rate continues to show to be high despite the economic and financial reforms. The rate of inflation depicts a minimum figure of 10.2 percent and a maximum of 32.9 percent with an

Table 4.3 Summary Statistics of the Determinant Factors of Bank Eficiency in Ghana

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
SIZE	211	11,935	1,388	7,910	14,560
INF	211	0.164	0.067	0.102	0.329
LLP	211	0.088	0.084	0.000	0.640
GDPG	211	0.057	0.012	0.045	0.084
CAP	211	0.136	0.113	-0.150	0.980

Notes: INF, LLP, GDPG and CAP are ratios and size in millions. Number of banks is 25.

average of 16.4 percent from 2001 to 2010. The loan loss provision ratio exhibits a worrying trend. On average, 8.8 percent of the total loans in the Ghanaian banking industry

exhibited a minimum of zero percent and a maximum of 64 percent. The range is overwhelmingly substantial during the study period. However, Ghanaian banks are well-capitalized where the average bank in the sample has a capital ratio of 13.6 percent. There are also noticeable differences in bank size during the study period.

The study also tests for multicollinearity problems between the determinant factors of bank efficiency. Table 4.4 reports the results of the correlation matrix of the determinant factors. The results show low correlation among the variables and allay the fear of multicollinearity problems. The results suggest that there is no significant correlation between the explanatory variables. A variance inflation factor (VIF) analysis for each explanatory variable is conducted to identify variables that are collinear (see Tables 1 and 2 in Appendix A). When the VIF is below value of 10 (e.g. Zhu et al., 2007; Wu, 2007; Smith et al.,

Table 4.4 Correlation Coefficients of Determinants of Bank Efficiency in Ghana

Variable	SIZE	INF	LLP	GDPG	CAP
SIZE	1.0000				
INF	-0.3089	1.0000			
LLP	-0.0149	0.0821	1.0000		
GDPG	0.2117	-0.2290	-0.1298	1.0000	
CAP	-0.2362	-0.0347	-0.1229	0.0336	1.0000

2009) indicates no problem of multicollinearity. In this study, the highest value of the VIF values for efficiency is 1.22 hence support the results.

4.9 Empirical Results and Analysis

This section presents the results of the level of bank efficiency and the determinants of bank efficiency in Ghana.

4.9.1 Average Bank Efficiency Scores by Year

Table 4.5 presents the results of the yearly and overall efficiency of the Ghanaian banking system over the period 2001 to 2010. The results show that the overall average pure technical efficiency score for the Ghanaian banking industry is 0.663 compared with the score of 0.505 for the overall average cost efficiency over the period 2001 to 2010. The

overall average pure technical efficiency score of 0.663 indicates that on average, banks in in Ghana wasted 33.7 percent of input usage relative to the "best-practice" bank. In other words, on average, banks could have produced the same amount of outputs with 33.7 percent fewer input resources. There is much waste of valuable resources in the Ghanaian banking system over the period under study.

Similarly, the overall average cost efficiency is 0.505. This implies the Ghanaian bank wastes 49.5 percent (almost half) of its costs relative to the "best-practice" bank. In other words, on average, the industry could reduce its cost by 49.5 percent and still produce the same amount of output. The results suggest Ghanaian bank managers did not use their inputs more efficiently over the period 2001 to 2010. Overall, the results show relatively low average efficiency scores during the study period. This suggests that Ghanaian banks are operating far from the efficiency frontier. This also implies that Ghanaian banks can obtain bigger cost savings by reducing their managerial and cost inefficiencies. The pure technical inefficiency (the underutilization of input usage) is an indication of bad senior management practices in input-usage and management of the loan portfolio in the form of less screening and monitoring of bank borrowers. The underutilization of input resources by Ghanaian banks could, in part, be attributed to banks expansion generating higher amount of fixed assets which are yet to produce returns (see Sathye, 2003). For example, the cost to the banks for the introduction of technologies is high simply because many people are not using these technologies. The limited use of technology by bank customers is attributed to illiteracy and high cost of using the technology. The cost of using, for example, ATM is high and not many customers have access to personal computers limiting internet banking usage. Biometric technology is being introduced in Ghana to solve the illiteracy problem. In addition, the high interest rates in Ghana confirm the high cost of capital and high non-performing loans contributing to high operating costs might explain the low level of efficiency of the banks. Thus, Ghanaian banks have inadequate control of their operating expenses and therefore should focus more on cost management.

Casu & Girardone (2009), in their study on five European countries, find an increase in input waste from 2000-2001 resulting in lower average efficiencies. The authors further explain that decreases in bank efficiency can be the cause of bank consolidation which allows managers to exploit market power. Similarly, high levels of inefficiency in some emerging countries such as India, Turkey and Brazil have also been reported (Sathye,

2003; Das & Ghosh, 2006; Denizer et al., 2007; Tescles & Tabak, 2010). In addition, low level of cost efficiency has been reported on six emerging South Eastern European countries for the period 1998 to 2003 (Staikouras et al., 2008). On the contrary, Fang et al. (2011) in their study reported efficiency score of 76.95 percent for the Croatian banking sector over period 1998 to 2008. Similarly, Ariff & Can (2008) study reports an average cost efficiency score of 79 percent for the Chinese banking industry during the period 1995-2004 and Maudos & Pastor (2003) study documents relatively higher efficiency score of 87.1 percent for the Spanish banking sector during 1985-1996.

Table 4.5 Average Efficiency Scores of the Ghana's Banking Industry (2001-2010)

Year	Number of banks	PTE		CE	
		Mean	Standard Deviation	Mean	Standard Deviation
2001	17	0.660	0.264	0.452	0.263
2002	18	0.603	0.235	0.416	0.253
2003	18	0.602	0.178	0.451	0.201
2004	18	0.606	0.157	0.484	0.188
2005	20	0.641	0.177	0.486	0.174
2006	22	0.617	0.199	0.469	0.201
2007	23	0.614	0.222	0.453	0.196
2008	25	0.700	0.204	0.526	0.206
2009	25	0.706	0.212	0.577	0.250
2010	25	0.819	0.199	0.661	0.276
Mean		0.663	0.213	0.505	0.231

Notes: PTE and CE represent pure technical efficiency and cost efficiency, respectively.

In terms of yearly results, the mean pure technical efficiency of the Ghanaian banking industry improves from 0.660 in 2001 to 0.819 in 2010, an increase of 24.1 percent. Pure technical efficiency declines from 0.660 in 2001 to 0.602 in 2003 indicating an increase in input wastage, but has a steady improvement in input utilization from 2007 to 2010.

Similarly, the cost efficiency of the Ghanaian banking industry improved considerably from 0.452 in 2001 to 0.661 in 2010, an increase of 46.2 percent. In early years, from 2002 to 2005, cost efficiency increases from 0.416 in 2002 to 0.486 in 2005, showing improvement in input utilization, but then declines to 0.469 in 2006 and eventually begins to show a steady improvement in input utilization from 2007 to 2010.

The trend in efficiency from 2007 to 2010 suggests that bank managers in Ghana have begun to use their inputs more efficiently that is, the managers are able to control the

underutilization or wastage of valuable input resources. Nevertheless, the results indicate that more effort is still required especially in terms of cost efficiency where a lot of input waste occurred.

Our results show both pure technical and cost efficiency are relatively unstable over the study period. The instability is more pronounced in cost efficiency than in technical efficiency. The results also show the low level of the efficiency scores in Ghana's banks. However, since 2007 there has been remarkable improvement in the efficiency scores in Ghana' banking sector. For instance, the average pure technical efficiency increased substantially from 0.706 in 2009 to 0.819 in 2010, representing a yearly increase of 16 percent, the biggest over the study period. Similarly, the average cost efficiency increased from 0.577 in 2009 to 0.661 in 2010 representing a yearly increase of 14.6 percent, also the biggest during the study period.

4.9.2 Composition of Efficient Frontier Banks

Table 4.6 describes the the composition of the Ghanaian bank efficiency frontier, which is the input and output combination of the 'best-practice' banks in Ghana. Panel A in Table 4.6 presents the pure technical efficiency frontier and panel B shows the cost efficiency frontier. Panel A in Table 4.6 shows a total of 108 out of the 211 observations are regarded pure technically efficient over the study period whereas Panel B indicates a total of 62 out of the 211 observations are considered as cost efficient. The result reveals that only a small

Table 4.6 Number of Efficient Frontier Banks (2001-2010)

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Panel A:PTE											
All Banks	8	8	8	11	12	16	12	11	10	12	108
Panel B: CE											
All Banks	3	5	5	5	7	7	9	7	6	7	62
No. of Banks	17	17	18	19	20	23	23	25	25	25	

Notes: All banks are the banks under study. PTE and CE represent pure technical efficiency and cost efficiency, respectively.

number of banks in Ghana is efficient each year. For instance, 12 out of 25 banks are on the pure technical efficiency frontiers and 7 out of 25 banks are on the cost efficiency frontiers in 2010. The low level of bank cost efficiency apparently reflects the high operating and financial costs of managing a bank in Ghana. Only Ghana commercial bank (GCB) and Barclays bank (BBG) remain on the cost efficiency frontier from 2001 to 2010 and 2002 to 2010, respectively (see Appendix D). This suggests that the other efficient banks remain on the frontier for a few years but fail to maintain their performances.

Similarly, in terms of pure technical efficiency, only these two banks remain on the pure technical efficiency frontier throughout the study period. This indicates the other pure technical efficient banks fail to remain on the frontier for longer years. These results suggest that the financial reforms have not produced the expected results.

Relative to pre-reforms period the financial sector reforms have improved the bank efficiency in Ghana, but there is more room for improvement, especially in terms of bank cost efficiency. The cost inefficiency of the Ghanaian banking industry reflects the higher cost of operation mainly due to high non-performing loans (inadequate credit monitoring) and inefficient control of operating expenses particularly high staff cost and cost of funds. This suggests that banks operating in a less competitive banking market such as Ghana are able to charge higher prices and interestingly, may not be under any pressure to control their costs (see Maudos et al., 2002) and therefore become less cost efficient. High non-performing loans in Ghana may be attributed to problems of adverse selection and moral hazard caused by asymmetric information between the banks and their customers. Banks can reduce adverse selection by screening potential borrowers and reduce moral hazard behaviour by monitoring borrowers (Vennet, 2002) in order to reduce bad debts (non-performing loans) and therefore total costs leading to increase in cost efficiency.

4.9.3 Determinants of Bank Efficiency

4.9.3.1 Bank Pure Technical Efficiency

Tables 4.7 presents the results for both the fixed effect and system GMM pure technical efficiency models used in the study. A positive coefficient implies an improvement in efficiency while a negative coefficient indicates decline in efficiency.

4.9.3.1.1 Model Specification and Validity of Instruments Tests

The diagnostic test of the fixed effect model for the technical efficiency shows p-value of the F-test to be 0.001 and therefore F-test is statistically significant at the 1 percent level confirming the joint significance of the coefficients of the explanatory variables (see Table 4.7). This indicates that the determinants employed are relevant in explaining the pure technical efficiency. The analysis of the residuals suggests the existence of heteroskedasticity and hence the application of White test (1980) for robust standard error.

In contrast, the results of the dynamic panel model show the p-value of the Hansen test of 0.921 is deemed closer to one and is viewed with concern (see Table 4.7). Consequently, this result suggests that the instruments are not valid (that is, the instruments correlate with the error terms). This raises the questions on the specification of the model. On the contrary, the difference-in-Hansen test (with p-value of 0.863) confirms the validity of the extra moment restrictions imposed by the levels equation in the system GMM specification. This suggests that the instruments used for the equations in levels are exogenous which strengthens the validity of instruments employed in the system GMM estimation. Further, the p-value of Arellano-Bond test statistics AR(1) is 0.011 which shows that AR(1) test rejects the null hypothesis of no existence of first-order serial autocorrelation in the pure technical efficiency equation. In contrast, the model does not exhibit second order serial correlation since the p-value of Arellano-Bond test statistics AR(2) is equal to 0.393 (because 0.393 is more than 10 percent level of significance and thus cannot reject the null hypothesis). Furthermore, the number of instruments is reasonably less than the number of banks. Nevertheless, the results show that the coefficient of the lagged pure technical efficiency is insignificant, and endogeneity of loan loss provision and capitalization is questionable as indicated by the Hansen test (because the p-value of 0.921 is closer to one). This suggests the superiority of the static model over the dynamic model. Therefore, the results of the pure technical efficiency are based on the fixed effect model estimates.

4.9.3.1.2 Impact of Bank Specific Factors on Pure Technical Efficiency

Table 4.7 shows bank size has a positive relationship with pure technical efficiency and is significant, suggesting that larger banks in Ghana have higher level of pure technical

Table 4.7 Determinants of Bank Pure Technical Efficiency

Variable PTE	Fixed Effect Model Estimates	System GMM Estimates
PTE_{t-1}	-	0.117 (0.99)
SIZE	0.522** (2.71)	0.422 (1.25)
INF	4.074* (1.81)	-0.243 (-0.17)
LLP	1.784 (0.48)	2.434 (0.53)
GDPG	-0.874 (-0.09)	-12.869 (-0.89)
CAP	7.319*** (4.57)	-7.485 (-0.66)
TREND		0.180 (1.33)
CONSTANT	-6.693*** (-2.82)	-3.737 (-0.77)
R-squared	0.144	
F-Statistic (p-value)	0.001***	0.000***
Wald test Heteroskedasticity (p-value)	0.000***	
Number of observations	211	186
Number of banks	25	25
Number of instruments		14
Hansen test (p-value)		0.921
Arellano-Bond test:		
AR(1) *p*-value		0.011
AR(2) *p*-value		0.393
Difference-in-Hansen test (p-values):		
GMM instruments for levels		0.863

Notes: t-statistics in parentheses below estimates. *, ** and *** indicate significant at 10%, 5% and 1%, respectively. PTE represents pure technical efficiency. F-Statistic is for the joint significance of the coefficients of the explanatory variables. AR(1) and AR(2) are tests for first and second order autocorrelation in the first-differenced residuals, respectively.

efficiency. This result is similar to studies of Miller & Noulas (1997) on US banks, Yildirim (2002) on Turkish banking industry, Ataullah & Le (2006) on India banks, Rezitis (2006) on Greece banks and Sufian (2009) on Malaysia banks. The economies of scale could be the possible reason for this positive relationship in Ghana. Large banks in Ghana operate nationwide and may face more competitive pressures than small banks which often

operate within the cities. Therefore, there is pressure on larger banks to control costs and be efficient.

The results in Table 4.7 indicate that bank capitalization has a significant positive effect on pure technical efficiency. This suggests that higher capitalized banks in Ghana are pure technical efficient. This could be that banks with higher capital are perceived to be relatively safe by depositors (capital playing a role of implicit deposit insurance) and therefore reduces their cost of borrowing leading to reduction in efficiency (Das & Ghosh, 2006). This finding is consistent with the results of Isik & Hassan (2003) on Turkey, Casu & Girardone (2004) on Italy and Pasiouras (2008) on Greece banks.

On the other hand, the result indicates that loan loss provision ratio is not important factors in determining bank pure technical efficiency in Ghana over the study period 2001- 2010. It is hypothesized that loan loss provision ratio will always impact negatively on bank efficiency since higher efficiency is expected to be associated with better credit risk evaluation (Berger & DeYoung, 1997; Altunbas et al., 2000). But interestingly, the results in Table 4.7 show that loan loss provision variable exhibits a positive relationship with pure technical efficiency. However, it is statistically insignificant and has no impact on pure technical efficiency. This result is similar to Altunbas et al. (2000) and Tecles & Tabak (2010) studies where efficiency is not very sensitive to credit risk. Similarly, this result is consistent with Casu & Girardone (2004) finding on Italian banks.

4.9.3.1.3 Impact of Macroeconomic Factors on Pure Technical Efficiency

The results in Table 4.7 show that the rate of inflation on pure technical efficiency is significant and positive. This suggests that the higher the inflation rate, the higher the efficiency. The rate of inflation in Ghana has been high and unstable even after economic structural adjustment reforms since 1987. The high inflation increases uncertainty the banks encounter in Ghana. This reflects the high interest rate charged by Ghanaian banks to compensate for their returns after more than two decades of financial service reforms. Thus, the positive sign on inflation depicts that Ghanaian banking industry is able to benefit from inflationary economic environment as the banks able to pass on the cost of inflation to their customers by charge higher lending rates relative to deposit rates. The result is similar to the findings of Grigorian & Manole (2006) on the banking sectors in 17

Eastern European transition countries. Thus, the high inflation in Ghana may be influencing bank behaviour such as stimulating banks to compete through excessive branch networks (see Kasman & Yildirim, 2006) and charging high interest margins.

GDP growth rate, on the other hand, has a negative impact on pure technical efficiency, but is statistically insignificant in explaining differences in pure technical efficiency. This supports the results of Fries & Taci (2005) and di Patti & Hardy (2005) whose studies show no significant association between efficiency and GDP growth rate 15 East European countries and Pakistan, respectively. However, these two studies find positive relationship between GDP growth rate and bank efficiency.

Finally, the findings also suggest that GDP growth rate and loan loss provision have no influence on managerial efficiency in Ghana banks between 2001 and 2010. The results show that bank capitalization, inflation and bank size are the only factors that influence pure technical efficiency, which suggests that these factors are important and should be accounted for in measuring the pure technical efficiency in the Ghana's banks.

4.9.3.2 Bank Cost Efficiency

Table 4.8 presents the results of the determinants of bank cost efficiency in Ghana.

4.9.3.2.1 Model Specification and Validity of Instruments Tests

In the case of fixed effect model, the F-test for the overall significance of the explanatory variables rejects the null hypothesis that all the explanatory are not different from zero. The results indicate that bank size and capitalization are the most important factors in determining bank cost efficiency in Ghana (see Table 4.8). The analysis of the residuals indicates the presence of heteroskedasticity and, as a result, White (1980) robust standard error test is applied.

In terms of the system GMM, the Arellano-Bond test statistics AR(2) of the residuals do not reject the specification of the error term, since the p-value of AR(2), 0.948, is more than 10 percent level of significance (see Table 4.8). Thus, there is no serial correlation in the error term. The p-value of the Hansen test is 0.881 and therefore fails to reject the null

hypothesis of over-identification of the validity of the instruments. Accordingly, the Hansen test of over-identification reports that the instruments used in the system GMM estimation are valid. The difference-in-Hansen test of exogeneity (with p-value of 0.784) indicates the validity of the extra moment restrictions imposed by the level equations in the system GMM specification and that the instruments used for the equations in levels are exogenous which strengthens the validity of instruments employed in the system GMM estimation. There is no evidence of correlation between the instruments and error terms. In addition, since the loan loss provision and capitalization are endogenous variables, the analysis of the results is based on the two-step system GMM. Finally, the number of instruments is less than the number of banks.

4.9.3.2.2 Impact of Bank Specific Factors on Bank Cost Efficiency

The system GMM results in Table 4.8 show that lagged cost efficiency, GDP growth rate and capitalization are the important factors in determining bank cost efficiency in Ghana.

The lagged cost efficiency is significant and has a positive effect on the bank efficiency of the current year. This implies that bank cost efficiency tends to persist from year to year. This suggests that an increase in lagged cost efficiency could help increase the current year's cost efficiency. The positive lagged cost efficiency may constitute some accumulated knowledge and technologies that may help banks to reduce costs (see Ataullah & Le, 2006). This implies that the financial services reforms in Ghana's banking industry have encouraged banks to improve their cost efficiency. The result is consistent with the studies of Staub et al. (2010) and Manlagnit (2011) which show lagged cost efficiency to have positive and significant effect on the current year efficiency. This result also suggests that a proper specification of cost efficiency should incorporate a dynamic term.

Table 4.8 shows that bank size is positive but has no significant impact on cost efficiency suggesting that larger banks in Ghana have no cost advantages over their smaller counterparts. Similarly, some previous studies did not observe any significant efficiency advantage for large banks. For instance, Girardone et al.'s (2004) study on Italian banking sector indicates no evidence of association between size and bank efficiency suggesting that larger banks are not more cost efficient than their smaller ones. Moreover, Staub et

al.'s (2010) study on the Brazilian banking system in the recent period 2000 to 2007 find that bank size is not an important factor in determining bank cost efficiency. The result is also consistent with the finding of Ariff & Can (2008) for large Chinese banks.

The bank capitalization coefficient is negative and statistically significant at 10 percent level of significance. This result suggests that well-capitalized banks are cost inefficient in Ghana contradicting the result documented in Table 4.7. This could be that higher shareholders' leverage is forcing banks to sacrifice costs in order to attain better results (Tabak et al., 2011). This suggests that moral hazard incentives (as banks are inefficient) may increase and banks are more likely to increase costs (see Ariff & Can, 2008). This may reduce cost efficiency. Thus, bank capitalization, on the one hand, may reduce bank capital risk, but on the other hand, may increase moral hazard incentives leading to increase in costs and therefore decline in cost efficiency (Ariff & Can, 2008). Ghana has worse credit information environment as the culture of credit risk management practices is not well-developed in Ghana's banking industry (Amissah-Arthur, 2010). In addition, the result may be an indication that well-capitalized banks in Ghana incur higher costs due to higher cost of capital resulting from the increase in minimum regulatory capital requirement (PricewaterhouseCoopers, 2011). This may increase costs and lead to decrease in cost efficiency. Thus, financial capital affects costs through its use as a source of financing loans (Berger & Mester, 1997; Ariff & Can, 2008; Manlagnit, 2011). This suggests raising capital in Ghana involves higher costs than taking deposits generating a negative relationship between bank capitalization and efficiency. This finding is similar to the results presented by Sufian (2009) on Malaysia over the period 1995-1999, Altunbas et al. (2007) on 15 European countries from 1992 to 2000 and Tabak et al (2011) on Latin American countries over the period 2001-2008.

Table 4.8 shows loan loss provision (proxy for credit risk) has a negative effect but has no significant influence on bank cost efficiency in Ghana during the study period 2001 to 2010. This is because the loan loss provision to NPLs is only 53.2 percent indicating under-provisioning for loans (International Monetary Fund, 2011). This result supports the findings of Staub et al. (2010) and Tecles & Tabak (2010) studies on the Brazilian banking system from 2000 to 2007 which show that loan loss provision ratio has insignificant impact on cost efficiency. Furthermore, Yildirim & Philippatos (2007) and Brissimis et al. (2008) also find loan loss provision to be negatively related to efficiency.

Table 4.8 Determinants of Bank Cost Efficiency

Variable CE	Fixed Effect Model Estimates	System GMM Estimates
CE_{t-1}	-	0.269* (1.85)
SIZE	0.511** (2.42)	0.033 (0.07)
INF	1.722 (1.33)	0.794 (0.38)
LLP	0.916 (0.34)	-5.445 (-1.03)
GDPG	-8.665 (-1.30)	-42.910* (-1.97)
CAP	3.501** (2.18)	-28.743* (-1.81)
TREND		0.356 (1.36)
CONSTANT	-6.138** (-2.49)	3.815 (0.59)
R-squared	0.109	
F-Statistic (p-value)	0.000***	0.004***
Wald Test Heteroskedasticity (p-value)	0.000***	
Number of observations	211	186
Number of banks	25	25
Number of instruments		14
Hansen test (p-value)		0.881
Arellano-Bond test:		
AR(1) *p*-value		0.042
AR(2) *p*-value		0.948
Difference-in-Hansen test (p-values):		
GMM instruments for levels		0.784

Notes: t-statistics in parentheses below estimates. *, ** and *** indicate significant at 10%, 5% and 1%, respectively. CE represents cost efficiency. F-Statistic is for the joint significance of the coefficients of the explanatory variables. AR(1) and AR(2) are tests for first and second order autocorrelation first-differenced residuals, respectively.

In addition, Staikouras et al. (2008) assess the cost efficiency of banks operating in six emerging South Eastern European countries and find a negative relationship.

4.9.3.2.3 Impact of Macroeconomic Factors on Bank Cost Efficiency

The GDP growth rate has a negative and significant effect on bank cost efficiency. This shows that economic growth reduces the banks' cost efficiency. This finding is consistent with the studies of Fries & Taci (2005) and Chan & Karim (2010) on the Middle Eastern/North African, but opposite to the findings of Maudos et al. (2002) on 10 European countries, Grigorian & Manole (2006) on 17 Eastern European countries and Lozano-Vivas & Pasiouras (2010) on 87 countries, who find that real GDP growth rate is positively related to cost efficiency. One possible explanation for the negative relationship is that during higher economic growth the banks lower their operating standards, such as less evaluation and monitoring of the borrowers leading to higher costs and thereby become cost inefficient. Thus, higher economic growth leads to greater risk taking (in less competitive banking markets) resulting in reduction in bank cost efficiency (Soedarmono et al., 2011).

In the case of inflation rate, contrary to our expectation, the results show that the inflation coefficient is positive but statistically insignificant, implying that inflation has a weak influence on cost efficiency. The result suggests that high inflation in Ghana does not contribute to bank cost efficiency. This finding supports the study of Yildirim (2002) who find no relationship between inflation and cost efficiency. The positive relationship revealed in this study indicates that Ghana banks are able to charge higher rates in high inflationary environment to compensate for their returns (see Chan & Karim, 2010).

Table 4.8 shows inflation, loan loss provision and bank size have no significant effect on bank cost efficiency in Ghana during the study period 2001 to 2010. The results also show that only bank capitalization and GDP growth rate influence the cost efficiency of banks suggesting that these factors should be accounted for in measuring the cost efficiency of the banks in Ghana. Bank capitalization is the only factor that influences both bank managerial (that is, pure technical efficiency) and cost efficiency in Ghana.

4.10 Summary

The findings reveal that Ghana banks operate with low levels of efficiency in a weak competitive environment, but the levels of efficiency has increased significantly from 2001

to 2010, particularly cost efficiency. However, the trend in efficiency from 2007 to 2010 suggests that bank managers in Ghana have begun to use their inputs more efficiently, that is, the managers are able to control the underutilization or wastage of valuable input resources. The results indicate that more effort is needed especially in the cost efficiency which is low relative to pure technical efficiency.

The results show that bank cost efficiency model recognises the dynamic nature of cost efficiency indicating the superiority of the system GMM over the fixed effect estimator. However, in terms of pure technical efficiency the fixed-effect estimator appears more effective.

In terms of the pure technical efficiency, bank size, capitalization and inflation are important determinants of pure technical efficiency. The results suggest that higher capitalized and larger banks in Ghana are pure technically efficient banks. Interestingly, Ghana banks are able to benefit from inflationary economic environment and high rate of interest by charging higher lending rates relative to deposit rates.

In the context of cost efficiency, lagged cost efficiency, GDP growth rate and capitalization are important factors in determining cost efficiency in Ghana banks. Cost efficiency tends to persist from year to year. The positive lagged cost efficiency indicates some accumulated knowledge and technologies that may help banks to reduce costs and become more efficiency. Further, well-capitalized banks in Ghana incur higher costs providing banking products and services due to high level of non-performing loans and higher cost of capital resulting from the increase in minimum regulatory capital requirement (PricewaterhouseCoopers, 2011). Moreover, higher economic growth in Ghana contributes to greater risk taking leading to decline in bank efficiency.

Even though the study reveals that there Ghana's banks are inefficient, the results presented in this study show major improvements in efficiency in comparison to banks' behaviour before the financial sector reforms. Before the financial sector reforms, bank efficiency virtually did not exist in Ghana's banking system.

Chapter 5
Bank Competition

5.1 Introduction

The chapter is divided into six sections. Section 5.2 discusses the measurement of competition using Lerner index. Section 5.3 reviews some previous studies on bank competition. Section 5.4 provides the methodology whereas variables measurements are presented in Section 5.5. Section 5.6 presents the empirical results and analysis. The chapter concludes with the summary.

5.2 Measurement of Bank Competition

On the degree of bank competition, Lerner index is employed to measure bank competition. Consequently, transcendental logarithmic (translog) total cost function is specified and marginal cost computed by using one output and three inputs.

5.2.1 Structural and Non-Structural Indicators

Structural and non-structural indicators are the two types of competition measurement that have gained prominence or widely used in the banking literature to evaluate the competitive behaviour of the banking industry. The structural indicators which employ the traditional industrial organization theory that focuses on the Structure-Conduct-Performance (SCP) paradigm. The SCP paradigm dominated the structure for empirical research in industrial organization between 1950s and early 1980s. The SCP hypothesis (1951) posits that greater concentration in banking market creates less competitive bank behaviour and leads to higher bank profitability. With this approach, the competitive characteristics of the industry are derived from structural characteristics that affect the firms' conduct or behaviour and performance. Thus, the SCP paradigm argues that market structure drives firms' conduct, which in turn drives their performance. This approach depends on the market structure tests to assess bank competition using the SCP model. The market structure tests employ various concentration indices such as the market share of the largest banks, or the HHI to measure the degree of competition. However, the limitation of

these approaches is that they infer the degree of competition from indirect proxies such as market structure (e.g. concentration levels, number of firms). Thus, structural approaches to measuring competition rely on concentration. Specifically, bank competition is considered inverse of HHI or bank concentration ratios. In addition, empirical studies have revealed that the relationship between concentration and performance is not always positive (see Jackson, 1992, Anzoategui et al., 2010) and that concentration is not a reliable measure of competition (see Cetorelli, 1999; Maudos & Fernandez de Guevara, 2004; Fernandez de Guevara et al.,2005; Claessens & Laeven, 2004).

To address these criticisms, an alternative approach, non-structural indicators of competition based on the New Empirical Industrial Organization (NEIO) approach has become widely popular in the banking literature since the early 1980s. NEIO measurements challenge the usual way of using market structure to measure banking competition. The NEIO aims to infer the conduct (e.g. pricing policies) of firms directly, without considering the analysis of the structure of the market (Degryse et al., 2009). In other words, the NEIO methods aim to measure the degree of competition directly by addressing firms' behaviour. The methods require the estimation of equations based on theoretical models of price and output determination. In particular, these include tests for competitive conditions in contestable markets: conjectural variation (Bresnahan, 1982; Lau, 1982), H-statistic (Panzar & Rosse, 1987), Lerner index (Lerner, 1934) and Boone Indicator (Boone, 2001, 2008). Thus, non-structural approaches to estimating competition do not rely on concentration.

Many empirical studies in banking have used the Panzar & Rosse (1987) H-Statistic (e.g. De Bandt & Davis, 2000; Bikker & Haaf, 2002; Claessens & Laeven, 2004; Claessens, 2009), Lerner indexes (e.g. Prescott & McCall (1975) for US banks; Angelini & Cetorelli (2003) for Italian banks; Fernandez de Guevara & Maudos (2007) for the Spanish banking sector; Fernandez de Guevara et al. (2005), Carbó et al. (2009), Casu and Girardone (2009) for the European banking industry; Solis & Maudos (2008) and Maudos & Solis (2011) for the Mexican banking system; Pruteanu-Podpiera et al. (2008) for Czech Republic, Delis & Tsionas (2009) for European and US banks; Turk-Ariss (2010) for selected region in the developing countries, conjectural variation measure by Bresnahan (1982), Lau (1982) and recently Boone indicators (e.g. Leuvensteijn et al., 2007; Schaeck & Cihák, 2008).

However, the two main and widely used methods for measuring bank competition (or bank market power) are H-Statistic (Panzar & Rosse, 1987) and Lerner index (Lerner, 1934).

In our study, Lerner index is chosen to assess bank competition (or market power) for four reasons[18]:

i. it can be estimated for each bank in the sample; consequently, the determinants of competition can be analysed by using information at bank level (bank-specific variables).
ii. the evolution of market power can be analysed estimating a Lerner index for each year.
iii. it better reflects competition in broader banking activity, it does not focus only on traditional banking loan and deposit services (Carbó et al., 2009).
iv. it offers a continuous measure of the degree of competition and as a result can have higher descriptive power when used as dependent variable in the subsequent analysis of determinants of competition (Maudos & Fernandez de Guevara, 2009).

5.2.2 Estimation of Lerner Index

Lerner index of monopoly (market) power has been widely used in the banking literature as a non-structural indicator of the degree of competition (market power is inversely related to competition). Lerner index is used to evaluate the difference between the prices that banks charge for their product and services and the marginal costs (MC) they pay to offer their product and services. In other words, it measures the ability of a bank to fix prices of their product and services above their MC. This difference between price and MC indicates the existence of market power. The Lerner index measures the capacity to set prices (interest rates and fees) above MC as a proportion of prices. This is expressed mathematically as:

$$\text{Lerner}_{it} = \frac{P_{it} - MC_{it}}{P_{it}} \qquad (5.1)$$

[18] Limitations of Lerner index as an indicator of market power include: a) it relies on the definition of revenue and costs; (b) the cost of risk is not included, despites its relevance on bank costs and revenues and (c) banking output is usually proxied by the total assets of each firm mainly because of data problems (Pindyck, 1985 and Perloff et al., 2007).

where P is the price of output and is calculated as total revenue divided by total assets following Fernandez de Guevara et al. (2005) and Carbó et al. (2009) methods. When the Lerner index is equal to zero indicates perfect competition and implies the bank has no pricing power. When the Lerner index equals to one indicates pure monopoly implying that the banks are able to charge a price far above the MC. The closer the Lerner index to one the higher the bank's market power and the closer to zero signifies increase in competitive behaviour of the banks. Finally, when the Lerner index is less than zero it implies pricing is below MC. Negative value of Lerner index is possible and it reflects non-optimizing behaviour of the banks (Delis & Pagoulatos, 2009; Soedarmono et al., 2011). This means that the banks do not function within the principles of a market economy and may be supported, for example, by the government (Delis & Pagoulatos, 2009).

5.2.2.1 Specification of Cost Function Model

As observed in the computation of the Lerner index, it is essential to know the banks output prices and their cost functions. The estimation of the cost function is performed separately in each bank. This permits the parameters of the cost function to vary from one bank to another to reflect different technologies (Maudos & Fernandez de Guevara, 2007). Fixed effects are also introduced in order to capture the effect of possible unobserved variables specific to each bank. A time trend variable is added to capture the changes in technology over time leading to movements in the cost function over time (Maudos & Fernandez de Guevara, 2007).

Following Fernandez de Guevara & Maudos, (2007, 2011), Fungacova & Weill, 2009 and Maudos & Solis, (2011), this study estimates a transcendental logarithmic (translog) cost function[19] developed by Christensen et al. (1973) with one output (total assets) and three input prices (price of labour, price of physical capital and price of deposits). The unrestricted translog cost function is specified as follows:

[19] The translog cost function offers a second-order Taylor expansion (logarithmic) approximation to an arbitrary continuous transformation surface. The translog is preferred to Cobb-Douglas form because it offers a better fit than the Cobb-Douglas form (Kumbhakar & lovell, 2000). The Fourier flexible form is even more general than the translog production function. However, the results of both cost functions are more or less in line with each other (Berger and Mester, 1997).

$$\mathrm{InTC_{it}} = \propto_{0i} + \propto_{y} \mathrm{Iny_{it}} + \frac{1}{2} \propto_{yy} (\mathrm{Iny_{it}})^2 + \sum_{j=1} \rho_j \mathrm{Inw_{jit}} + \frac{1}{2} \sum_{j=1} \sum_{k=1} \beta_{jk} \mathrm{Inw_{jit}}\, \mathrm{Inw_{kit}}$$

$$+ \sum_{j=1} \delta_{jy} \mathrm{lnw_{jit}} \mathrm{Iny_{it}} + \mu_1 \mathrm{Trend} + \frac{1}{2} \mu_2 \mathrm{Trend}^2 + \mu_3 \mathrm{TrendIny_{it}}$$

$$+ \sum_{j=1} \pi_j \mathrm{TrendInw_{jit}} + \mathrm{v_{it}} \qquad (5.2)$$

where

i denotes banks and *t* denotes years,

j and k are production inputs,

TC = total cost which is the sum of personnel expenses, other non-interest expenses and interest expenses,

y = total assets which is a proxy for the bank output,

w_{jit} = input prices

Trend = time trend representing technology,

α_{0i} = unobserved specific effect,

v = the disturbance term,

$\propto$, ρ, β, δ, μ, and π are coefficients to be estimated.

The estimation is performed by imposing symmetry of cross-partial derivatives and linear homogeneity restrictions in input prices (Fernandez de Guevara & Maudos, 2007, 2011; Fungacova & Weill, 2009; Maudos & Solis, 2011). The linear homogeneity[20] conditions are imposed by normalising price of capital and price of deposits by the price of labour. In addition, symmetry of cross price effects requires that $\beta_{jk} = \beta_{kj}$ for all $j \neq k$. After imposing linear homogeneity with respect to input prices and symmetry of cross-partial coefficients the translog cost function is specified as:

[20] In order to correspond to a well-behaved production function, a cost function must be homogeneous of degree one in prices; that is, for a fixed level of output, total cost must increase proportionally when all prices increase proportionally.

$$\begin{aligned}\mathrm{InTC_{it}} = {} & \emptyset_{0i} + \theta_y \mathrm{Iny_{it}} + \theta_1 \mathrm{Inw^*_{1it}} + \theta_2 \mathrm{Inw^*_{2it}} + \frac{1}{2}\gamma_{11}(\mathrm{lnw^*_{1it}})^2 + \delta_{12}\mathrm{lnw^*_{1it}}\mathrm{lnw^*_{2it}} \\ & + \frac{1}{2}\gamma_{22}(\mathrm{lnw^*_{2it}})^2 + \tau_{1y}\mathrm{lnw^*_{1it}}\mathrm{Iny_{it}} + \tau_{2y}\mathrm{lnw^*_{2it}}\mathrm{Iny_{it}} + \frac{1}{2}\gamma_{yy}(\mathrm{Iny_{it}})^2 \\ & + \lambda_1 \mathrm{Trend} + \frac{1}{2}\lambda_2 \mathrm{Trend}^2 + \varphi_1 \mathrm{Trend}\mathrm{lnw^*_{1it}} + \varphi_2 \mathrm{Trend}\mathrm{lnw^*_{2it}} \\ & + \varphi_3 \mathrm{Trend}\mathrm{Iny_{it}} + \mathrm{u}_{it} \qquad (5.3)\end{aligned}$$

where

i denotes banks and *t* denotes years,

TC = total cost which is the sum of personnel expenses, other non-interest and interest expenses,

y = total assets which is a proxy for the bank output,

w_1 = price of deposit and is defined as the ratio of interest expenses to total deposits[21],

w_2 = price of fixed capital and is defined as the ratio of capital-related expenses (i.e. operating expenses minus personnel expenses) to fixed assets,

w_3 = price of labour and is defined as the ratio of personnel expenses to total assets,

$w_1^* = w_1/w_3$

$w_2^* = w_2/w_3$

$\emptyset_{0i}$ = unobserved specific effect,

μ = the disturbance term,

∅, θ, δ, γ, τ, λ and φ are coefficients to be estimated.

Following Shaffer (1993) Berg and Kim (1994) Fernandez de Guevara et al. (2005) and Turk-Ariss (2010), it is assumed that the flow of goods and services produced by a bank is proportional to its total assets since total assets account for the entire product of the bank, thus, total assets is used as a proxy for the bank output in this study.

Finally, a fixed effect regression is used to estimate the coefficients of the cost function which are then used to compute the MC. Fixed effect regression model is the preferred model because the banks used in our study are not randomly chosen. Due to the lack of statistical data information, proxies are used for the banks' outputs and the three prices of inputs following Maudos & Fernandez de Guevara (2005, 2007); Pruteanu-Podpiera et al.

[21] There were many missing data on total borrowing.

(2008); Fungacova & Weill (2009); Fernandez de Guevara & Maudos (2011) and Turk-Ariss (2010) studies.

MC is then obtained by taking the first derivative of the translog cost function with respect to y_{it}:

$$MC_{it} = \frac{d(InTC_{it})}{dy_{it}} = \frac{TC_{it}}{y_{it}}\left[\theta_y + \gamma_{yy} lny_{it} + \tau_{1y} lnw^*_{1it} + \tau_{2y} lnw^*_{2it} + \varphi_3 Trend\right] \qquad (5.4)$$

The coefficients θ, γ, τ, and ω_3 estimated in the cost function equation (5.3) are plugged into equation (5.4) to compute the marginal cost.

5.3 Literature Review

This section is divided into three parts; evidence of bank competition in developed countries and in developing and emerging countries both based on individual-country and cross-country studies.

5.3.1 Evidence on Developed Countries

Individual country studies by Nathan & Neave (1989) for Canada, Vesala (1995) for Finland, Hempell (2002) for Germany, and Maudos & Pérez (2003) and Carbó et al. (2003) for Spain, all conclude that monopolistic competition is prevalent in these countries banking sectors. In addition, Molyneux et al. (1996) examine the degree of competition in Japanese banking system in 1986 and 1988 and find existence of monopoly power in 1986, but monopolistic competition in 1988. Using data from the period 1988-1996, Coccorese (1998) find evidence of monopolistic competition in the Italian banking system.

Smith & Tripe (2001) use pooled regressions for the period from 1996 to 1999 to assess New Zealand banking market competitiveness using Panzar & Rosse (1987) H-Statistic and find that New Zealand banking market operate under conditions of monopolistic competition. The authors' cross-sectional regression analysis indicates conditions of monopolistic competition for 1996, while the analysis suggests the existence of monopoly or conjectural variation oligopoly conditions in 1997. There is evidence that the New Zealand banking market behaved like a natural monopoly in a perfectly contestable

market, perfect competition or sales-maximising firms subject to a break-even constraint in 1998 and 1999.

Maudos & Pérez (2003) study is one of the studies on Spanish banking sector to assess the degree of bank competition. The study spans the period from 1992 to 2001. The authors apply both the Lerner index and the Panzar & Rosse H-statistic test to compute bank competition and report evidences of monopolistic competition. In the same year, Carbó et al. (2003) obtain similar result as Maudos & Pérez (2003) indicating prevalence of monopolistic competition in the period 1986-1999, as well as an increase in market power since 1996. Similarly, in a recent study on bank competition in Spain, Fernandez de Guevara & Maudos (2011) find the existence of monopolistic competition. Their results confirm Maudos & Pérez (2003) and Carbó et al.'s (2003) findings of monopolistic competition in Spanish banks since 1996.

In another study, Coccorese (2004) addresses the competitive conditions in the Italian banking industry using the Rosse–Panzar H-statistic test for a panel of banks for the period 1997–1999 both nationwide and in the standard four macro-regions within the country. The study shows that Italian banks earn revenues as if they are under conditions of monopolistic competition. Their results also indicate that there is a positive association between the local economic performance and the degree of competition in the banking sector: banks behave competitively where local macroeconomic data reveal lower unemployment rates, greater per capita GDP, faster loan growth rates, lower bad loans to total loans ratio, and lower market loan rates.

A study by Fernandez de Guevara & Maudos (2007) investigate the degree and determinants of market power in the Spanish banking sector in the period 1986-2002. Their findings reveal that the market power of the Spanish banking system decreased considerably until the mid-1990s, but find existence of an increase of market power from the mid-1990s. This is the period the European banking sectors embarked on considerable financial reforms and consolidation. Their results also show that the savings banks have more market power than the commercial banks. Their study uses fixed effects regression model to assess the explanatory factors of market power employing the Lerner index. The authors find that bank size has a negative and significant impact on market power. Their

findings also indicate that loan loss provision ratio is not an important factor for explaining market power in the Spanish banking sector.

Matthews et al. (2007) examine competitive conditions among the major British banks, during the period of major structural changes. They estimate the Rosse–Panzar H-statistic for a panel of 12 banks for the period 1980–2004. The authors also estimate the Lerner index of market power and both measures confirm that UK banking system is monopolistically competitive. The study also reports that the intensity of competition in the core market for bank lending is almost the same throughout the 1980s and 1990s. On the other hand, competition in the non-core business of banking (off-balance sheet business) appears to be less intense. The authors are, however, puzzled at the results that competitive conditions on the core business of banking (balance sheet business) are unchanged in the 1990s and 2000s as in the 1980s. This is because their empirical investigation includes a number of mergers and acquisitions by banks and newly converted banks. Their results reveal a small reduction in concentration in the 1990s, indicating that the mergers and acquisitions by the banks have been neutralised by the new bank entrants.

5.3.2 Evidence on Developing and Emerging Countries

Buchs & Mathisen's (2005) study on 20 banks operating in Ghana during 1998-2003 using Panzar-Rosse (1987) approach and find evidence of a non-competitive market structure in the Ghanaian banking system. In a later study on bank competition in Ghana, Aboagye et al. (2008) use data from 2001 to 2006 and employ the Lerner index (1934) and their finding also support the view that Ghanaian banks exhibited market power. Using a fixed effects panel regression model to estimate the determinants of competition, they find a negative relationship between bank efficiency (proxy by staff costs) and market power. In addition, the bank size and time trend have significant positive relationship with market power. Thus, increase in bank size leads to more market power. The passage of time leads to increase in market power. Furthermore, their result indicates that changes in the rate of inflation have strong and negative effect on market power. Their result showed that both concentration variables Herfindahl-Hirshman index (HHI) and bank market share in Ghana do not lead to market power including credit risk. Thus, bank size, efficiency (proxy by staff costs), inflation and time are found to be the most important factors influencing the bank competition in Ghana.

Yuan (2006) investigates the degree of competition in the banking industry in China over the period 1996-2000 before its affiliation with the World Trade Organisation (WTO) using Panzar-Rosse (1987) H-statistic. The findings of the study show that the banking system in China is close to perfect competition in the years; 1996, 1997, 1999 and 2000, whereas monopolistic competition is evidenced in 1998. The four largest banks in China show evidence of monopolistic competition from 1996 to 2000. In contrast, the small banks operate under conditions of perfect competition under the same period of time. The author also suggests that the Chinese banking system was already showing competitive behaviour before it became a member of WTO in 2001.

Gunalp & Celik (2006) use the Panzar-Rosse (1987) H-statistic to assess the competitive conditions of the Turkish banking industry over the period 1990 to 2000. Their results show the existence of monopolistic competition in the Turkish banking industry. The authors conclude that their findings are in accordance with the result of Aydinli (1996) on the competitiveness of the Turkish banking industry.

Simpasa (2010) examines the intensity of competition experienced by Zambian commercial banks in the post-reform era 1998-2006 using unbalanced panel of 388 observations. Simpasa's findings indicate the existence of market power in the Zambian banking industry. Moreover, in his quest to investigate the factors influencing Zambian banking competition, the author finds strong impact of market structure index, capital and cost efficiency on market power. The author's results also indicate that credit risk and inflation have negative and significant impact on bank market power in Zambia.

In a more recent study, Maudos & Solis (2011) investigate the evolution of competition in the Mexican banking sector from 1993-2005, a period that covers the eras of deregulation, liberalization and consolidation of the banking sector in Mexico. The authors find evidence of monopolistic competition. Thus the transformation experienced by Mexican banking sector have not led to greater competitiveness within the sector.

5.3.3 Evidence on Cross-Countries

Looking at the cross-country studies on the European Union banking markets, Molyneux et al. (1994) examine the bank competition on a sample of banks in France, Germany, Italy, Spain and the UK for the period 1986-89. They find that monopolistic competition exists in all countries except Italy where the monopoly power is observed.

To examine the competitive structure of the banking industry in the entire European Union and in individual European Union countries, Bikker & Groeneveld (2000) provide evidence of the existence of monopolistic competition in the European banking sectors, however, to various degrees. Similarly, De Bandt & Davis (2000) assess the effect of European Monetary Union on market conditions for banks operating in the Euro zone over the period 1992-1996. The authors provide evidence of monopolistic competition in Germany and France for large banks and monopoly for small banks. In Italy, however, the study finds that both small and large banks operate under the condition of monopolistic competition. The authors also compare European Union banking market with the behaviour of US banking markets and find that US banking market shows a higher level of competition than European Union banking market. Specifically, De Bandt & Davis (2000) find that the behaviour of large banks in the European Union was not fully competitive as compared to the US.

In another study on Europe, Weill (2004) measures bank competition for a sample of 12 European Union countries over the period 1994-1999 and finds monopolistic competition in the banking sector for all 12 European Union countries. The author also evaluates the relationship between bank competition and X-efficiency and finds evidence of a negative relationship between bank competition and efficiency in European Union banking.

Maudos & Nagore (2005) use a panel data of 10,479 annual observations over the period 1995-1999 to investigate 58 banking sectors from both developed and developing countries. Their study examines the effect of bank-specific, regulatory, institutional, macroeconomic and financial development variables on bank competition, using information at both national and bank level using generalised linear squares with random effects. Their findings show that size and bank efficiency explain a substantial proportion of market power and are the most important for explaining the differences in market power

among banks. The authors also find market structure variables and the level of financial development help to explain the differences observed in the levels of bank competition. However, their study indicates that macroeconomic and regulatory conditions are not important in explaining the differences in market power.

In the same year, Fernandez de Guevara et al. (2005) assess the evolution of competition in the banking industries of five European countries by estimating the Lerner Index of market power and examine their determinants. They employ 18,810 observations of the banking sectors of Germany, France, Italy, Spain, and the United Kingdom over period 1992-1999. Their study finds large differences in the Lerner index among the sample countries suggesting market power (lack of competition) still exist in spite of the reforms in the European banking systems. This trend may be attributed to low level of cross-border bank penetration. The low level of integration in the European banking markets is due to natural and policy-induced barriers that protects national markets from outside competition. The introduction of the single currency and the measures of the Financial Services Action Plan over the period 1999-2005 may increase the levels of competition and financial integration. Further, the findings of their study suggest that the size of banks, operating efficiency, default risk and economic growth are the main explanatory variables for market power. The authors apply fixed effects estimator and observe that economic growth and bank size have positive and significant effect on market power. Their results also show that default risk has positive but insignificant impact on market power and more efficient banks enjoy higher margins.

Casu & Girardone (2006) evaluate the effect of increased consolidation as a result of deregulation of the financial services in the European Union (EU) and the development of the Economic and Monetary Union on the competitive conditions of the EU 15 countries banking markets. The authors employ the Panzar-Rosse (1987) H-statistic to assess the degree of competition in the EU-15 countries. Their findings show empirical evidence of monopolistic competition in the single market. In most countries, banks achieve higher cost efficiency through rationalization processes and reduction in cost.

Bikker & Spierdijk (2008) examine the evolution in bank competition spanning 15 years in 101 countries with 112,343 bank-year observations from 17,476 different banks. Using the Panzar-Rosse (1987) H-statistic, the authors document large changes in the

competitiveness of the banking industry over time. On average, they observe small changes in competition over time in all the 101 countries under evaluation, but substantial differences for several countries and regions. For instance, the major Western economies under evaluation show a large fall in bank competition during the past years. The EU record a substantial fall in the degree of competition, especially the EU 15 record approximately 60% drop in the level of competition, with a 10% fall experience by the Eastern Europe members of the EU. On the other hand, the emerging countries' banking sectors document more competitive behaviour during the past few years. Consolidation is seen as the cause in the fall in competition as consolidation process is seen to create larger banks with higher market powers.

Using the 15 older European Union (EU15) countries and 14 Central and Eastern European (CEE) countries, during financial reform periods, Delis & Pagoulatos (2009) find evidence of bank competition in 15 older European countries but not in 14 Central and Eastern European countries. Using the generalised method of moments (GMM), they examine the impact of the quality of institutions, bank size, ownership, inflation, gross domestic product per capita and bank capital on bank market power during the financial reforms period in EU15 and 14 CEE countries. Their empirical findings reveal a positive relationship between institutional quality and bank competition in EU15 which indicates institutional quality promotes bank competition in EU15. In contrast, similar banking reforms failed to enhance competition in the 14 CEE countries due to insufficient legal, institutional and bureaucratic quality. The authors also find negative and significant relationship between foreign ownership and market power, re-enforcing the perspective that foreign bank entry helps increase efficiency through increased competition and better quality of reforms (Javorcik, 2004). This negative relationship, according to their results, is more pronounced in the 14 CEE countries. Their results also indicate that publicly owned banks have considerable market power in the 14 CEE countries. Bank capitalization and size are positively related with market power. There is a negative impact of gross domestic product per capita on market power in the EU15 banking sectors and positive in the 14 CEE countries. Finally, inflation has a negative and significant effect in both EU15 and the 14 CEE countries.

Turk-Ariss (2009) investigates 12 banking sectors in the Middle East and Northern Africa (MENA) countries over the period 2000–2006. Using Panzar & Rosse (1987) H-statistic,

the author finds evidence of monopolistic competition in the banking sectors. On the determinants of bank competition, Turk-Ariss observes that bank capitalization has a negative effect suggesting that well-capitalized banks operate in less competitive environment. This finding is consistent with Bikker & Haaf (2002) results but inconsistent with the results of Claessens & Laeven (2004) who find a positive relationship. In broader set up, Anzoategui et al. (2010) examine bank competition in the MENA region during 1994–2008, using the H-statistic and the Lerner index. These two measures suggest that the banking sectors in MENA region are less competitive compare to other developing countries around the world and have not improved in recent years. They also assess the determinants of bank competition across countries and find evidence that lower levels of bank competition in the MENA are due to the region's worse credit information environment and high barriers to entry into the banking sector (lower market contestability). The authors also find that competition is more pronounced in countries with large size of non-bank financial intermediaries. The banking sector is not contestable, because of high barriers to entry and exit.

Sun (2011) analyses the effect of both the introduction of euro and before and after the recent financial crisis on bank competition in the euro area, the U.S and U.K. The results indicate that overall bank competition decline from 0.699 to 0.518 (changes in the values of H-Statistic) after the introduction of euro which is consistent with the findings of Bikker & Spierdijk (2008), who also report some decline in European banks competitive behaviour. Similarly, the bank competition in euro area falls after the financial crisis. The decline is more pronounced in US and Spain where large credit and housing booms occurred.

Delis (2012) estimates the degree of market power at the bank-level for 84 banking sectors drawn from both developed and developing countries across the world with data sample ranging from 1987–2005 using the Boone Indicator (2008). The author finds that worldwide bank competition steadily improves in the period 1993–2002, but decreases after 2003. However, the market power of banks in the lower-middle and low-income countries are higher than that observed in high-income countries. Using GMM estimator for dynamic panels developed by Blundell & Bond (1998) which permits regressors to be treated as exogenous, predetermined, or endogenous, the author analyses the determinants of bank-level market power. Delis findings show evidence of positive association between

bank capitalization and competition suggesting the importance of bank capitalization for the improvement of competition. Similarly, the author notices that bank size is positively related to market power. Thus, larger and well-capitalized banks have higher market power and the author identifies the causes to be:

i. banks have access to cheaper sources of funds
ii. banks cope better with moral hazard issues on the part of borrowers

In addition, banks market power increase in countries with high inflation. The author observed that low income countries have higher values of lagged one market power suggesting evidence of informational opacity of the banking systems in less developed countries.

On determinants of bank competition, only Delis & Pagoulatos (2009) and Delis (2012) employed a dynamic model specification. In other words, other studies used static models to investigate the internal and external factors that affect bank competition. They failed to recognise the importance of the lagged competition (or lagged market power) on the current competition. They also ignore the endogeneity of some of the regressors including credit risk and bank capital. Regarding the dynamic nature of bank competition, Berger et al. (2000) indicate that developed banking systems may still have informational opacity, networking and relationship lending. These characteristics will cause bank rents and market power to persist for some time.

Some studies use HHI or bank concentration ratios which are appropriate measure for bank concentration in terms of bank competition (market power). However, recent studies have identified the inappropriateness of using market concentration measures as indicators of banking competition (see Maudos & Fernandez de Guevara, 2004; Claessens & Laeven, 2004; Fernandez de Guevara et al., 2005, 2007; Carbó et al., 2009). Consequently, the non-structural (that infer market power from the observation of banks' conduct) indicators of competition such as Panzar-Rosse (1987) H-statistics or the Lerner index (1934) among others have emerged as the appropriate measures of competition or market power.

5.4 Methods

5.4.1 Estimation of Bank Competition in Ghana's Banking Industry

The section computes bank competition using the approach discussed in Section 5.1. Fixed effect regression estimator is used to estimate the parameters of the total cost function. The results will be used as the dependent variable in the estimation of the determinants of bank competition using fixed effect regression estimator for the static model and two-step system GMM for the dynamic model (as discussed in the Chapter 3)

The main variables involve in estimating the Lerner index are bank costs, price of total assets computed as the ratio of total income (interest and non-interest) to total assets, with a single output represented by total assets and three input prices (for deposits, labour expenses and capital-related expenses). The input prices are also defined as in Table 4.2.

In the Ghanaian banking industry, interest and operating expenses dominate the bank costs. The operating expenses reported in the banks' annual income statements include the following elements: salaries and wages, employee benefits, depreciation and amortisation, administrative expenses and software licensing and other information technology expenses. The interest expenses are expenses relating to deposits due to customers and deposits from banks. These variables and their prices are used to compute the Lerner index (see Table 4.2).

5.4.2 Determinants of Bank Competition

The following key factors are considered for identifying the determinants of bank competition in the Ghanaian banking industry: credit risk, capital, fee income and bank size as bank-specific characteristics, inflation as macroeconomic factor.

5.4.2.1 Static Panel Model of Bank Competition

The static panel data model that is used to investigate the determinants of the bank competition in Ghana as follows:

$$\mathrm{LERNER_{it}} = \omega_1 \mathrm{CAP_{it}} + \omega_2 \mathrm{SIZE_{it}} + \omega_3 \mathrm{LLP_{it}} + \omega_4 \mathrm{INF_{it}} + \omega_5 \mathrm{FEE_{it}} + \eta_i + \mathrm{e_{it}} \quad (5.5)$$

where

i represents the individual bank and *t* denotes time,

ω_j = parameters to be estimated,

η_i = individual bank specific effect,

e_{it} = error term,

$LERNER_{it}$ = Lerner index of market power,

CAP_{it} = capitalization, and is measured as total equity divided by total assets,

$SIZE_{it}$ = bank size, and is measured as natural logarithm of total assets,

LLP_{it} = loan loss provision ratio proxy as credit risk, and is measured as loan loss provisions divided by total loans,

$GDPG_{it}$ = real gross domestic product growth rate,

FEE_{it} = fee income, and is measured as non-interest income divided by total income

INF_{it} = inflation rate, and is measured as change in consumer price index.

This model assumes that all explanatory variables are exogenous.

5.4.2.2 Dynamic Panel Model of Bank Competition

In terms of the dynamic nature of bank competition, Berger et al. (2000) indicate that developed banking systems may still have informational opacity, networking and lending relationship[22]. These characteristics will cause bank rents and market power to persist for some time. For instance, if a banking industry is characterised by informational opacity due to networking, it is likely that the bonds that created the networking are strong and thus persistent (Agoraki et al., 2011). To capture the dynamic behaviour of bank competition, one-year lagged market power is added to the explanatory variables of the dynamic model (5.4). Following Delis & Pagoulatos (2009) and Delis (2012) the dynamic panel data model is given as follows:

$$LERNER_{it} = \phi_1 LERNER_{it-1} + \phi_2 CAP_{it} + \phi_3 SIZE_{it} + \phi_4 LLP_{it} + \phi_5 INF_{it} + \phi_6 FEE_{it} + \eta_i + v_{it} \quad (5.6)$$

[22] Relationship bank lending can be defined simply as the provision of financial services repeatedly to the same customer (Elyasiani & Goldberg, 2004). Firms benefit from relationship lending because it is associated with lower loan interest rate, reduction in collateral requirements (Berger & Udell, 1995) and enhanced credit availability (Cole, 1998; Elsas & Krahnen, 1998).

where

i represents the individual bank and *t* denotes time,

ϕ_j = parameters to be estimated,

η_i = an individual bank specific effect,

v_{it} = an error term,

$LERNER_{it}$ = Lerner index of market power,

$LERNER_{i,t-1}$ = one-year lagged market power,

CAP_{it} = capitalization, and is measured as total equity divided by total assets,

$SIZE_{it}$ = bank size, and is measured as natural logarithm of total assets,

LLP_{it} = loan loss provision ratio proxy as credit risk, and is measured as loan loss provisions divided by total loans,

$GDPG_{it}$ = real gross domestic product growth rate,

FEE_{it} = fee income, and is measured as non-interest income divided by total income

INF_{it} = inflation rate, and is measured as change in consumer price index

5.5 Variable Measurements

This section explains the measurements of the variables used in the determinants of bank competition (bank-specific and macroeconomic factors) as well as the signs of their relationships with bank competition.

5.5.1 Bank-Specific Factors

The bank-specific variables considered are size, credit risk, bank capitalization and fee income.

5.5.1.1 Size

In regards to the relationship between bank size and bank competition, it is expected that bank size affects the Lerner index positively, indicating that large banks tend to have more market power (Fernandez de Guevara et al., 2005; Maudos & Nagore, 2005).

5.5.1.2 Credit Risk

It is hypothesized that the relationship between credit risk and market power is positive. Lower loans loss provision ratio will prompt banks to lower their prices relative to

marginal cost leading to lower price-cost margins, indicating weaker market power (Simpasa, 2010). Hence, the impact of the credit risk on the Lerner Index is expected to be positive.

5.5.1.3 Bank Capitalization

A positive relationship is expected between well-capitalized banks and market power. Higher regulatory capital requirements (as mandated by Bank of Ghana in 2006 and 2009) will make banks well-capitalized and this will lead to improvement of buffer for risk absorption, however, this could increase market power. Tighter regulatory burden will prompt banks to raise margins in order to build up adequate capital necessary for absorbing risk in the industry (Simpasa, 2010). Similarly, well-capitalized banks have higher market power in a less competitive environments, suggesting that banks pay less for deposits because depositors view these banks as safe (Maudos & Nagore, 2005). Thus, a positive relationship is hypothesized.

5.5.1.4 Fee Income

Fee income is measured as non-interest income divided by total income. This variable is included due to the growing importance of non-interest income in recent years in Ghana as a result of the increasing competition in the traditional loan and deposit services. Therefore a positive impact of fee income on market power is expected. Fee income from non-traditional services has a positive and significant influence on the market power (Maudos & Nagore, 2005; Carbo et al., 2009).

5.5.2 Macroeconomic Factor

The rate of inflation is included to account for the impact of macroeconomic conditions on bank competition. This is because macroeconomic developments are likely to affect the quality of banks' assets (Soedarmono et al., 2011).

5.5.2.1 Inflation Rate

Inflation rate is expected to have a positive relationship with bank market power (negative with bank competition). This is because high rate of inflation compels banks to increase their product prices leading to high market power (Simpasa, 2010).

Finally, in this study, bank capitalization and loan loss provision (non-performing loans) are considered as endogenous. The recent banking studies have identified an endogenous relationship between market power and bank risk taking (Berger et al., 2009; Uhde & Heimeshoff, 2009; Gonzales, 2005; Schaeck & Cihak, 2008, Agoraki et al., 2011). Lower credit risk will prompt banks to lower their prices relative to marginal cost weakening banks' market power (Simpasa, 2010). On the other hand, more market power may lead to higher credit risk as banks charge higher interest rates on loans making it difficult for the bank borrowers to repay their loans (Berger et al., 2009). Similarly, bank capitalization is considered to be endogenous determinant factor of market power (Delis & Pagoulatos, 2009; Delis, 2012). Higher bank capitalization may give banks higher market power. Banks with higher market power may generate higher profits leading to higher levels of capital. Ultimately, banks with higher market power may have better access to equity capital markets (Delis, 2012).

5.6 Empirical Results and Analysis

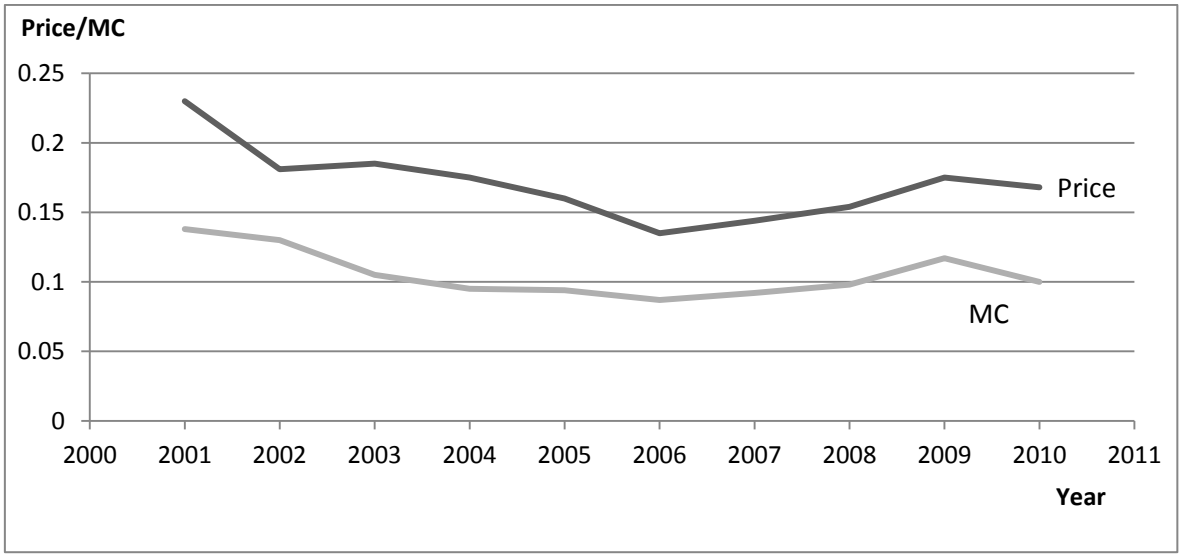
This section presents the results of the degree of bank competition and the determinants of bank competition of Ghana's banks during the study period 2001-2010.

5.6.1 Average Output Price and Marginal Cost

Figure 5.1 shows the prices and marginal costs in Ghana's banking industry. During the study period, the gap between the average price of bank output and MC has not reduced much. This in part is due to high interest rates in Ghana as well as the inability of the Ghana banks to consistently reduce their operating costs. Even though MC and output price have fallen during the study period they are still high. Interestingly, both output price and MC run almost parallel to each other.

Figure 5.1 reveals that MC declines from 2001 to 2006 but rises until 2009 and decline during the period 2009-2010. In parallel, the average output price declines sharply from 2001 to 2002 followed by a rise in 2003, but falls again until 2006. The output price again increases for three years between 2006 and 2009 and then falls moderately between 2009 and 2010. During the study period, the average output price decline from 0.230 in 2001 to 0.168 in 2010 due to the fall of the money market rate. At the same period, MC also

Figure 5.1 Average Output Price and Marginal Cost of Ghana's Banking Industry



reduces from 0.138 in 2001 to 0.100 in 2010 as a result of the fall in both financial and operating costs. Concurrently, the value of the Lerner index (the relative measure) increases from 0.343 in 2001 to 0.400 in 2010 signalling an increase in bank market power. This suggests a reduction in bank competition in Ghana over the study period. Thus, Ghana banks are able to set prices well above MC over the same period. This pricing behaviour has helped the banks to preserve their market power. This finding is consistent with the results of Simpasa (2010) on Zambian banking system, where the Lerner index is characterised mostly by the high price of bank products and services.

Broadly, the reduction in MC[23] in the periods 2001 to 2006 and 2009 to 2010 is attributed to decrease in operating and financial costs. The decline in operating and financial costs reflects the significant reduction in government Treasury bill. At the same time, the output price also falls due to fall in lending rates in response to the decline in interest rates on government Treasury bill. However, the MC decline faster than the output price. Both MC and output price may have seen some decline over the study period, but are still high in Ghana.

[23] Increase in marginal costs is attributed to increase in operating and financial costs whereas increase in price response to increase in lending rates.

5.6.2 Lerner Index in Ghana's Banking Industry

The Lerner Index of market power is also an indicator of the degree of competition. Market power is inversely related to competition. Table 5.1 reports the Lerner index for Ghanaian banks for each year over the period 2001 to 2010. The market power has increased from 0.343 in 2001 to 0.400 in 2010 suggesting a decline in bank competition. The average Lerner index for the period is 0.349 as oppose to 0.385 recorded by Maudos & Nagore (2005) on Ghana for the period from 1995 to 1999 in cross-country studies. Delis& Pagoulatos (2009) characterise the value of Lerner index between 0.10 and 0.40 (in most EU 15 countries) as moderately competitive behaviour[24]. Consequently, the banking environment in Ghana over the study period could be described as moderately competitive. This implies that the Ghanaian banking industry experience a weak competition. This finding supports the previous empirical studies on banking sectors in both developed and developing countries (De Bandt & Davis, 2000 for EU countries; Delis & Pagoulatos, 2009 for Central and Eastern Europe and the EU; Fungacova et al., 2010 for Russia; Buchs & Mathisen, 2005 and Aboagye et al., 2008 for Ghana; Simpasa, 2010 for Zambia).

The development in bank competition in Ghana has not been regular and there is no noticeable steady trend towards a strong banking competition over the study period despite the experience of economic growth and banking reforms. The reduction in competition in

Table 5.1 Lerner Index in Ghana's Banking Industry (2001-2010)

Year	Number of Banks	Output Price	Standard Deviation	Marginal Cost	Standard Deviation	Mean	Standard Deviation
2001	17	0.230	0.046	0.138	0.046	0.343	0.440
2002	18	0.181	0.022	0.130	0.074	0.287	0.358
2003	18	0.185	0.031	0.105	0.037	0.441	0.133
2004	18	0.175	0.025	0.095	0.028	0.461	0.117
2005	20	0.160	0.047	0.094	0.027	0.289	0.505
2006	22	0.135	0.033	0.087	0.018	0.275	0.438
2007	23	0.144	0.025	0.092	0.024	0.359	0.149
2008	25	0.154	0.039	0.098	0.032	0.340	0.280
2009	25	0.175	0.030	0.117	0.043	0.316	0.345
2010	25	0.168	0.043	0.100	0.032	0.400	0.150
Mean						0.349	0.318

Notes: The mean Lerner indices per year are the means of all the Lerner indices of the year for each bank. Lerner index of market power is an inverse measure of competition.

[24] Maudos and Nagore consider any Lerner index over 0.30 as high market power.

the early years of the study period is followed by increase in competition during the periods 2001 to 2002, 2004 to 2006 and 2007 to 2009. The Lerner index increases sharply from 2009 to 2010 indicating a rise in market power and therefore decline in competition. This occurs because interest rates on treasury bills fall from 23.7 percent in 2009 to 12.3 percent in 2010 as a result of the steady reduction in the government borrowing precipitating a decline in the price of output (Bank of Ghana Annual Report, 2011). The average lending rate of 33 percent in the beginning of the 2010 falls to to 25.8 percent in December 2010 (PricewaterhouseCoopers, 2011), whereas the average interest paid on deposits fall from 13.2 percent in 2009 to 8.3 percent in 2010 reducing marginal cost (PricewaterhouseCoopers, 2011). Further, banks in Ghana did not reduce their interest rate on loans even with sharp fall in inflation and money market rates from 2009 to 2010. The banks assign their insensitivity to the interest rate to high level of non-performing loans and higher cost of capital as a result of the increase in minimum regulatory capital (PricewaterhouseCoopers, 2011). This result of less competition is in line with study by Anzoategui et al. (2010) who investigate bank competition in the Middle East and Northern Africa region during 1994-2008 and attributes it to the region's worse credit information environment and high barriers to entry into the banking market.

In addition, the improvement in competition may be, in part, due to the foreign banks entry into the Ghana's banking market as a result of the financial reforms. For instance, four foreign banks (Zenith Bank Limited, United Bank of Africa, Guaranty Bank Limited and Intercontinental Bank Limited) and one domestic bank (Fidelity Bank Limited) entered Ghana's banking market between 2004 and 2006 and three foreign banks (Bank of Baroda, Access Bank and BSIC) during the period from 2007 to 2008.

Due to high operational costs (as a result of high cost of capital and high non-performing loans), high inflation rates and less competitive pressures in Ghana interest spread is still high in spite of more than two decades of financial reforms (see Barajas et al., 1998).

5.6.3 Determinants of Bank Competition in Ghana

This section analyses the impact of bank-specific and macroeconomic factors on bank competition that impact bank competition in Ghana. The study compares the static and dynamic panel models. The determinants of bank competition include size, capitalization,

loan loss provision ratio, fee income as the bank specific factors and inflation as the macroeconomic factor. For meaningful system GMM results, this study uses a small number of determinant factors. This is due to the small number of banks and observations used in this study. Increasing the determinant factors will increase the number of instruments in the system GMM estimation which may invalidate the system GMM results.

The static model assumes that the determinant factors are all exogenous. Previous studies report the possibility of endogeneity in modelling market power and risk relationship (Shaeck & Cihak, 2007; Berger et al., 2009) and the association between market power and capitalization (Delis, 2009). Therefore, in this study, bank capitalization and loan loss provision ratio are considered to be endogenous variables. Consequently, the results of the fixed effect model may be considered biased.

The dynamic model treats the lagged dependent variable, capitalization and loan loss provision as endogenous. Moreover, the study restricts the GMM instruments to second and third lags as well as collapsing the instrument matrix to limit the instruments count. Combining the two techniques gives credible results. The regressions are estimated by employing the Hansen and second order autocorrelation tests to select the appropriate lags used as instruments for the system GMM estimation. Table 6.8 presents the results of the determinants of bank market power in Ghana.

5.6.3.1 Model Specification and Validity of Instruments Tests

The results in Table 5.2 indicate that the fixed effect model (static model) passes the F-test (with p-value of 0.081) of the overall significance of the explanatory variables. This shows that the determinants employed are relevant in explaining bank competition. White (1980) robust standard error test is employed due to the presence of heteroskedasticity in the residuals.

The results in Table 5.2 show the Hansen test cannot be rejected and hence is insignificant as revealed by the Hansen test p-value of 0.709 (since 0.709 is more than 10 percent level of significance). This suggests that the model does not suffer from over-identification. Therefore, the instruments used in this model are valid, that is, the instruments are not correlated with the error term. The results also indicate that second-order (AR2)

autocorrelations are not present. This is because the null hypothesis of second-order (AR2) autocorrelations cannot be rejected since the p-value of AR2 is 0.318. The results signal that the model appears correctly specified. The results in Table 5.2 also reveal a p-value of 0.491 for the difference-in-Hansen test suggesting that the additional subset of instruments used in the system GMM estimates is exogenous. This implies the assumption that any correlation between the endogenous variables and unobserved fixed effect is constant over time holds. This assumption makes possible the inclusion of the levels equation in the system GMM equation. Finally, the number of instruments is reasonably less than the number of banks.

Given these results, the analysis of bank competition model will be based on the two-step system GMM estimation instead of the fixed effect model. Using the fixed effect model estimation will render biased results in the presence of the endogenous variables: lagged Lerner index, capitalization and loan loss provision. This indicates the superiority of the dynamic model over the static model making the reliance on the system GMM more realistic.

5.6.3.2 Impact of Bank Specific Factors on Bank Competition

The coefficient (0.519) of lagged Lerner index in the model is positive and statistically significant at 1 percent level suggesting persistence of bank market power in Ghana (see Table 5.2). This finding implies the existence of rigidity in Ghana's banking industry (see Delis & Pagoulatos, 2009). This confirms Acquah (2006) assertion that Bank of Ghana distinctively advocates that the entry of new banks be selective, well-managed, and paced over time as well as clear exit rules to ensure systemic stability and avoid decline in banks' franchise value. This could contribute, in part, to the high bank operating and financial cost in Ghana. The bank operating costs is high generating higher spreads in Ghana. Thus, the banks pass on costs to borrowers by charging higher interest to compensate for the higher operating costs. Such attitude is reminiscence of the bank market power and reflection of less competitive environment in Ghana. In addition, informational opacity due to information asymmetry had characterised the lending function in Ghana's banking industry. The problem of information asymmetry puts the banking system at greater risks leading to higher lending rates. The evidence of this problem is the Ghanaian banking

Table 5.2 Determinants of Bank Market Power

Variable LERNER	Fixed Effect Model Estimates	System GMM Estimates
$LERNER_{t-1}$	-	0.519*** (4.92)
SIZE	0.087** (2.64)	-0.033 (-0.75)
INF	0.466 (1.36)	-0.006 (-0.01)
LLP	0.050 (0.17)	0.088 (0.14)
FEE	0.468 (1.12)	0.258 (0.63)
CAP	-0.702** (-2.18)	-3.082* (-2.03)
TREND		0.022 (0.98)
CONSTANT	-0.801 (-1.67)	0.758 (1.63)
R-squared	0.226	
F-Statistic (p-value)	0.081*	0.000***
Wald Test Heteroskedasticity (p-value)	0.000***	
Number of observations		186
Number of banks		25
Number of instruments		14
Hansen test (p-value)		0.709
Arellano-Bond test:		
AR(1) *p*-value		0.042
AR(2) *p*-value		0.318
Difference-in-Hansen test (p-values):		
GMM instruments for levels		0.491

Notes: t-statistics in parentheses below the estimates. *, ** and *** indicate significant at 10%, 5% and 1%, respectively. LERNER represents Lerner index of market power. F-Statistic is for the joint significance of the coefficients of the explanatory variables. AR(1) and AR(2) are tests for first and second order autocorrelation in the first-differenced residuals, respectively.

industry's high non-performing loans. However, XDS Data limited, credit reference bureau, is operating in Ghana (since 2009) and Hudson Price Data Solutions and Dun and Bradstreet (since 2011) to provide credible information on prospective bank borrowers (Bank of Ghana, 2009a) to help reduce the problem of information asymmetry. This result also suggests that a proper specification of market power (or competition) should incorporate a dynamic term.

It is hypothesized that bank capitalization and market power are positively related suggesting that well-capitalized banks have higher market power, which implies that the banks pay less for deposits as depositors consider these banks to be more safer (Maudos & Nagore, 2005). This lowers the banks' funding costs. However, the results in Table 6.8 indicate negative and strong significant relationship between bank capitalization and market power. The result indicates that better bank capital adequacy in Ghana reduces market power in the banking industry and therefore increases bank competition. The possible explanation is that the banks pay more for deposits as depositors perceive them to be less safer increasing the banks' funding costs leading to decrease in market power and increase in competition.

Another possible explanation for the negative relationship between bank capitalization and market power is the evidence that banks in Ghana pay higher interest on deposits to attract depositors because of the high yield on government securities (see PricewaterhouseCoopers, 2009). This increases funding costs and reduces market power and therefore increases competition. This finding supports the view that well-capitalized banks are more competitive. It is consistent with the finding by Turk-Ariss (2009) who also finds negative and statistically significant effect of bank capitalization on market power on the Middle East and North Africa banking sectors. Moreover, it is also consistent with the results of Bikker & Haaf's (2002) study on 23 European and non-European countries. However, the result differs from the finding of Simpasa (2010) where higher regulatory capital requirement appears to increase bank market power and therefore reduces bank competition in Zambia. Similarly, Delis & Pagoulatos (2009) find a positive impact of bank capitalization on bank market power using bank data from 15 EU and 17 Central and Eastern countries. In addition, Delis's study (2012) also shows that bank capitalization is positively related to bank market power using 84 banking sectors worldwide.

In contrast, fee income is not statistically significant and as a result is not considered relevant in the explanation of the differences in market power in Ghana. Fee income is not statistically significant because the banking industry in Ghana relies generally on interest income. Despite the adoption of universal banking policy, Ghana banks still concentrate on the core activities (see Appendix H) rather than fee income activities such as cash

management services and financial commitments (PricewaterhouseCoopers, 2011). This suggests a lower level of diversification in banks' sources of income in Ghana.

Similarly, loan loss provision ratio has positive effect on market power. It is statistically insignificant and cannot account for the differences in market power in Ghana's banking sector. Nevertheless, the positive relationship suggests that more risky banks have compensated their higher probability of default with higher margins.

On the other hand, bank size is negative and has insignificant impact on market power. Thus, bank size has weak relationship with bank competition suggesting that bank size does not matter as far as Ghana's banking industry is concern. This finding also implies that there is no evidence that larger banks have more market power than smaller banks in Ghana. This is an indication that larger banks do not have cost advantage and therefore have no ability to set higher fees. This finding differs from the findings of Aboagye et al. (2008) who find that an increase in bank size leads to more market power in Ghana. However, the authors applied static fixed effect regression model. This result of weak impact of bank size on market power reflects the remarkable decline in bank market concentration. The bank concentration in Ghana using HHI has declined considerably from 1,065.9 points in 2000 to 744.0 points in 2008 (Bank of Ghana, February 2009) representing a decrease in bank market concentration of 30.2%, as a result of the increase in the number of banks.

5.6.3.3 Impact of Macroeconomic Factors on Bank Competition

The result reveals that the rate of inflation is statistically insignificant and negatively related to market power and therefore has no influence on bank competition. The negative relationship between inflation rate and market power is consistent with the finding of Aboagye et al. (2008) and Simpasa (2010) who also report that the rate of inflation is negatively related to bank market power in Ghana and Zambia. However, the authors find that the rate of inflation has significant impact on bank market power employing the static fixed effect regression estimator.

5.7 Summary

The findings reveal that Ghana's banks are weak competitively from 2001 to 2010. The findings show that the dynamic term (lagged market power) is significant suggesting that bank competition model recognises the dynamic nature of competition indicating the superiority of the system GMM over the fixed effect estimator.

Bank capitalization plays an important role in determining the Ghanaian banking industry competitive environment. The results indicate that well-capitalized banks are more competitive in Ghana. There is also persistence of bank market power in Ghana an evidence of the existence of opaqueness and rigidity in Ghana's banking industry.

The significant lagged market power indicates the importance of dynamic adjustment over instantaneous adjustment. The finding reveal that the dynamic models are more appropriate in estimating the determinants of bank competition in Ghana's banking industry relative to the static model.

Chapter 6
Causality Between Bank Efficiency and Bank Competition in Ghana

6.1 Introduction

The third objective of this study is to investigate the causality between bank competition and efficiency. The chapter is divided into five sections. Section 6.2 presents relationship between bank efficiency and bank competition. Section 6.3 describes the literature review. Section 6.4 discusses the empirical models and method used to estimate the causality between bank efficiency and bank competition. Section 6.5 presents the results and Section 6.6 provides the summary of the chapter.

6.2 Relationship between Bank Efficiency and Bank Competition

Competition, in this financial reform era, is perceived to foster efficiency. This perspective is supported by the quiet-life hypothesis proposed by Hicks (1935) which supports a positive (negative) causality only running from competition (market power) to efficiency. Quiet-life hypothesis indicates that firms with greater market power may take advantage of the gains from less competitive environment in which managers are under no pressure to reduce cost. Berger & Hannan (1998) support this view and suggest that the lack of competition may also reduce the effort of managers to operate efficiently supporting the quiet-life hypothesis. On the other hand, the efficiency-structure hypothesis, proposed by Demsetz (1973) posits a reverse causality between competition and cost efficiency. Berger (1995), Goldberg & Rai (1996) and Weill (2004) also supported this hypothesis. The efficiency-structure hypothesis explains that efficient firms can reduce costs and as a result have higher market share which leads to a higher level of concentration indicating lower level of competition. Thus, causality runs from efficiency to competition. Similarly, more efficient banks (banks with better management of their inputs) can benefit from their greater efficiency and use it as a barrier to entry and hence achieve greater market power (Fernandez de Guevara & Maudos, 2007). The relationship will be estimated using the Stata software.

The association between bank efficiency and competition is of great interest because of its policy implications regarding bank failures, economic development, and financial stability.

6.3 Literature Review

There are only a few studies that have investigated the relationship between bank competition and efficiency, most of them regressed cost efficiency on a set of variables for market structure (HHI or bank concentration ratio), for example, Berger & Hannan (1998) on US banks; Weill (2004), Casu & Girardone (2006), Maudos & Fernandez de Guevara (2007) on European banks; Ataullah & Le (2006) on India. More precisely, Berger and Hannan (1998) investigate the relationship between bank market structure and bank cost efficiency for the U.S. banking sector. The authors find that market power negatively relates to cost efficiency. Similarly, Casu & Girardone (2006) study on 15 European Union countries for the period 1997-2003 reports a negative association between bank competition and bank efficiency suggesting that a more efficient banking systems can be less competitive. Casu & Girardone finding is supported by Weill's (2004) study on the EU banking systems. Using the Indian banking industry over the period 1992-1998, Ataullah & Le (2006) report a positive relationship between bank competition and bank efficiency. In these studies, the HHI or bank concentration ratio is considered as inverse of bank competition.

In Maudos & Fernandez de Guevara (2007) study, the authors focus on the impact of market power (using Lerner index) on the cost efficiency of banks with data from the 15 European Union countries. Their result documents that market power positively links with cost efficiency.

Williams (2012) investigates the relationship between bank efficiency and market power to primarily test the quiet life hypothesis for a sample of 419 Latin American commercial banks over the period 1985-2010. The author employs two-stage least squares model with instrumental variables to control for the simultaneous relationship between bank efficiency and market power (using Lerner index). The author's result rejects the quiet life hypothesis in favour of the efficient structure hypothesis.

With the exception of the study by Ataullah & Le (2006) which used the dynamic method system GMM, the rest of the studies use static regression models such as Tobit regression model, logistic regression model, two-stage least squares, generalised least squares and fixed or random effect regression models in their estimations.

However, only a handful of recent studies have directly addressed the issue of the causality between competition and efficiency (see Casu & Girardone, 2009; Pruteanu-Podpiera et al., 2008; Schaeck & Cihák, 2008; Ab-Rahim et al., 2011). For example, Schaeck & Cihák (2008) study on the relationship between efficiency, competition and soundness in EU and US banking sectors and find evidence that Granger-causality runs from bank competition to cost efficiency, but not vice versa. Their samples span over the period 1995-2005 and include 3,665 banks from Europe and 8,990 banks from the US.

Using data on Czech banking system over the period 1994-2005, Pruteanu-Podpiera et al. (2008) investigate the effect and evolution of bank competition and the relationship with cost efficiency. The authors did not include any other explanatory variables besides competition and efficiency. Their results, based on Granger-causality techniques, indicate that causality between bank competition and bank efficiency run in both directions. Moreover, the authors also notice evidence of a negative relationship between market power and efficiency in the Czech banking sector. Their results, therefore, reject the quiet life hypothesis which posits a negative relationship between market power and efficiency. It indicates that the higher the market power, the lower the effort of managers to maximize operating efficiency and hence managers enjoy "quite life". This means managers are under no pressure to reduce cost. Therefore, firms with market power choose to operate inefficiently.

Using similar method employed by Pruteanu-Podpiera et al. (2008), Casu & Girardone (2009) used an unbalanced sample of 2701 commercial bank observations operating in France, Germany, Italy, Spain and United Kingdom over the period 2000-2005 to investigate the causality between bank efficiency and bank competition using Granger-causality test. Similar to Pruteanu-Podpiera et al. (2008), the authors did not include any other explanatory variables in their model. They notice that market power may have positive impact on bank efficiency. On the other hand, their study reports a weak causality

running from bank efficiency to bank competition. Their results, however, do not suggest that increases in bank efficiency enhance market power.

Ab-Rahim et al. (2011) examine the causality between bank competition and bank efficiency (technical efficiency, pure technical efficiency and scale efficiency) using 10 domestic Malaysian banks over period 1995–2005. The authors apply generalized least square estimator to estimate the causal relationship between bank competition and bank efficiency. Their results reveal that positive causality runs from bank competition to bank efficiency. The reverse causality indicates a negative causality running from bank efficiency to bank competition.

A few recent studies have directly addressed the issue of the causality between competition and efficiency (see Pruteanu-Podpiera et al., 2008; Schaeck & Cihák, 2008; Casu & Girardone, 2009; Ab-Rahim et al., 2011). The linkage between bank efficiency and competition is of great interest because of its policy implications for bank efficiency, bank failures, financial stability and economic development.

6.4 Estimation Method

The recent bank studies have adopted dynamic GMM approach (a departure from static approach used by previous studies) using Granger-causality test to assess the causality between competition and efficiency. The pioneers of this approach are Pruteanu-Podpiera et al. (2008) and Casu & Girardone (2009). These authors applied either the first-differenced GMM estimator (Pruteanu-Podpiera et al., 2008) or system GMM estimator (Casu & Girardone, 2009).

Following Casu & Girardone (2009) method, the Granger-causality analysis is performed using a two-step system GMM estimation with Windmeijer (2005) corrected standard error (for small sample bias) as described in Chapter 3.

6.4.1 Granger Causality Test

According to Granger causality, a variable X Granger-causes variable Y if past values of variable X contain information that helps predict or better explain the present value of variable Y.

It is essential to note that the Granger causality tests only indicate that changes in one variable precede changes in another variable of interest. Inferences on causality is achieved by running Wald tests on the coefficients of the lagged X and lagged Y in order to check whether they are jointly statistically different from zero (Casu & Girardone, 2009).

6.4.2 Empirical Models

This study follows Pruteanu-Podpiera et al. (2008) and Casu & Girardone (2009)[25]framework, the dynamic panel data model used to assess the Granger causal relationship between bank efficiency and competition as follows[26]:

$$\mathrm{EFF_{it}} = \sum_{j=1}^{n} \rho_i \mathrm{EFF_{it-j}} + \sum_{j=1}^{n} \psi_i \mathrm{LERNER_{it-j}} + \eta_i + \upsilon_{it} \qquad (6.1)$$

$$\mathrm{LERNER_{it}} = \sum_{j=1}^{n} \vartheta_i \mathrm{LERNER_{it-j}} + \sum_{j=1}^{n} \ddot{\Upsilon}_i \mathrm{EFF_{it-j}} + \eta_i + \xi_{it} \qquad (6.2)$$

where

i represents the individual bank and *t* denotes time,

ψ_j, ρ_j, ϑ_i and $\ddot{\Upsilon}_i$ = parameters to be estimated,

η_i = individual bank fixed effect,

υ_{it} and ξ_{it} = error terms,

$\mathrm{LERNER_{it}}$ = Lerner index of bank market power,

$\mathrm{LERNER_{i(t-j)}}$ = j^{th} lagged market power, j =1,2, …n

$\mathrm{EFF_{it}}$ = pure technical efficiency (PTE) or cost efficiency (CE) of the bank *i*

[25] Pruteanu-Podpiera, et al. (2008) and Casu and Girardone (2009) did not include any other explanatory variable as such it is viewed as a baseline specification model.

[26] The causality uses the bank efficiency and bank competition computed in chapters 4 and 5 respectivlely.

$EFF_{i(t-j)}$ = j^{th} lagged pure technical efficiency or cost efficiency, j =1,2,…n

In addition, the optimal lag length *n* of the variables involved in the causality test is based on Schwarz information criterion (SIC). It is imperative to note that Granger causality test results are sensitive to the choice of lag length in vector autoregression (VAR) model and therefore it is essential to specify the lag structure correctly (Hartwig, 2010, 2011).

We test the following hypotheses:

i. the coefficients ψ_i are set jointly equal to zero (to test whether competition Granger-causes efficiency)
ii. the coefficients $\ddot{Y}_i$ are set jointly equal to zero (to test whether efficiency Granger-causes competition)

The test statistics is distributed as χ^2 with two degrees of freedom. The sign of the causal relationship is assessed by the sum of the jointly significant coefficients. A positive (negative) sum implies that the causal relationship is also positive (negative), that is, an increase (decrease) in EFF in the past increased (decreased) the LERNER in the present (see Casu & Girardone, 2009).

6.5 Empirical Results and Analysis

A Granger causality test between efficiency and competition tests whether causality runs at least in one direction and possibly in both directions.

Before examining Granger causality between bank efficiency and competition, we decide to explicitly test efficiency and competition for stationarity. Since the data structure of this study is unbalanced panel, the stationarity of the variables (PTE, CE and LERNER) is assessed using unit root test developed by Maddala & Wu (1999) for unbalanced panels based on Fisher[27] (1932) test that uses Phillips-Perron (1988) test. Phillips-Perron test accounts for serial correlation using the Newey-West (1987) heteroskedasticity and autocorrelation-consistent covariance matrix estimator. The null hypothesis assumes the existence of non-stationarity in all the series and the alternative

[27] Fisher test does not require a balanced panel. In practice, the Fisher test may reduce the bias caused by the lag selection (Maddala and Wu, 1999). Another variant of Fisher test is augmented Dickey-Fuller.

Table 6.1 Fisher Philips-Perron Panel Unit Root Test Results

	PTE		CE		LERNER	
	Statistic	P-value	Statistic	P-value	Statistic	P-value
PP-Fisher χ^2	267.578	0.000	238.417	0.000	183.875	0.000

Note: LERNER, PTE and CE represent the Lerner index of market power, pure technical efficiency and cost efficiency, respectively.

hypothesis is that at least one series is stationary. Table 6.1 reports the results of the Fisher unit root test. The results in Table 6.1 reject the null hypothesis that all panel series are non-stationary in levels for efficiency and competition.

6.5.1 Causality Tests

Granger causality tests are sensitive to the selection of lag lengths, and could influence the results. The maximum lag length for the vector autoregression (VAR) is set at 4, and the Schwarz Information Criterion is used to select the appropriate lag length following

Table 6.2 Causality Test: Optimal Lag Length using Schwarz Information Criterion

Lag	**1**	**2**	**3**	**4**
Variable:				
CE	1.217	1.339	1.402	1.547
PTE	1.700	1.723	1.846	1.993

Note: PTE and CE represent pure technical efficiency and cost efficiency, respectively.

Atukeren (2008), Hartwig (2010) and Miyakoshi & Tsukuda (2004). Table 6.2 shows that based on Schwarz information criterion the optimal lag length is one.

The next step is to estimate the causal relationship between efficiency and competition using the two-step system GMM estimator (using lag-one efficiency and lag-one market power as explanatory variables). The small sample standard error correction proposed by Windmeijer (2005) has been applied.

6.5.1.1 Causality Tests between Bank Pure Technical Efficiency and Bank Competition

To investigate the causality running from pure technical efficiency to competition, the dependent variable is competition and the endogenous explanatory variables are lagged pure technical efficiency and lagged market power. The results are presented in the Table 6.3.

Table 6.3 Granger Causality Tests (dependent variable → competition)

Dependent Variable LERNER	**System GMM Estimates**	**P-value**
CONSTANT	0.207***	0.002
	(3.46)	
$LERNER_{t-1}$	0.550***	0.001
	(3.84)	
PTE_{t-1}	0.006	0.734
	(0.34)	
F-Statistics (p-value)	0.000***	0.000***
Number of observations	186	
Number of banks	25	
Number of instruments	8	
Hansen test (p-value)	0.362	
AR(1) *p*-value	0.110	
AR(2) *p*-value	0.259	
Difference-in-Hansen test (p-value):		
GMM instruments for levels	0.149	

Notes: t statistics in parentheses. *, ** and *** indicate significant at 10%, 5% and 1%, respectively. Time trend is included in the model. LERNER and PTE represent Lerner index of market power and pure technical efficiency, respectively. F-Statistic is for the joint significance of the coefficients of the explanatory variables. AR(1) and AR(2) are tests for first and second order autocorrelation in the first-differenced residuals, respectively. Market power is inversely related to competition.

Table 6.3 shows the results of the Granger causality test with competition as the dependent variable. The results in Table 6.3 do not reject the null hypothesis of no causality running from pure technical efficiency to competition since the p-value of the lagged pure technical efficiency, 0.734, is greater than 10 percent level of significance. Therefore pure technical efficiency does not Granger-cause market power (competition). In other words, there is no evidence that increases in market power precede increases in pure technical efficiency indicating that lagged pure technical efficiency cannot be used to predict current market power (competition). It should be noted that the p-value of difference-in-Hansen test is above the conventional level of significance but it is still considered small and should be

viewed with concern (Roodman, 2007). The result also shows that the lagged competition is statistically significant. This implies that current competition is influenced by previous years' competition.

Table 6.4 shows the results of the Granger causality test with pure technical efficiency as the dependent variable and it is regressed on lagged pure technical efficiency and lagged competition. Table 6.4 results do not reject the null hypothesis of no causality running

Table 6.4 Granger Causality Tests (dependent variable → pure technical efficiency)

Dependent Variable PTE	**System GMM Estimates**	**P-value**
CONSTANT	-0.843**	0.044
	(-2.13)	
PTE_{t-1}	0.348	0.042
	(0.042)	
$LERNER_{t-1}$	0.623	0.581
	(0.56)	
F-Statistics (p-value)	0.000***	0.000***
Number of observations	186	
Number of banks	25	
Number of instruments	8	
Hansen test (p-value)	0.134	
Arellano-Bond test:		
AR(1) *p*-value	0.024	
AR(2) *p*-value	0.416	
Difference-in-Hansen test (p-value):		
GMM instruments for levels	0.432	

Note: t statistics in parentheses. *, ** and *** indicate significant at 10%, 5% and 1%, respectively. Time trend is included in the model. LERNER and PTE represent Lerner index of market power and pure technical efficiency, respectively. F-Statistic is for the joint significance of the coefficients. AR(1) and AR(2) are tests for first and second order autocorrelation in the first-differenced residuals, respectively. Market power is inversely related to competition.

from competition to pure technical efficiency since the p-value of the lagged market power, 0.581, is greater than 10 percent level of significance. The result shows that competition does not Granger-cause pure technical efficiency. This means increases bank competition do not foster pure technical efficiency. In addition, the result reveals that the lagged pure technical efficiency is not different from zero implying that current pure technical efficiency does not rely on previous years' pure technical efficiency.

The results in Tables 6.3 and 6.4 indicate that there is no causal relationship between pure technical efficiency and market power. The diagnostic tests are all appropriate except that the p-value of the Hansen test appears small even though it is above the conventional level of significance.

6.5.1.2 Causality Tests between Bank Cost Efficiency and Bank Competition

This section presents the results of the causal relationship between bank cost efficiency and competition. Lerner index of market power is estimated as a function of lagged competition and lagged cost efficiency.

Table 6.5 results show that the lagged cost efficiency coefficient is positive and significant at the 10 percent level. The p-value of 0.057 rejects the null hypothesis of no causality

Table 6.5 Granger Causality Tests (dependent variable → competition)

Dependent Variable LERNER	**System GMM Estimates**	**P-value**
CONSTANT	0.237***	0.000
	(6.30)	
$LERNER_{t-1}$	0.475***	0.000
	(7.12)	
CE_{t-1}	0.020*	0.057
	(2.00)	
F-Statistics	0.000***	0.000***
Number of observations	186	
Number of banks	25	
Number of instruments	8	
Hansen test (p-value)	0.732	
Arellano-Bond test:		
AR(1) *p*-value	0.048	
AR(2) *p*-value	0.349	
Difference-in-Hansen test (p-value):		
GMM instruments for levels	0.376	

Note: t statistics in parentheses. *, ** and *** indicate significant at 10%, 5% and 1%, respectively. Time trend is included in the model. LERNER and CE represent Lerner index of market power and cost efficiency, respectively. F-Statistic is for the joint significance of the coefficients of the explanatory variables. AR(1) and AR(2) are tests for first and second order autocorrelation in the first-differenced residuals, respectively. Market power is inversely related to competition.

running from cost efficiency to competition at the 10 percent level of significance. The results show that efficiency positively Granger-causes market power and hence efficiency

negatively Granger-causes competition. This result is consistent with Demsetz's (1973) efficient structure hypothesis, where higher cost efficiency leads to higher market power. This result suggests that cost efficient banks operating in Ghana could reduce costs and gain higher market shares and as such increase their market power relative to their competitors. Thus, bank managers have incentives to reduce cost as that could increase their market power. The finding urges the Ghana bank regulators and policy makers to promote or pursue policies that enhance bank cost efficiency. However, these policies could also increase market power leading to less competition in Ghana's banking market. The policymakers face trade-off. Similar results have been reported by Weill (2004) on European banks, Weill et al. (2006) on Czech banking industry, Maudos & Fernandez De Guevara (2007) on Spanish banking sector, Koetter et al. (2008) on US banks and Williams (2012) on 419 Latin American commercial banks but opposite to the findings of Casu & Girardone (2009) whose study reveals that higher market power enable banks in five European Union countries to attain higher level of cost efficiency. Competition can enhance or deteriorate financial stability of banks. The implication of this finding is that any policies relating to bank competition should first look at the potential impact on bank cost efficiency. In other words, policymakers can design or use policies that would promote bank cost efficiency in order to achieve increase in bank competition. Therefore, the improvement in bank cost efficiency should be the focus of regulatory policies so as to ensure competitive conditions in Ghana's banking industry. The economic rationale of this finding is that it saves the government the cost of designing and implementing competition policies that would not have any impact on bank cost efficiency. This is because the result suggests that policies on cost efficiency will rather have effect on bank competition.

The finding that lagged cost efficiency leads to increase in current market power is essential from the view of bank prudential regulation. The trend in cost efficiency could serve as early indicator of the direction of bank competition in Ghana.

To examine the reverse causality running from competition to cost efficiency, the dependent variable is cost efficiency and lagged cost efficiency and lagged market power as endogenous explanatory variables. The results in Table 6.6 reveal that the reverse causality running from market power to cost efficiency offers no evidence that market power (competition) Granger-cause cost efficiency (no rejection on p-value = 0.917). The result shows that market power has no significant impact on cost efficiency. This finding

raises questions about policies that are directed to promote bank competition with the objective of reducing the price of financial services and products (see Fang et al., 2011). Moreover, the results indicate that pursuing greater bank competition in Ghana may not help banks to gain economies of scale in monitoring and consequently, may have no impact on loan rates (see Fang et al., 2011). The result does not support the existence of the

Table 6.6 Granger Causality Tests (dependent variable → cost efficiency)

Dependent Variable CE	**System GMM Estimates**	**P-value**
CONSTANT	-0.829***	0.000
	(-4.54)	
CE_{t-1}	0.354**	0.035
	(2.23)	
$LERNER_{t-1}$	0.067	0.917
	(0.11)	
F-Statistics (p-value)	0.000***	0.000***
Number of observations	186	
Number of banks	25	
Number of instruments	8	
Hansen test (p-value)	0.25	
Arellano-Bond test:		
AR(1) *p*-value	0.047	
AR(2) *p*-value	0.272	
Difference-in-Hansen test (p-value):		
GMM instruments for levels	0.322	

Note: t statistics in parentheses. *, ** and *** indicate significant at 10%, 5% and 1%, respectively. Time trend is included in the model. LERNER and CE represent Lerner index of market power and cost efficiency, respectively. F-Statistic is for the joint significance of the coefficients of the explanatory variables. AR(1) and AR(2) are tests for first and second order autocorrelation in the first-differenced residuals, respectively. Market power is inversely related to competition.

Hick's (1935) quiet life hypothesis in Ghana's banking industry since an increase in bank market power does not lead to a reduction in bank cost efficiency.

The causality findings in Tables 6.5 and 6.6 reveal that the causality between bank market power (competition) and bank cost efficiency is not bidirectional but rather unidirectional, this is because causality runs only from bank cost efficiency to market power (competition) but not vice versa.

6.6 Summary

The findings indicate that there is no evidence of causal association between bank pure technical efficiency and bank competition. On the contrary, causality runs only from cost efficiency to competition but not vice versa, suggesting that cost efficiency can be used to predict the direction of bank competition. Thus, increase in bank cost efficiency could encourage more bank market power and hence less competition. Thus, to increase bank cost efficiency, the Bank of Ghana (banks regulator) may have to allow some increase in bank market power. However, the reverse causality indicates that increase in bank market power (competition) cannot stimulate cost efficiency in Ghana's banking industry.

Chapter 7
Conclusions and Policy Implications

7.1 Introduction

Ghana's banking industry has undergone major financial reforms since 1988 which have transformed the banking industry by enhancing bank competition, efficiency and productivity. The financial reform process has been gradual but consistent. The financial sector reforms are aimed at increasing banks competitiveness, efficiency and performance in Ghana's banking system that could then contribute in greater measure to stimulate economic growth and ensure financial stability. During the pre-reforms era, Ghana's banking industry was besieged with inadequate capital, insufficient loans loss provisions, high operating costs due to inefficient operations, high nonperforming loans and endured immense political influence (International Monetary Fund, 1999; World Bank, 1989). The reforms have undoubtedly increased the capacity of financial institutions to mobilise domestic savings and strengthened economic growth in Ghana.

It is expected that increased competition in the financial sector will to lead to lower costs and improve efficiency, offer greater product innovation and enhance the quality of financial products (Claessens, 2009). However, it is not clear that deregulation process that increases bank competitiveness always improves bank efficiency (Fecher & Pestieau, 1993). Thus, the association between competition and bank performance is more complex (Claessen & Leaven, 2004) and that it is naïve to assume that bank competition is always good.

Thus, the studies in bank competition in both developed and developing countries have reported mixed results. Most studies on banking sectors have shown evidence of imperfect competitions in developing and emerging countries (Gunalp & Celik, 2006 on Turkey; Maudos & Solis, 2011 on Mexico; Simpasa, 2010 on Zambia; and Aboagye et al., 2008 on Ghana) in developed countries (Fernandez de Guevara & Maudos, 2011 on Spain; Matthews et al., 2007 on Britain; and Rezitis, 2010 on Greece) and in cross-country studies (Claessens & Laeven, 2004 on 50 developed and developing countries; Soedarmono et al., 2011 on 12 Asian countries; Anzoategui et al., 2010 on Middle East and Northern Africa

region; and Weill, 2004 on 12 EU countries). In contrast, very few studies have reported perfect competition. For example, Nathan and Neave (1989) in their study find perfect competition for Canadian banks in 1982, but reject the hypothesis of monopoly and perfect competition for Canadian banks over the period 1983-1984. Staikouras et al.'s (2001) study on Argentina reports that competitive conditions in Argentina banks are closer to perfect competition for the period 1997 to 1999. Similarly, Yuan (2006) investigates the degree of competition in the banking industry in China over the period 1996-2000 before it became a member of WTO and finds that the banking system in China is closer to perfect competition.

Similarly, various studies on financial reforms and efficiency have indicated mixed results as well. For instance, individual country bank studies by Gilbert & Wilson (1998) on Korea, Kumbhakar & Lozano-Vivas (2001) on Spain and Mukherjee et al. (2001) on the US, and cross-country bank studies by Ataullah et al. (2004) on India and Pakistan, Casu et al. (2003) on Italy and Spain, Hermes & Nhung (2010) on four Latin America and six Asia countries have found some favourable effect of financial sector reforms on bank efficiency. On the other hand, individual country studies by Wheelock & Wilson (1999) on U.S banks, Sturm & Williams (2004) on Australian banks, Ariff & Can (2008) on Chinese banks and Sathye (2003) on Indian banks and cross-country studies by Casu et al. (2003) on French and German banks and Fries & Taci (2005) on 15 East European countries banks have reported inefficiencies in these banking sectors.

The Ghana's banking reforms are designed to modernise the banking system. The main reforms include the elimination of restrictions of foreign banks entry, liberalisation of banks interest rates and bank charges, new regulatory and supervisory framework, and modernization of payment and settlement system. Currently, there are 27 banks operating in Ghana, all under the licence of universal banking. Only three banks are state-owned, namely Ghana Commercial Bank, Agricultural Development Bank and National Investment Bank. The Ghanaian banking reform is still on-going so the understanding of bank efficiency and competition and their determinants as well as the causal relationship between bank efficiency and competition is vital to ensure improvements in bank efficiency and competition which could ultimately ensure financial stability and stimulate economic growth in Ghana**.** Thus, the present research in bank efficiency and competition in Ghana's banking industry after two decades of banking reforms is informative and

necessary to policymakers, regulators and bank management in Ghana that are interested in the level of bank efficiency and the degree of bank competition and their determinants**.** In addition, the causal direction between bank efficiency and competition will determine what policies should be geared towards bank competition in order to help enhance bank efficiency or vice versa. The policymakers and regulators have come to realize the vital role the banking industry plays in the Ghana's economy. That is, the role in having a safe and sound banking system to facilitate financial stability and economic development.

This study investigates the level of bank efficiency and the degree of bank competition and their determinants as well as the causal relationship between bank efficiency and competition taking into consideration the heterogeneity of the Ghana's banks. The study has also taken into account the time it takes for the impacts of competition and efficiency to materialize as well as its instantaneous impact (static impact). The study estimates both the static and dynamic models for both bank efficiency and competition. The static models are estimated using the fixed effect estimator (applying ordinary least squares after mean deviation) while the dynamic models estimation are conducted employing the GMM estimator (two-step system GMM). The GMM estimator includes the dynamic nature of bank efficiency and competition which offer valid instruments that deal with unobserved heterogeneity and endogeneity.

The diagnostic tests indicate the superiority of the static model over the dynamic model in the case of bank pure technical efficiency. This implies the fixed-effect method is preferred in the case of the static pure technical efficiency model. However, the dynamic model is superior to the static model in the context of both bank cost efficiency and competition suggesting that the two-step system GMM approach is the appropriate method for the dynamic cost efficiency and competition models. In other words, cost efficiency and competition models recognize the dynamic nature of bank cost efficiency and competition in Ghana. Hence the analyses for the determinants of bank efficiency and competition are based on the superior estimation techniques. In addition, the two-step system GMM is used to assess the causality between bank competition and efficiency.

The annual sample data for this study is an unbalanced panel which covers 25 Ghana banks generating 211 observations.

The rest of the chapter summarises the findings of the study in Section 7.2 and provides the policy implications in Section 7.3. Limitations of the study and future research recommendations are discussed in Section 7.4.

7.2 Summary of the Findings

7.2.1 Bank Efficiency

This study investigates the level and determining factors of bank efficiency in Ghana to answer research question one:

How efficient are Ghanaian banks and what role have bank-specific and macroeconomic factors played in the variation of efficiency across Ghanaians banks?

To answer the first part of research question one, the study estimates bank efficiency using the DEA approach. Overall, the results show relatively low average efficiency scores for Ghana's banks during the study period, suggesting that Ghana banks are operating far from the efficiency frontier. This finding is attributed to underutilisation or waste of input resources. This implies there is much waste of valuable input resources in the Ghanaian banking system. However, from 2007 onwards, the results show remarkable improvement in the efficiency scores in Ghana banks. Thus, Ghana banks are able to control the underutilization and wastage of valuable input resources. Nevertheless, the results indicate that more effort is still required to improve Ghana banks' performance especially in terms of cost efficiency.

Our results also show that both pure and cost efficiencies are relatively unstable over the study period. The instability is easily noticeable in cost efficiency than in pure technical efficiency. In addition, out of 25 banks, only two banks namely GCB and BBG are able to remain on the bank efficiency frontiers from 2001 to 2010 and 2002 to 2010, respectively. This suggests that the other banks remain on the efficient frontier for a few years but fail to maintain their performances.

The study results exhibiting low bank efficiency reflects the high operating and financial costs of managing a bank in Ghana. Ghana banks face challenges such as high cost of borrowing and high non-performing loans. Non-interest operating expenses of banks in

Ghana include staff costs, occupancy, publicity and advertisement, fees and commissions, depreciation and other administrative costs. Staff cost (comprising of salaries and wages, and employee benefits) accounted for 51% in 2006 compared to 49% in 2002 of the total non-interest operating expenses (PricewaterhouseCoopers, 2007). Employee benefits continue to be the largest expense item, contributing 46 percent in 2009 and 47 percent in 2010 of the staff cost (PricewaterhouseCoopers, 2011). This may be due to the competitive remuneration to attract and retain qualified bank staff. The banks have failed to train sufficient qualified staff to meet their demands to help stem out the shortfalls in qualified bank staff in Ghana's banking sector. In addition, Ghana banks have high level of non-performing loans. Increased cost of funds (including higher cost of capital emanating from the increase in minimum regulatory capital) and high inflation rate have been identified by banks as factors for worsening loan default rate (PricewaterhouseCoopers, 2010). Furthermore, the banks are still saddled with the associated costs of the previous years' deterioration in nonperforming loans, a reason used by many banks in order not to further reduce their lending rates (PricewaterhouseCoopers, 2011).

The second part of research question one is accomplished by estimating and analysing the impact of bank size, capitalization, loan loss provision ratio, inflation rate and GDP growth rate on bank efficiency. The diagnostic tests indicate that the fixed effect estimator is preferred in the pure technical efficiency model while the two-step system GMM is considered superior in the cost efficiency model.

With reference to the macroeconomic factors, the results suggest that the rate of inflation has a positive and significant effect on bank pure technical efficiency. Thus, Ghana banks are able to benefit from inflationary economic environment. GDP growth rate is significant and negatively related to bank cost efficiency. This shows that economic growth reduces the banks' cost efficiency in Ghana's banking sector. This is because the banks lower their operating standards during the boom period as a result of aggressive lending. Thus, bank management conduct less screening of borrowers and less monitoring of loan performance (lack of internal risk control) ultimately increase their non-performing loans portfolio (eventually it becomes more costly to monitor) and thereby become less cost efficient. On the contrary, GDP growth rate has no impact on pure technical efficiency while inflation rate has negligible effect on cost efficiency.

Turning to bank-specific factors, the results reveal that bank capitalization and bank size are significant and positively related to pure technical efficiency. This suggests that well-capitalized and larger banks in Ghana are pure technically efficient. This could be that banks with higher capital are perceived to be relatively safe therefore encourages more deposits at lower interest expenses leading to lower total costs. The finding also shows that the loan loss provision ratio has no impact on pure technical efficiency.

In contrast to the results on pure technical efficiency, the findings reveal that bank capitalization has negative and significant effect on bank cost efficiency suggesting that well-capitalized banks are less cost efficient. As Ariff & Can (2008) suggest bank capitalization may reduce bank capital risk, but, it may also increase moral hazard incentives leading to increase in costs and therefore decline in bank cost efficiency. Loan loss provision ratio, bank size and rate of inflation, however, are not important factors in influencing bank cost efficiency in Ghana.

The findings also show that lagged cost efficiency is an important factor in determining bank cost efficiency in Ghana. The lagged cost efficiency is significant and has a positive effect on the current year cost efficiency. This implies that bank cost efficiency tends to persist from year to year. Therefore, an increase in lagged cost efficiency could help increase the current year's cost efficiency. The positive lagged cost efficiency may constitute some accumulated knowledge and technologies that may help the banks to lower costs. The level of bank cost efficiency is low in Ghana's banking sector but persists from year to year. Policymakers should direct banks to focus on cost efficiency.

7.2.2 Bank Competition

In this study, the degree and the determining factors of bank competition in Ghana is investigated in order to answer research question two:

Has competition in Ghana's banking sector improved and what are the determinants of competition (or market power) within the industry?

In order to answer the first part of research question two, we used the Lerner index to measure the degree of competition following recent empirical studies on bank competition

(Carbó et al., 2009; Casu and Girardone, 2009; Delis & Tsionas, 2009; Maudos & Fernandez de Guevara, 2007; Turk-Ariss, 2010). The study results exhibit that the value of the Lerner index increases from 0.343 in 2001 to 0.400 in 2010 signalling an increase in bank market power. The average Lerner index for the study period is 0.349. This suggests that the Ghanaian banking industry is weak competitively and as a result Ghana banks are able to set prices well above marginal cost. However, using the cross-country studies Maudos & Nagore (2005) find the value of the Lerner index for Ghana's banking industry is 0.385 for the period from 1995 to 1999. This apparently shows that there has been some improvement in competition in Ghana's banking industry underscoring the increases in competition during the periods from 2001 to 2002, 2004 to 2006 and 2007 to 2009. The results also reveal that the development in bank competition in Ghana is not regular and there is no noticeable steady trend towards a strong banking competition over the study period despite the experience of economic growth and banking reforms.

Overall, the findings exhibit that both marginal costs and output price decline over the study period but marginal cost declines faster than the output price. This enabled banks in Ghana to set prices well above marginal cost over the same period. This pricing behaviour has helped the banks to preserve their market power. The reduction in marginal cost is attributed to decrease in operating and financial costs while the decline in output price is due to fall in lending rates in response to the decline in interest rates on government Treasury bill. The interest rate on Treasury bill dropped from approximately 28.9 percent in 2001 to 10.2 percent in 2006 (Bank of Ghana Annual Report, 2005, 2009) and from 23.7 percent in 2009 to 12.3 percent in 2010 (Bank of Ghana Annual Report, 2011).

To answer the second part of research question two, the determinants of bank competition is estimated and analysed. The study investigates the impact of size, capitalization, loan loss provision ratio, fee income (bank specific factors) and inflation rate (macroeconomic factor) on bank competition in Ghana. The analysis is based on the two-step system GMM estimation as the dynamic model appears to be more appropriate than the static model.

The results show that the lagged Lerner index is positive and statistically significant suggesting persistence of bank market power in Ghana. This provides evidence of opaqueness and rigidity in Ghana's banking industry which results in high bank operating and financial costs.

In contrast, fee income is not statistically significant and is not considered relevant in explaining the differences in market power in the Ghanaian banking industry. Fee income is not statistically significant because the banking industry in Ghana relies heavily on interest income (see Appendix H). This indicates that Ghana banks may still focus on their core activities suggesting lower level of diversification in banks' sources of income in Ghana. Similarly, the coefficient of loan loss provision ratio is positive but is statistically insignificant and therefore has negligible influence on market power in Ghana's banking industry. This suggests that loan quality has no significant role in determining bank competition in Ghana.

In terms of the macroeconomic factors, the result reveals that the rate of inflation is statistically insignificant and negatively related to market power and therefore has no effect on bank competition.

7.2.3 Causality between Bank Competition and Bank Efficiency

To answer research question three: Does bank competition (or market power) influence bank efficiency and vice versa.

Causality test between bank efficiency and competition is conducted using two-step system GMM. The causality tests results show no causality running from pure technical efficiency to bank competition and the reverse causality does not runs from bank competition to bank pure technical efficiency. This finding suggests lagged pure technical efficiency cannot be used to predict current market power and the reverse causality result indicates lagged market power cannot help to predict current pure technical efficiency.

In addition, the results of the causal relationship between bank cost efficiency and competition suggest no evidence of causality running from bank competition to bank cost efficiency. However, the results show that bank cost efficiency positively Granger-causes market power. This indicates that an increase in the bank cost efficiency leads to an increase in the bank's market power and hence less bank competition. The policymakers face trade-off. The finding suggests that policymakers in designing or promoting policies that enhance bank cost efficiency should be cautious since it could lead to less bank

competition in Ghana. This finding indicates that, in terms of causation, bank cost efficiency is more significant than pure technical efficiency.

7.3 Policy Implications of the Study

The financial reform in Ghana is an ongoing process. The findings of this study offer important implications for the bank regulators, policymakers and bank management in Ghana, relating to design and formulation of regulatory changes and competitive policies to help promote bank efficiency, financial stability and sustain economic growth.

The results show that banks are inefficient in Ghana. The inefficiencies have generated high bank operating costs in Ghana's banking industry. Bank management should be encouraged to set-up internal policies and procedures to control the wastage of valuable input resources. In addition, as bank risk management practices are not well-developed by Ghana banks, banks should strengthen their risk management practices (screening borrowers to reduce adverse selection and monitoring loan performance to reduce moral hazard problems) in order to minimize financial losses. This is because poor risk analysis can have a very negative effect on bank operations by exposing depositors and creditors to unnecessary risk which could quickly deplete bank capital and fund. Banks should also desist from unnecessary risk taking through aggressive lending as a means of competing which may increase default risk and impose heavy financial losses. These measures will help reduce high non-performing loans. Moreover, banks should encourage their customers to make use of technology in their banking transaction (e.g. ATMs, mobile banking and internet banking) which will reduce the workload of bank staff and hence number of staff and staff cost.

Furthermore, banks in Ghana have failed to train sufficient qualified staff, and therefore the policymakers should urge the banks to train more staff to meet their demands in order to stem out the unrealistic increases in employees benefits in order to retain the well-qualified staff. This will help solve the qualified bank staff retention problems responsible for the high bank staff turnover costs in Ghana. Banks should not resort to spending unnecessary as a means to retain staff. For instance, they may align or adjust their staff cost, particularly employees benefits to their revenue (that is, employees benefits should not increase disproportionately to the bank revenue).

Ghana banks have market power to set prices (for example, interest rates on loans and deposits) as indicated by the Lerner index value of 0.349 for the period 2001-2010. In other words, prices are not competitive. Thus, the higher their market power, the higher will be the cost of financial intermediation. This may negatively affect investment and lower economic growth. There are other ways that bank competition in Ghana can be improved. For example, it is difficult for customers to switch between banks because switching costs are high. Switching costs are fixed costs that bank customers face when switching banks. The higher the switching costs, the harder it will be for newer entrants to gain customers or cheaper existing participants to grow market share (Barry, 2010). Therefore, switching cost is a barrier to bank competition. Examples of `switching costs' include the transactions costs of closing an account with one bank and opening another with a competitor. The ability to switch between banks enables bank customers to react quickly to new, innovative or better products, which compels banks to develop better and more competitive products. Thus, bank switching and customer mobility are critical to effective competition in the banking market. Therefore policymakers could ensure customers' mobility by demanding that the banks to justify the high switching costs. Thus, the policymakers should ask the banks to provide the underlining reasons to support high switching costs.

In addition, many households still do not have access to financial services such as ATMs and internet banking. Policymakers should persuade the banks to provide households greater access to financial services at reasonable cost and convenience. Another problem is the unavailability of informed data on prices of services for customers. Therefore, policymakers should provide price information on financial services to assist bank consumers to compare prices, for example, interest rates on deposit (Caessens, 2009), interest rates on loans, ATM withdrawal fees and cheque clearance fee. This will help bank customers to have access to competitive prices of financial products and services and could promote bank competition. However, policymakers and banks should be cautious of a competitive pricing, because taking from the lesson learnt from other developed countries, too much competition could weaken banks' standard of evaluating borrowers. For example, increased competition led banks to lower lending standards in the recent subprime mortgage lending market in US that caused systemic financial crisis across the world. This led to the bankrupt of Lehman Brothers, acquisition of Bear Stearns and Merrill Lynch and bailed-out of Goldman Sachs and Morgan Stanley by the U.S

government. These failures increased the instability in the global financial system resulting, for instance, the nationalization of UK bank, Northern Rock (González, 2009; Hall, 2008; Llewellyn, 2009).

Ghana economy has enjoyed economic growth throughout the period under study. However, the finding of this study indicates that the GDP growth rate negatively influences bank cost efficiency. This suggests that banks lower their evaluation standards of borrowers or reduce their monitoring of loan performance during boom period. Therefore, regulators and policymakers should emphasize credit risk management practices. For instance, credit risk management involving control of adverse selection problems by screening loan applicants and moral hazard problems via loan performance monitoring. This may help them avoid unnecessary risk-taking especially during boom times in order to reduce their non-performing loan problems which have plagued the Ghanaian banking industry for a long time and therefore reduce banks' operating costs. The non-performing loans pose considerable constraint to banks' credit delivery and lending rates reduction (Bank of Ghana Financial Stability Report, December 2010). For instance, the non-performing loans ratio increases from 16.2 percent in 2009 to 17.6 percent 2010 (Bank of Ghana Financial Stability Report, February 2011). The non-performing loans problem has reduced but it is still high. These policies could help promote bank cost efficiency in Ghana.

The results reveal that bank size has a positive and significant effect on pure technical efficiency suggesting that increase in bank size increases pure technical efficiency. This means large banks appear to be more pure technically efficient than small banks in Ghana. This may be due to the fact that the large banks have been able to use current technology such as ATM networks, internet banking and the SWIFT (Society for Worldwide Interbank Financial Telecommunication) system (for transacting international payments). Thus, improvements in technology and financial services may lessen the costs more for large banks, to some extent, than for small banks. Therefore, for pure technical (managerial) efficiency purposes, policymakers could encourage consolidation among the small banks through mergers and acquisitions in order to improve pure technical efficiency. In this case, the policy of consolidation may allow banks through economies of scale and scope to better integrate technological changes. For instance, providing many ATM networks would have considerable effect on bank technical efficiency. Consolidation may reduce the

amount of personnel and, thus, reduce staff cost which is 51 percent of the Ghanaian banking industry's total operating costs. However, banks cannot easily lay off staff due to the rigid labour market regulation in Ghana. Therefore, policymakers may have to allow banks the flexibility of hiring and firing. However, mergers and acquisitions may increase bank concentration which may lead to decrease in bank competition and increase in profitability.

The results show that previous year's cost efficiency (lagged cost efficiency for the cost efficiency model) is statistically significant and has positive effect on the current cost efficiency suggesting that bank cost efficiency is persistent. This implies that bank cost efficiency in Ghana persist from year to year. This persistence suggests that relatively cost efficient banks tend to remain cost efficient over a period of time consistent with the result of Staub et al. (2010) and Manlagnit (2011). This is an evidence of accumulation of knowledge and technologies that help the banks to lower their operating costs (see Ataullah & Le, 2006). The persistent cost efficiency should encourage banks to focus on cost efficiency in order to reduce financial and operating costs which would help them increase their profits. On the contrary, the results show that bank market power in Ghana persists from year to year. However, the persistent market power may weaken competitive forces and discourage innovation of financial products and services to the detriment of the bank customers and economy in the form of higher prices of products and services. Policymakers and regulators should redefine or scrap the policy of selecting and managing banks' entry and exit to reduce or eliminate the persistence of the bank market power.

The results also indicate that causality runs from bank cost efficiency to bank market power. Thus, promoting bank cost efficiency may ultimately lead to higher bank market power and hence less competitive environment in the banking market in Ghana since causality runs from bank cost efficiency to bank competition. The finding implies that any policy relating to bank competition should also look at the potential impact on bank cost efficiency. However, bank regulators and policymakers faced the choice of either reducing cost efficiency to reduce bank market power or increase cost efficiency to increase bank market power. In addition, causality running from bank cost efficiency to bank competition suggests that cost efficiency could serve as early indicator of the direction of bank competition in Ghana. Furthermore, this finding could save the government the cost of designing and implementing competition policies that would not have any impact on bank

cost efficiency. The reason is that causality runs from bank cost efficiency to bank competition but not vice versa.

7.4 Limitations of the Study and Future Research

This section provides some limitations of the study and recommends some corresponding directions for future research.

The first limitation relates to the small number of banks included in the data sample. The small number of Ghana banks prevents this study from employing more determinant factors such as bank profitability, liquidity, interest rate, market share and bank concentration (measured by the HHI) for both bank efficiency and competition for the dynamic system GMM estimations. This is because increasing the determinant factors will increase the number of instruments in the system GMM estimation which may invalidate the system GMM results. The increase in the number of instruments could become large relative to the number of banks in the regression. This could generate too many instruments (over-fitting endogenous variables) in the system GMM estimations which will weaken the specification tests and bias the results (Roodman, 2007, 2009). Thus, when the instrument count is high, the Hansen test of validity of the instruments weakens (Roodman, 2009). This could mean accepting a model as valid when the problem of endogeneity is partially solved.

Second, this study only applies DEA to measure bank efficiency. The main drawback of the DEA approach is that it does not take into account the random error in the data, and due to the small number of observations parametric methods could not be considered because parametric methods require a large sample size in order to produce reliable estimations. Future research should consider parametric measures such as stochastic frontier analysis, distribution free approach and thick frontier approach to examine the level of bank efficiency in Ghana in order to optimise the efficiency results. Unlike the DEA where any deviation from the efficiency frontier is attributed to inefficiency, these methods incorporate the error term into the efficiency estimation and separate inefficiency from random errors. In terms of bank competition, the use of other approaches such as H-statistic and Boone indicator should be considered for comparison purposes since the determination of competition may differ depending on the approach chosen. This is

because the various competition indicators measure different things (Carbo et al., 2005). Using these other measures would establish the robustness of the estimated levels of bank efficiency as well as the degree of bank competition in Ghana.

Third, technical and cost efficiency may be inadequate to draw conclusions on banks' overall performance. Technical efficiency is the ability of a firm (bank) to obtain a maximum set of output from a given set of inputs and cost efficiency measures how close a bank's cost is to the minimal cost (or best practice bank's cost) for producing a certain level of output with given input prices and technology. Profit efficiency, on the other hand, takes into consideration both cost and revenue efficiency. Profit efficiency is based on the economic goal of profit maximisation. The objective of profit maximization not only requires goods and services to be produced at a minimum cost, it also demands the maximization of revenues. Profit efficiency essentially captures the efficiencies (or inefficiencies) on the input side as well as the output side. Computing profit efficiency, therefore, constitutes a more important source of information for bank management. Therefore, investigating the profit efficiency of Ghana banks would enrich the banking literature. To avoid ignoring the possibility of inefficiencies on the revenue side, future research should also include profit efficiency.

Fourth, this study examines the causality between bank efficiency and competition without incorporating any other factors such as bank capitalization, size, non-performing loans and the GDP growth rate in the models. The relationship between market power and efficiency might be more complex (Casu & Girardone, 2009) and that other explanatory variables such as bank size, non-performing loans, GDP growth rate and capitalization may impact both the magnitude and the direction of the causality and therefore should be considered in the future research.

Finally, this study only examines Ghana's banking industry and we suggest that future research study could use cross-country studies including other African states such as Nigeria, Kenya, Zambia, Tanzania and Uganda which have also undertaken similar financial reforms. Such a study may provide useful information about cross-country comparison of bank efficiency and competition in other countries with banks in Ghana.

Appendix A: Variance Inflation Factor Results

Table A. 1 Variance Inflation Factor - Efficiency

Variable	VIF	1/VIF (Tolerance)
Size	1.22	0.8206
Inflation	1.16	0.8652
GDP growth	1.10	0.9100
Capitalization	1.09	0.9148
Loan loss provision	1.03	0.9666
Mean VIF	1.12	

Note: PTE or CE is the dependent variable. VIF stands for Variance inflation factor.

Table A. 2 Variance Inflation Factor – Lerner

Variable	VIF	1/VIF (Tolerance)
Size	1.19	0.8431
Inflation	1.13	0.8864
Fee income	1.11	0.9024
Capitalization	1.03	0.9754
Loan loss provision	1.03	0.9755
Mean VIF	1.09	

Note: LERNER is the dependent variable. VIF stands for Variance inflation factor.

Appendix B: Summary Statistic of Bank Specific Factors

Table B.1 Summary Statistic of Bank Specific Factors: 2001-2010

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Size										
Mean	10.486	10.859	11.268	11.563	11.502	11.835	12.287	12.479	12.797	13.152
Standard Deviation	1.474	1.290	1.179	1.085	1.248	1.124	0.995	1.218	1.117	0.858
LLP										
Mean	0.100	0.122	0.116	0.097	0.086	0.067	0.066	0.059	0.082	0.106
Standard Deviation	0.094	0.111	0.088	0.063	0.063	0.046	0.067	0.058	0.071	0.130
CAP										
Mean	0.134	0.104	0.097	0.119	0.192	0.140	0.103	0.143	0.152	0.158
Standard Deviation	0.073	0.075	0.074	0.043	0.232	0.076	0.045	0.153	0.110	0.091
FEE										
Mean	0.240	0.327	0.288	0.298	0.256	0.259	0.280	0.238	0.238	0.235
Standard Deviation	0.067	0.106	0.091	0.091	0.108	0.090	0.086	0.109	0.091	0.090

Appendix C: Pagan and Hall Heteroscadasticity Test

Table C.1 Pagan and Hall Heteroscadasticity Test

	χ^2-statistic	P-value
Ho: error is homoskedastic		
PTE	22.098	0.0047
CE	18.019	0.0211
LERNER	17.041	0.0297

Appendix D: Efficient Frontier for GCB and BBG

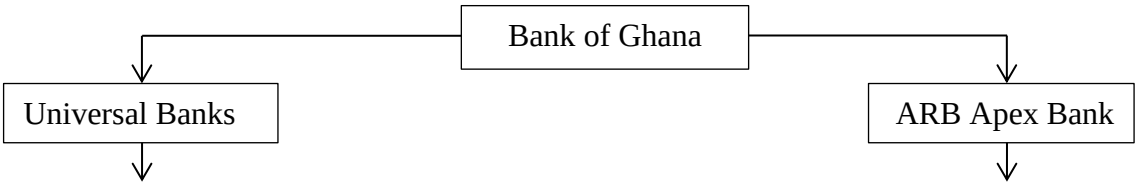
Table D.1 Efficient Frontier for GCB and BBG (2001-2010)

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
PTE:										
GCB	1	1	1	1	1	1	1	1	1	1
BBG	1	1	1	1	1	1	1	1	1	1
CE:										
GCB	1	1	1	1	1	1	1	1	1	1
BBG	0.69	1	1	1	1	1	1	1	1	1

Notes: GCB and BBG stand for Ghana Commercial Bank and Barclays Bank of Ghana

Appendix E: Structure of the Banking Industry in Ghana

Figure E. Structure of the Banking Industry in Ghana (2010)



1. Access Bank (not included in this study)
2. Agricultural Development Bank
3. Amalgamated Bank (now Bank of Africa)
4. Bank of Baroda
5. Barclays Bank
6. Banque Sahélo-Saharienne pour I'Investissement et le Commerce Limited (BSIC)
7. CAL Bank
8. Ecobank
9. Energy Bank (not included in this study)
10. Fidelity Bank
11. First Atlantic Merchant Bank
12. Ghana Commercial Bank
13. Guaranty Trust Bank
14. HFC Bank
15. Intercontinental Bank
16. International Commercial Bank
17. Merchant Bank
18. National Investment Bank
19. Prudential Bank
20. SG-SBB Bank
21 Stanbic Bank
22. Standard Chartered bank
23. The Trust Bank
24. UniBank
25. UT Bank
26. United Bank for Africa
27. Zenith Bank

Rural Banks (135)

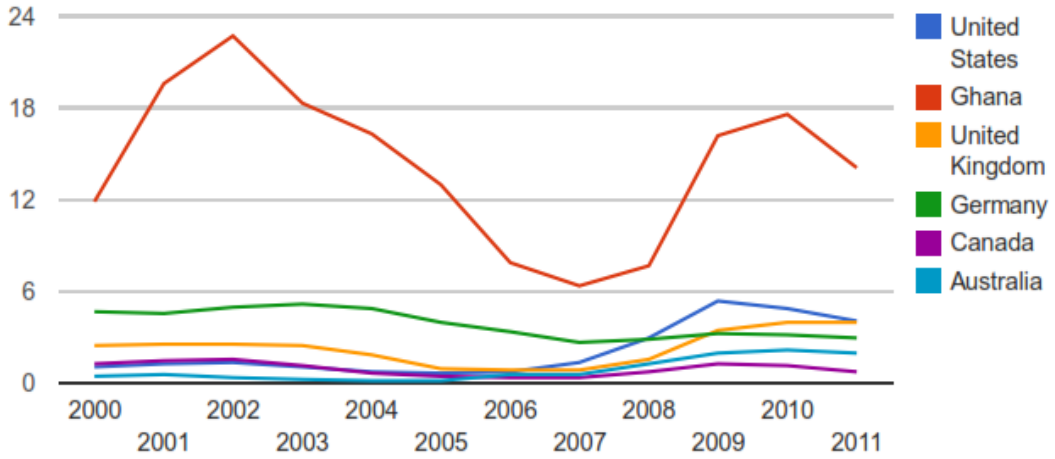
Appendix F: The List of the Banks used in this Study

Table F. List of the Banks used in this Study

Agricultural Development Bank	International Commercial Bank
Amalgamated Bank (now Bank of Africa)	Merchant Bank
Bank of Baroda	National Investment Bank
Banque Sahélo-Saharienne pour I'Investissement et le Commerce Limited (BSIC)	Prudential Bank
Barclays Bank	SG-SBB
CAL Merchant Bank	Stanbic Bank
Ecobank	Standard Chartered Bank
Fidelity Bank	The Trust Bank
First Atlantic Merchant Bank	Unibank
Ghana Commercial Bank	United Bank of Africa
Guaranty Trust Bank	UT Bank
HFC Bank	Zenith Bank
Intercontinental Bank	

Appendix G: Non-Performing Loans: Compare Ghana to Other Countries

Figure 7.1 Non-Performing Loans: Compare Ghana to Other Countries



Source: TheGlobaleconomy.com

Appendix H: Fee Income versus Interest Income

Table G. Fee Income versus Interest Income (as a Percentage of Total Income)

Year	Fee Income	Interest income
2001	14.7	77.6
2002	21.1	67.0
2003	19.3	71.3
2004	21.0	70.0
2005	20.5	71.0
2006	20.7	71.6
2007	21.5	70.9
2008	17.8	69.6
2009	14.8	74.1
2010	14.9	78.0

Source: Bank of Ghana

Appendix I: Interest Rate Spread

Table H. Interest Rate Spread

Year	Interest Rate Spread
2001	14.2
2002	15.4
2003	11.7
2004	13.2
2005	10.8
2006	10.2
2007	8.4
2008	8.6
2009	9.1
2010	11.1

Source: Bank of Ghana

Appendix J: Cost-Income Ratio

Table I. Cost–Income Ratio

Year	Cost-Income Ratio
2001	40.2
2002	59.0
2003	63.9
2004	63.5
2005	67.4
2006	67.0
2007	62.5
2008	64.8
2009	62.8
2010	58.5

Source: Bank of Ghana

Appendix K: Concept of Efficiency

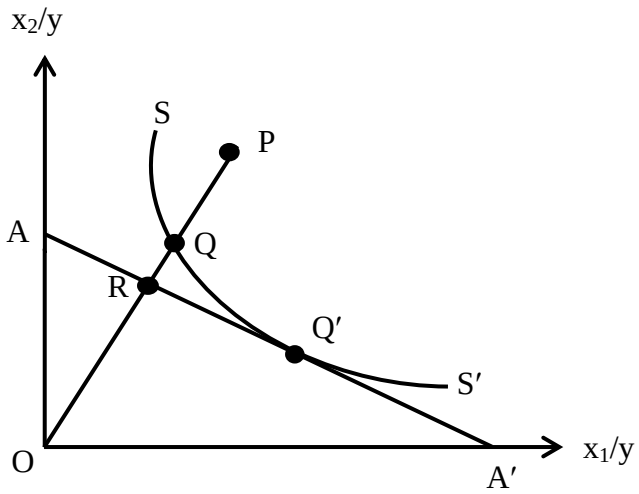
1. The Concept of Efficiency

The concept of efficiency is employed to characterise the use of resources within a unit or units within an industry or sector. Efficiency is the performance of units transforming inputs into outputs (Forsund & Hjalmarsson, 1974). The efficiency measurement was first pioneered by Farrell (1957) based on the work of Koopmans (1951) and Debreu (1951). According to Farrell (1957), the concept of efficiency measurement has two components: technical efficiency and allocative efficiency. Farrell (1957) defined technical efficiency as the ability of a firm to obtain a maximum set of output from a given set of inputs and allocative efficiency as the ability of a firm to use the inputs in optimal proportions for the given prices. The combination of these two measures produces a measure of overall economic or cost efficiency. Farrell (1957) adopted input reducing focus or input-oriented measure as opposed to output-oriented measure.

1.1 Input-Oriented Technical and Cost Efficiencies

The concept of efficiency based on input-oriented measure under constant returns to scale is illustrated in Figure 7.2.

Figure 7.2. Input-Oriented Technical and Cost Efficiencies



Consider a bank is using only two inputs x_1 and x_2 to produce a single output y at point P under constant returns to scale. SS′is the production function or frontier which indicates all

efficient combination of x_1 and x_2. Any bank operating on SS′ is considered technically efficient. For example, point Q is technically efficient because it lies on the efficient isoquant SS′. Given that the bank produces at the point P implies it is technically inefficient, since by producing at point Q, it could produce the same output with fewer inputs. The technical inefficiency of the bank could be represented by the distance QP. This is expressed by ratio QP/OP, which means that all inputs could be proportioally reduced without a reduction in outputs. Therefore the bank's technical efficiency (TE) is given by the ratio:

TE = OQ/OP which is equal to 1- QP/OP (A.1)

Technical efficiency scores vary between zero and one. A value of one shows that the bank is technically efficient. On the other hand, a bank is described as technically inefficient if its efficiency score is less than one. Thus, a value closer to one shows that the level of output of the bank for a given level of input is closer to technically efficient point whereas a value nearer to zero suggests that the level of output is nearer to the most technically inefficient point for a given level of input.

If input prices are known and represented by the line AA′ (isocost) in Figure 7.2, then a bank is allocatively inefficient for producing at point P, because it has chosen incorrect combination of inputs at the given prices. The point R is allocativelly efficient but technically inefficient. Then the allocative efficiency (AE) of the bank operating at point P could be calculated as:

AE = OR/OQ (A.2)

Thus, the point Q′ in Figure 7.2 is the minimum cost combination of x_1 and x_2 on the efficient isoquant SS′. If a bank operates at the point Q′ which is allocativelly and technically efficient instead of point Q, which is technically efficient but allocativelly inefficient, then the production cost could be reduced by the distance RQ. The distance RQ represents the reduction in production cost that would occur if production were to occur at the the allocativelly and technically efficient point Q′

The economic or cost efficiency (CE) is defined by the ratio:

$$CE = OR/OP \qquad (A.3)$$

which is equal to the product of technical and allocative efficiency. Thus,

$$TE \times AE = (OQ/OP) \times (OR/OQ) = (OR/OP) = CE$$

Again, economic or cost efficiency scores vary between the value zero and one. A value closer to one suggests that the level of output of the bank for a given level of input is closer to cost efficient point while value closer to zero indicates that the level of output is closer to the most inefficient point for a given level of input. The value of cost efficiency must be equal to one for a bank to be declared cost efficient, which implies the bank is both technically and allocativelly efficient. The input-oriented technical efficiency measure addresses the concern of how much reduction in input quantities is possible in order to produce a given level of output. On the other hand, one can also address the concern with how much can output quantities be proportionally increased without changing the input quantities used. This is an output-oriented measure.

Appendix L: Summary Statistics of the Determinant Factors of Bank Competition in Ghana

Table J. Summary Statistics of the Determinant Factors of Bank Competition in Ghana (2001-2010)

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
SIZE	211	11,935	1.388	7,910	14,560
INF	211	0.164	0.067	0.102	0.329
LLP	211	0.088	0.084	0.000	0.640
GDPG	211	0.057	0.012	0.045	0.084
CAP	211	0.136	0.113	-0.150	0.980
FEE	211	0.268	0.096	0.000	0.554

Notes: INF, LLP, GDPG, CAP, FEE are expressed in ratios, size is in million cedis.

Appendix M: Asset and Liability Structures of Ghana's Banking Sector

Table K. Assets and Liability Structures of Ghana's Banking Sector (2001-2010)

	2001	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*
Panel A										
Cash and Due from Banks	25.2	28.9	29.5	27.0	20.7	23.5	23.3	25.2	26.3	25.3
Investments	28.0	31.7	27.7	27.7	26.9	23.3	17.6	14.5	21.3	26.5
Net Advances	37.7	30.4	35.2	35.6	43.0	45.0	50.3	52.3	43.8	40.1
Other assets	5.7	5.7	4.8	6.3	6.5	5.2	5.7	4.7	5.4	5.2
Fixed Assets	3.4	3.3	2.7	2.7	3.0	3.1	3.1	3.2	3.0	2.9
Panel B										
Total deposits	58.3	60.0	62.7	64.2	64.8	55.2	63.0	65.0	63.9	67.9
Total borrowings	8.4	7.5	8.0	7.4	9.0	11.3	13.5	12.7	13.3	10.8
Other Liabilities	19.5	19.0	16.7	15.5	13.4	10.7	12.2	11.8	9.8	7.4
Shareholders' Funds	13.1	12.6	12.5	12.6	12.8	11.7	10.3	10.4	12.6	13.3

Source: Bank of Ghana.

Notes: Panel A represents components of assets as a percentage of total assets. Panel B represents components of liabilities as a percentage of total liabilities

Appendix N: Selected Indicators of Ghana's Banking Sector

Table L. Selected Indicators of Ghana's Banking Sector

	2001	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*
Loan to Deposits	74.2	62.0	66.5	63.8	75.1	74.5	84.4	85.9	77.1	67.7
Loan to deposits+ Borrowings	64.9	55.1	59.0	57.1	66.0	63.5	69.5	71.8	63.8	58.4
Investments to deposits	48.0	52.8	44.3	43.1	41.5	35.7	27.9	22.3	33.3	38.9
NPL ratio	19.6	22.7	18.3	16.1	13.0	7.9	6.9	7.7	14.9	17.6
Loan provision to Gross loan	10.0	13.5	11.4	9.3	8.5	5.8	4.7	5.1	9.4	9.4
Market share (Top 5)	NA	NA	70	66	61	58	56	52	50	4.5
Herfindahl Index	NA	NA	1141	1066	961	871	838	744	693	600

Source: Bank of Ghana
Notes: All the data are expressed in percentages. NA means not available.

References

Aboagye, A. Q., Akoena, S., Antwi-Asare, T., & Gockel, A. (2008). Explaining the market power of Ghanaian banks. *South African Journal of Economics, 76*, 569-585.

Acquah, P. A. (2006). Evaluating the banking system in Ghana. *BIS Review, 75*.

Acquah, P. A. (2009). Enhancing confidence in the Ghanaian financial system in the midst of the financial crisis. *BIS Review, 60*.

Agoraki, M.-E. K., Delis, M. D., & Pasiouras, F. (2011). Regulations, competition and bank risk-taking in transition countries. *Journal of Financial Stability, 7*(1), 38-48.

Aigner, D., Lovell, C. A. K., & Schmidt, P. (1977). Formulation and estimation of stochastic frontier production function models. *Journal of Econometrics, 6*(1), 21-37.

Al-Sharkas, A. A., Hassan, M. K., & Lawrence, S. (2008). The impact of mergers and acquisitions on the efficiency of the US banking industry: Further evidence. *Journal of Business Finance & Accounting, 35*(1-2), 50-70.

Allen, F., & Gale, D. (2004). Competition and financial stability. *Journal of Money, Credit & Banking, 36*(3), S453(428).

Allen, L., & Rai, A. (1996). Operational efficiency in banking: An international comparison. *Journal of Banking & Finance, 20*(4), 655-672.

Altunbas, Y., Carbo, S., Gardener, E. P. M., & Molyneux, P. (2007). Examining the relationships between capital, risk and efficiency in European banking. *European Financial Management, 13*(1), 49-70.

Altunbas, Y., De Bondt, G., & Marques-Ibanez, D. (2004). Bank capital, bank lending, and monetary policy in the euro area. *Centre for Banking and Financial Studies, School of Accounting , Banking and Economics, University of Wales.*

Altunbaş, Y., Gardener, E. P. M., Molyneux, P., & Moore, B. (2001). Efficiency in European banking. *European Economic Review, 45*(10), 1931-1955.

Altunbas, Y., Liu, M.-H., Molyneux, P., & Seth, R. (2000). Efficiency and risk in Japanese banking. *Journal of Banking & Finance, 24*(10), 1605-1628.

Aly, H. Y., Grabowski, R., Pasurka, C., & Rangan, N. (1990). Technical, scale, and allocative efficiencies in U.S. banking: An empirical investigation. *The Review of Economics and Statistics, 72*(2), 211-218.

Amissah-Arthur, K. B. (2010). Risk management in well-capitalized banks. *BIS Review 92*.

Andersen, P., & Petersen, C. N. (1993). A procedure for ranking efficient units in data envelopment analysis. *Management Science, 39*(10), 1261-1264.

Anderson, T. W., & Hsiao, C. (1982). Formulation and estimation of dynamic models using panel data. *Journal of Econometrics, 18*(1), 47-82.

Angelini, P., & Cetorelli, N. (2003). The effects of regulatory reform on competition in the banking industry. *Journal of Money, Credit & Banking, 35*(5), 663-684.

Anzoategui, D., Peria, M. S. M., & Rocha, R. (2010). Bank competition in the Middle East and Northern Africa Region. *World Bank Policy Research Working Paper, 5363*.

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The Review of Economic Studies, 58*(2), 277-297.

Arellano, M., & Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics, 68*(1), 29-51.

Arestis, P., & Demetriades, P. (1999). Financial liberalization: The experience of developing countries. *Eastern Economic Journal, 25*, 441–457.

Ariff, M., & Can, L. (2008). Cost and profit efficiency of Chinese banks: A non-parametric analysis. *China Economic Review, 19*(2), 260-273.

Ashton, J. K. (2001). Cost efficiency characteristics of British retail banks. *The Service Industries Journal, 21*(2), 159-174.

Ataullah, A., Cockerill, T., & Le, H. (2004). Financial liberalization and bank efficiency: a comparative analysis of India and Pakistan. *Applied Economics, 36*(17), 1915-1924.

Ataullah, A., & Le, H. (2006). Economic reforms and bank efficiency in developing countries: the case of the Indian banking industry. *Applied Financial Economics, 16*(9), 653-663.

Avkiran, N. K. (1999). The evidence on efficiency gains: The role of mergers and the benefits to the public. *Journal of Banking & Finance, 23*(7), 991-1013.

Ayadi, F. O., Adebayo, A. O., & Omolehinwa, E. (1998). Bank performance measurement in a developing economy: An application of data envelopment analysis. *Managerial Finance, 24*(7), 5-5-16.

Aydinli, I. (1996). *Market Structure of the Turkish Banking System: 1991-1994* (in Turkish), Capital Markets Board Publication, No. 40, Ankara.

Baltagi, B. H. (2008, 4th edition). Econometric Analysis of Panel Data, Chichester: John Wiley & Sons Ltd.

Bank of Ghana. (2000). Developments in banks and non-bank financial institutuions. *Bank of Ghana Annual Reports*, Accra, Ghana.

Bank of Ghana. (2004). Developments in banks and non-bank financial institutuions. *Bank of Ghana Annual Reports*, Accra, Ghana.

Bank of Ghana. (2006). Developments in banks and non-bank financial institutuions. *Bank of Ghana Annual Reports*, Accra, Ghana.

Bank of Ghana. (2007a). Developments in banks and non-bank financial institutuions. *Bank of Ghana Annual Reports*, Accra, Ghana.

Bank of Ghana. (2007b). Payments, Clearing and settlements system. *Bank of Ghana Annual Reports*, Accra, Ghana.

Bank of Ghana. (2008). Developments in banks and non-bank financial institutuions. *Bank of Ghana Annual Reports*, Accra, Ghana.

Bank of Ghana. (2009a). Developments in banks and non-bank financial institutuions. *Bank of Ghana Annual Reports*, Accra, Ghana.

Bank of Ghana. (2009b). Payments, Clearing and settlements system. *Bank of Ghana Annual Reports*, Accra, Ghana.

Bank of Ghana. (2010). Payments, Clearing and settlements system. *Bank of Ghana Annual Reports*, Accra, Ghana.

Bank of Ghana. (February 2009). Financial stability report. *Volume 5 no. 1/2009*, Accra, Ghana.

Bank of Ghana. (February 2010). Financial stability report. *Volume 5 no. 5/2010*, Accra, Ghana.

Bank of Ghana. (February 2011). Financial stability report. *Volume 5 no. 1/2011*, Accra, Ghana.

Bank of Ghana. (February 2013). Financial stability report. *Volume 5 no. 1/2013*, Accra, Ghana.

Banker, R. D., Charnes, A., & Cooper, W. W. (1984). Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis. *Management Science, 30*(9), 1078-1092.

Banker, R. D., & Natarajan, R. (2005). Productivity change, technical progress, and relative efficiency change in the public accounting industry, change in the public accounting industry. *Management Science, 51*(2), 291-304.

Banker, R. D., & Natarajan, R. (2008). Evaluating contextual variables affecting productivity using data envelopment analysis. *Operations Research 56*, 48-58.

Barry, A. (2010). *Switching cost hinder bank competition: NAB.* Retrieved(www.abc.net.au/news),

Benston, G. (1965). Branch banking and economis of scale. *Journal of Finance, 20*, 312-331.

Berg, S. A., & Kim, M. (1994). Oligopolistic interdependence and the structure of production in banking: An empirical evaluation. *Journal of Money Credit and Banking, 26*, 309-322.

Berger, A. N. (1993). Distribution-free estimates of efficiency in the U.S. banking industry and tests of the standard distributional assumptions. *Journal of Productivity Analysis 4*, 261-292.

Berger, A. N. (2007). International comparisons of banking efficiency. *Financail Market Institutional Instruments, 16*, 119–144.

Berger, A. N., Bonime, S. D., Covitz, D. M., & Hancock, D. (2000). Why are bank profits so persistent? The roles of product market competition, informational opacity, and regional/macroeconomic shocks. . *Journal of Banking & Finance 24*, 1203–1235.

Berger, A. N., & DeYoung, R. (1997). Problem loans and cost efficiency in commercial banks. *Journal of Banking & Finance, 21*(6), 849-870.

Berger, A. N., & Hannan, T. H. (1998). The efficiency cost of market power in the banking industry: A test of the "Quiet Life" and related hypotheses. *The Review of Economics and Statistics, 80*(3), 454-465.

Berger, A. N., Hanweck, G. A., & Humphrey, D. B. (1987). Competitive viability in baniking scale, scope and product mix economies. *Journal of Monetary Economics, 20*, 501-520.

Berger, A. N., Hasan, I., & Zhou, M. (2006). Bank ownership and efficiency in China: What will happen in the world's largest nation? . *Federal Reserve Board, Mimeo*.

Berger, A. N., & Humphrey, D. B. (1991). The dominance of inefficiencies over scale and product mix economies in banking. *Journal of Monetary Economics, 28*, 117-148.

Berger, A. N., & Humphrey, D. B. (1997). Efficiency of financial institutions: International survey and directions for future research. *European Journal of Operational Research, 98*(2), 175-212.

Berger, A. N., & Mester, L. J. (1997). Inside the black box: What explains differences in the efficiencies of financial institutions? *Journal of Banking & Finance, 21*(7), 895-947.

Berger, A. N., & Udell, G. F. (1995). Relationship lending and lines of credit in small firm finance. *Journal of Business, 68*, 351–381.

Bhattacharyya, A., Lovell, C. A. K., & Sahay, P. (1997). The impact of liberalization on the productive efficiency of Indian commercial banks. *European Journal of Operational Research, 98*(2), 332-345.

Bikker, J. A., & Groeneveld, J. M. (2000). Competition and concentration in the EU banking industry. *Kredit und Kapital, 33*, 62-98.

Bikker, J. A., & Haaf, K. (2002). Competition, concentration and their relationship: An empirical analysis of the banking industry. *Journal of Banking & Finance, 26*(11), 2191-2214.

Bikker, J. A., & Spierdijk, L. (2008). How banking competition changed over time. *Tjalling C.Koopmans Research Institute Discussion Paper Series*, No. 08–04.

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics, 87*(1), 115-143.

Bond, S. R. (2002). Dynamic panel data models: A guide to micro data methods and practice. *Institute for Fiscal Studies Working Paper*, CWP09/02.

Boone, J. (2001). Intensity of competition and the incentive to innovate. *International Journal of Industrial Organization, 19,* 705-726.

Boone, J. (2008). A new way to measure competition. *Economic Journal, 188*, 1245–1261.

Boyd, J. H., & Nicoló, G. D. (2005). The theory of bank risk taking and competition revisited. *The Journal of Finance, 60*(3), 1329-1343.

Bozec, R., & Dia, M. (2007). Board structure and firm technical efficiency: Evidence from Canadian state-owned enterprises. *European Journal Of Operational Research 177*(3), 1734-1750.

Bresnahan, T. F. (1982). The oligopoly solution concept is identified. *Economics Letters, 10*, 87–92.

Buchs, T. D., & Mathisen, J. (2005). Competition and efficiency in banking: Behavioral evidence from Ghana. *IMF Working Paper* No.05/17.

Canhoto, A., & Dermine, J. (2003). A note on banking efficiency in Portugal, New vs. Old banks. *Journal of Banking & Finance, 27*(11), 2087-2098.

Carbó, S., Fernández de Guevara, J., Humphrey, D., & Maudos, J. (2009). Estimating the intensity of price and non-price in banking *Banks and Bank Systems, 4*(2), 4–19.

Carbó, S., Humphrey, D., Maudos, J., & Molyneux, P. (2009). Cross-country comparisons of competition and pricing power in European banking *Journal of International Money and Finance 28*, 115–134.

Carbó, S., Humphrey, D., & Rodriguez, F. (2003). Deregulation, bank competition and regional growth. *Regional Studies, 37*, 227-237.

Carvallo, O., & Kasman, A. (2005). Cost efficiency in the Latin American and Caribbean banking systems. *Journal of International Financial Markets, Institutions and Money, 15*(1), 55-72.

Casu, B., & Girardone, C. (2006). Bank competition, concentration and efficiency in the single European market. *The Manchester School, 74*(4), 441-468.

Casu, B., & Girardone, C. (2009). Testing the relationship between competition and efficiency in banking: A panel data analysis. *Economics Letters, 105*(1), 134-137.

Casu, B., & Molyneux, P. (2003). A comparative study of efficiency in European banking. *Applied Economics, 35*(17), 1865-1876.

Cetorelli, N. (1999). Competitive Analysis in Banking: Appraisal of the Methodologies. *Economic Perspectives 1*, 2–15.

Chang, H., Choy, H. L., Cooper, W. W., & Lin, M. W. (2008). The Sarbanes Oxley Act and the production efficiency of public accounting firms in supplying accounting auditing and consulting services: An application of data envelopment analysis. *International Journal of Services Sciences, 1*(1), 3-20.

Chang, T. C., & Chiu, Y. H. (2006). Affecting factors on risk-adjusted efficiency in Taiwan's banking industry. *Contemporary Economic Policy, 24*(4), 634-648.

Charnes, A., Cooper, W. W., Golany, B., Seiford, L., & Stutz, J. (1985). Foundations of data envelopment analysis for Pareto-Koopmans efficient empirical production functions. *Journal of Econometrics, 30*(1-2), 91-107.

Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research 6*, 429-444.

Charnes, A., Cooper, W. W., Seiford, L., & Stutz, J. (1982). A multiplicative model for efficiency analysis. *Socio-Economic Planning Sciences, 16*(5), 223-224.

Chen, T. (2001). An estimation of X-inefficiency in Taiwan's banks. *Applied Financial Economics, 11*(3), 237-242.

Chen, T., & Yeh, T. L. (1998). A Study of efficiency evaluation in Taiwan's banks. *International Journal of Service Industry Management, 9*(5), 402-415.

Chen, X., Skully, M., & Brown, K. (2005). Banking efficiency in China: Application of DEA to pre- and post-deregulation eras: 1993–2000. *China Economic Review, 16*(3), 229-245.

Christensen, L. R., Jorgenson, D. W., & Lau, L. J. (1973). Transcendental Logarithmic Production Frontiers. *The Review of Economics and Statistics, 55*(1), 28-45.

Claessens, S. (2009). Competition in the financial sector: Overview of competition policies *IMF Working Paper No.09/45*.

Claessens, S., & Laeven, L. (2004). What drives bank competition? Some international evidence. *Journal of Money, Credit & Banking, 36*(3), S563(521).

Coccorese, P. (1998). Assessing the competitive conditions in the Italian banking system: Some empirical evidence. *BNL Quarterly Review, 205*, 173-191.

Coccorese, P. (2004). Banking competition and macroeconomic conditions: a disaggregate analysis. *Journal of International Financial Markets, Institutions and Money, 14*(3), 203-219.

Coelli, T. J., & Perelman, S. (1996). A comparison of parametric and non-parametric distance functions: With application to European railways. *CREPP Discussion Paper*, University of Liege, Liege.

Coelli, T. J., Rao, D. S. P., & Battese, G. E. (1998). An Introduction to Efficiency and Productivity Analysis, Kluwer Academic Publishers, Boston.

Coelli, T. J., Rao, D. S. P., O'Donnell, C. J., & Battese, G. E. (2005). *An introduction to efficiency and productivity analysis*, Second ed. Springer.

Cole, R. A. (1998). The importance of relationships to the availability of credit. *Journal of Banking & Finance, 22*(6-8), 959-977.

Cooper, W., Seiford, L., & Kaoru, T. (2000). Data envelopment analysis; A comprehensive text with models, application, references and DEA-Solver software,. Kluwer Academic Publishers, Boston.

Cox, D. R. (1970). *The Analysis of Binary Data*. Methuen, London

Das, A., & Ghosh, S. (2006). Financial deregulation and efficiency: An empirical analysis of Indian banks during the post reform period. *Review of Financial Economics 15*, 193-221.

Das, A., & Ghosh, S. (2009). Financial deregulation and profit efficiency: A nonparametric analysis of Indian banks. *Journal of Economics and Business, 61*(6), 509-528.

Davidson, R., & MacKinnon, J. G. (2004). *Econometric theory and methods*. Oxford: Oxford University Press.

De Bandt, O., & Davis, E. P. (2000). Competition, contestability and market structure in European banking sectors on the eve of EMU. *Journal of Banking & Finance, 24*(6), 1045-1066.

De Jonghe, O., & Vennet, R. V. (2008). Competition versus efficiency: What drives franchise values in European banking? *Journal of Banking & Finance, 32*(9), 1820-1835.

Debreu, G. (1951). The Coefficient of Resource Utilisation. *Econometrica, 19*, 273-292.

Degryse, H., Kim, M., & Ongena, S. (2009). *Microeconometrics of banking methods, applications and results* New York: Oxford University Press

Delis, M. D., Koutsomanoli-Fillipaki, A., Staikouras, C. K., & Katerina, G. (2009). Evaluating cost and profit efficiency: a comparison of parametric and nonparametric methodologies. *Applied Financial Economics, 19*(3), 191-202.

Delis, M. D., & Pagoulatos, G. (2009). Bank competition, institutional strength and financial reforms in Central and Eastern Europe and EU. *MPRA Paper No. 16494*.

Delis, M. D., & Papanikolaou, N. I. (2009). Determinants of bank efficiency: Evidence from a semi-parametric methodology. *MPRA Paper NO. 13893*.

Delis, M. D., & Tsionas, E. G. (2009). The joint estimation of bank-level market power and efficiency. *Journal of Banking & Finance, 33*(10), 1842-1850.

Demsetz, H. (1973). Industry structure, market rivalry, and public policy. *Journal of Law and Economics, 16*, 1-9.

Denizer, C., Dinc, M., & Tarimcilar, M. (2007). Financial liberalization and banking efficiency: evidence from Turkey. *Journal of Productivity Analysis* 177–195.

Deprins, D., Simar, L., & Tulkens, H. (1984). Measuring labor inefficiency in Post Offices, in Marchand, M., Pestieau, P. and Tulkens, H. (eds.). *The Performance of Public Enterprizes: Concepts and Measurements*, 243-267.

DeYoung, R., & Nolle, D. E. (1996). Foreign-owned banks in the US: buying market share or earning it *Journal of Money, Credit, and Banking 28*, 622-636.

Di Patti, E. B., & Hardy, D. C. (2005). Financial sector liberalization, bank privatization, and efficiency: Evidence from Pakistan. *Journal of Banking & Finance, 29*(8-9), 2381-2406.

Drake, L. (2001). Efficiency and productivity change in UK banking. *Applied Financial Economics, 11*(5), 557-571. doi:10.1080/096031001752236825

Drake, L., Hall, M. J. B., & Simper, R. (2006). The impact of macroeconomic and regulatory factors on bank efficiency: A non-parametric analysis of Hong Kong's banking system. *Journal of Banking & Finance, 30*(5), 1443-1466.

Dyson, R. G., Allen, R., Camanho, A. S., Podinovski, V. V., Sarrico, C. S., & Shale, E. A. (2001). Pitfalls and protocols in DEA. *European Journal of Operational Research, 132*(2), 245-259.

Elsas, R., & Krahnen, J. P. (1998). Is relationship lending special? Evidence from credit-file data in Germany. *Journal of Banking & Finance, 22*(10-11), 1283-1316.

Elyasiani, E., & Goldberg, L. G. (2004). Relationship lending: a survey of the literature. *Journal of Economics and Business 56*, 315–330.

Elyasiani, E., & Mehdian, S. (1990). Efficiency in the commercial banking industry, a production frontier approach. *Applied Economics, v22*(n4), p539(513).

Farrell, M. J. (1957). The measurement of productive efficiency. *Journal of the Royal Statistical Society, 120*, 253–278.

Favero, C. A., & Papi, L. (1995). Technical efficiency and scale efficiency in the Italian banking sector: a non-parametric approach. *Applied Economics, 27*(4), 385-395. doi:10.1080/00036849500000123

Fernandez de Guevara, J., & Maudos, J. (2009). Regional Financial Development and Bank Competition: Effects on Firms' Growth. *MPRA Paper No. 15256*.

Fernández de Guevara, J., & Maudos, J. (2007). Explanatory factors of market power in banking: An application to the Spanish case. . *The Manchester School, 75*(3), 275–296.

Fernández de Guevara, J., & Maudos, J. (2011). Banking competition and economic growth: cross-country evidence. *The European Journal of Finance, 17*(8), 739-764.

Fernández de Guevara, J., Maudos, J., & Pérez, F. (2005). Market power in European banking sectors. *Journal of Financial Services Research, 27*(2), 109-137.

Ferrier, G., & Valdmanis, V. (1996). Rural hospital performance and its correlates. *Journal of Productivity Analysis 7*, 63-80.

Fiordelisi, F., Marques-Ibanez, D., & Molyneux, P. (2011). Efficiency and risk in European banking. *Journal of Banking & Finance, 35*(5), 1315-1326.

Fisher, R. A. (1932). *Statistical methods for research workers*. Edinburgh: Oliver & Boyd.

Forsund, F. R., & Hjalmarsson, L. (1974). On the measurement of productive efficiency *Swedish Journal of Economics 76*, 141-154.

Fries, S., & Taci, A. (2005). Cost efficiency of banks in transition: Evidence from 289 banks in 15 post-communist countries. *Journal of Banking & Finance, 29*(1), 55-81.

Fu, X., & Heffernan, S. (2005). Cost X-efficiency in China's banking sector *Cass Business School Working Papers WP-FF-14-2005*.

Fukuyama, H. (1993). Technical and scale efficiency of Japanese commercial banks: A non-parametric approach. *Applied Economics, 25*, 1101-1112.

Fungáčová, Z., Solanko, L., & Weill, L. (2010). Market power in the Russian banking industry. *BOFIT Discussion Papers*, 3.

Fungáčová, Z., & Weill, L. (2009). How market power influences bank failures: Evidence from Russia. *BOFIT Discussion Paper* No.12/09, Bank of Finland.

Gilbert, R. A., & Wilson, P. W. (1998). Effects of deregulation on the productivity of Korean banks. *Journal of Economics and Business, 50*(2), 133-155.

Giokas, D. I. (2008). Cost efficiency impact of bank branch characteristics and location. *Managerial Finance, 34*, 1-11.

Girardone, C., Molyneux, P., & Gardener, E. P. M. (2004). Analysing the determinants of bank efficiency: the case of Italian banks. *Applied Economics, 36*(3), 215(213).

Goddard, J. A., Molyneux, P., & Wilson, J. O. S. (2001). *European Banking: Efficiency, Technology and Growth* John Wiley & Sons.

Goderis, B., Marsh, I. W., Castelo, J. V., & Wagner, W. (2007). Bank behaviour with access to credit risk transfer markets. *Bank of Finland Research Discussion Paper 4/2007*.

González, F. (2009). Determinants of bank-market structure: Efficiency and political economy variables. *Journal of Money, Credit and Banking, 41*(4), 735-754.

Grabowski, R., Rangan, N., & Rezvanian, R. (1994). The effect of deregulation on the efficiency of U.S. banking firms. *Journal of Economics and Business, 46*(1), 39-54.

Grigorian, D. A., & Manole, V. (2002). Determinants of Commercial Bank Performance in Transition: An Application of Data Envelopment Analysis. *World Bank Policy Research Working Paper 2850.*

Grigorian, D. A., & Manole, V. (2006). Determinants of commercial bank performance in transition: An application of data envelopment analysis. *Comparative Economic Studies, 48*(3), 497.

Gujarati, D. N. (1992). *Basic econometrics* (2nd ed.). Singapore: Mcgraw-Hill Book Company.

Günalp, B., & Çelik, T. (2006). Competition in the Turkish banking industry. *Applied Economics, 38*(11), 1335-1342.

Halkos, G. E., & Tzeremes, N. G. (2009). Exploring the existence of Kuznets curve in countries' environmental efficiency using DEA window analysis. *Ecological Economics, 68,* 2168-2176.

Hall, M. J. B. (2008). The sub-prime crisis, the credit squeeze and Northern Rock: The lessons to be learnt. *Journal of Financial Regulation and Compliance 16*(1), 19-34.

Hancock, D. (1985). The financial firm: production with monetary and nonmonetary goods. *Journal of Political Economy, 93*(5), 859-880.

Hao, J., Hunter, W. C., & Yang, W. K. (2001). Deregulation and efficiency: the case of private Korean banks. *Journal of Economics and Business, 53*(2-3), 237-254.

Havrylchyk, O. (2006). Efficiency of the Polish banking industry: Foreign versus domestic banks. *Journal of Banking & Finance, 30*(7), 1975-1996.

Hayakawa, K. (2009). First-difference of forward orthogonal deviation: which transformationto use in dynamic panel models?: A simulation study. *Economics Bulletin, 29*(3), 2014-2023.

Hempell, H. (2002). Testing for competition among German banks. . *Economic Research Centre, Deutsche Bundesbank,* Discussion Paper 04/02.

Hermes, N., & Nhung, V. T. H. (2010). The impact of financial liberalization on bank efficiency: evidence from Latin America and Asia. *Applied Economics, 42*(26), 3351-3365.

Hicks, J. R. (1935). Annual survey of economic theory: The theory of monopoly. *Econometrica, 3*(1), 1-20.

Hoff, A. (2007). Second stage DEA: Comparison of approaches for modelling the DEA score. *European Journal of Operational Research, 181*(1), 425-435.

Huang, T., Chiang, L., & Chen, K. (2011). An empirical study of bank efficiencies and technology gaps in European banking. *The Manchester School, 79*(4), 839-860.

Hunter, W. C., & Timme, S. G. (1995). Core deposits and physical capital: A reexamination of bank scale economies and efficiency with quasi-fixed inputs. *Journal of Money, Credit and Banking, 27*(1), 165-185.

International Monetary Fund. (1999). Ghana: Selected issues. *IMF Staff Country Report No.99/3*, International Monetary Fund, Washington, D.C.

International Monetary Fund. (2003). Ghana: Selected issues. *IMF Country Report No.03/134*, International Monetary Fund, Washington, D.C.

International Monetary Fund. (2007). Ghana: Selected Issues *IMF Country Report No. 07/208*, International Monetary Fund, Washington, D.C.

International Monetary Fund. (2011). Ghana: Financial system stability assessment update. *IMF Country Report No.11/131*, International Monetary Fund, Washington, D.C.

Isik, I., & Hassan, M. K. (2002). Technical, scale and allocative efficiencies of Turkish banking industry. *Journal of Banking & Finance, 26*(4), 719-766.

Isik, I., & Hassan, M. K. (2003). Efficiency, ownership and market structure, corporate control and governance in the Turkish banking industry. *Journal of Business Finance & Accounting, 30*(9-10), 1363-1421.

Jackson, W. E. (1992). Is the market well-defined in a bank merger and acquistion analysis. *The Review of Economics and Statistics, 74*(4).

Jallab, M. S., Gbakou, M. B. P., & Sandretto, R. (2008). Foreign direct investment, macroeconomic instability and economic growth in MENA countries. *Center National de la Recherche Scientifique - GATE Working paper 2008-17*.

Javorcik, B. S. (2004). Does foreign direct investment increase the productivity of domestic firms? In search of spillovers through backward linkages. *American Economic Review, 94*, 605-627.

Kablan, S. (2010). Banking efficiency and finacial development in Sub-Saharan Africa. *IMF Working Paper WP/10/136*.

Kapur, I., Hadjimichael, M., Hilbers, P., Schiff, J., & Szymczac, P. (1991). Ghana: Adjustment and growth, 1983-1991. *IMF Occasional Paper No. 86*, Washington D.C, International Monetary Fund.

Kasman, A., & Yildirim, C. (2006). Cost and profit efficiencies in transition banking: the case of new EU members. *Applied Economics, 38*(9), 1079-1090.

Koetter, M., Kolari, J. W., & Spierdijk, L. (2008). Efficient competition? Testing the 'Quiet Life' of U.S. banks with Adjusted Lerner indices. Paper presented at the 44th Bank market structure conference, . *Federal Reserve Bank of Chicago*.

Koopmans, T. C. (1951). *An Analysis of Production as an Efficient Combination of Activities, in T. C. Koopmans (ed.), Activity Analysis of Production and Allocation*: Cowles Commission for Research in Economics Monograph 13, New York, Wiley.

Kumbhakar, S. C., & Lovell, C. A. K. (2000). *Stochastic Frontier Analysis*, Cambridge University Press.

Kumbhakar, S. C., & Lozano-Vivas, A. (2004). Does deregulation make markets more competitive? Evidence of mark-ups in Spanish savings banks. *Applied Financial Economics, 14*(7), 507-515. doi:10.1080/0960310042000216060

Kwan, S., & Eisenbeis, R. (1997). Bank risk, capitalization and operating efficiency. *Journal of Financial Services Research 12*, 117–131.

Lau, L. J. (1982). On identifying the degree of competitiveness from industry price and output data. *Economics Letters, 10*, 93–99.

Leightner, J. E., & Lovell, C. A. K. (1998). The impact of financial liberalization on the performance of Thai banks. *Journal of Economics and Business, 50*(2), 115-131.

Lerner, A. P. (1934). The concept of monopoly and the measurement of monopoly power. *Review of Economic Studies 1*, 157–175.

Leuvensteijn, M. v., Bikker, J. A., Rixtel, A. A. R. J. M. v., & Kok-Sørensen, C. (2007). A new approach to measuring competition in the loan markets of the euro area. European Central Bank.

Llewellyn, D. T. (2009). The failure of Northern Rock: A multi-dimensional problem. *SUERF – The European Money and Finance Forum.*

Loukoianova, E. (2008). Analysis of the efficiency and profitability of the Japanese banking system. *IMF Working Paper No. 08/63*.

Lovell, C., Walters, L., & Wood, L. (1994). *Stratified models of education production using modified DEA and regression analysis*. In: Charnes A, Cooper WW, Lewin AY, Seiford LM (eds) Data envelopment analysis: theory, methodology and applications Boston, MA: Kluwer Academic Publishers.

Matthews, K., Murinde, V., & Zhao, T. (2007). Competitive conditions among the major British banks. *Journal of Banking & Finance, 31*(7), 2025-2042.

Maudos, J., & Fernández de Guevara, J. (2004). Factors explaining the interest margin in the banking sectors of the European Union. *Journal of Banking & Finance, 28*(9), 2259-2281.

Maudos, J., & Fernández de Guevara, J. (2007). The cost of market power in banking: Social welfare loss vs. cost inefficiency. *Journal of Banking & Finance, 31*(7), 2103-2125.

Maudos, J., & Nagore, A. (2005). Explaining market power differences in banking: A cross-country study. *WP-EC*, 2005-2010.

Maudos, J., Pastor, J. M., Pérez, F., & Quesada, J. (2002). Cost and profit efficiency in European banks. *Journal of International Financial Markets, Institutions and Money, 12*(1), 33-58.

Maudos, J., & Perez, F. (2003). Comptencia vs poder de mercado en la banca espanola. *Moneda y Credito, 217*, 139-166.

Maudos, J., & Solís, L. (2011). Deregulation, liberalization and consolidation of the Mexican banking system: Effects on competition. *Journal of International Money and Finance 30*, 337–353.

McAllister, P. H., & McManus, D. (1993). Resolving the scale efficiency puzzle in banking. *Journal of Banking & Finance, 17*(2-3), 389-405.

McKinnon, R. I. (1973). *Money and Capital in Economic Development* The Brookings Institution, Washington, DC.

Meeusen, W., & van de Broeck, J. (1977). Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error. *International Economic Review, 18*, 435-444.

Mester, L. J. (1993). Efficiency in the savings and loan industry. *Journal of Banking & Finance, 17*(2-3), 267-286.

Mester, L. J. (1996). A study of bank efficiency taking into account risk-preferences. *Journal of Banking & Finance, 20*(6), 1025-1045.

Miller, S. M., & Noulas, A. G. (1996). The technical efficiency of large bank production. *Journal of Banking & Finance, 20*(3), 495-509.

Mitchell, K., & Onvural, N. M. (1996). Economies of Scale and Scope at Large Commercial Banks: Evidence from the Fourier Flexible Functional Form. *Journal of Money, Credit and Banking, 28*(2), 178-199.

Moffat, B. D., & Valadkhani, A. (2011). Efficiency of Botswana's financial institutions: A data envelopment analysis. *Applied Economics Letters, 18*(7), 697-702.

Molyneux, P., Lloyd-Williams, D. M., & Thornton, J. (1994). Competitive conditions in European banking. *Journal of Banking & Finance, 18*(3), 445-459.

Molyneux, P., Thornton, J., & Llyod-Williams, M. D. (1996). Competition and market contestability in Japanese commercial banking. *Journal of Economics and Business, 48*(1), 33-45.

Mukherjee, K., Ray, S. C., & Miller, S. M. (2001). Productivity growth in large US commercial banks: The initial post-deregulation experience. *Journal of Banking and Finance 25*, 913-939.

Murthy, D. S., Sudha, M., Hegde, M. R., & Dakshinamoorthy, V. (2009). Technical efficiency and its determinants in Tomato production in Karnataka, India: Data Envelopment Analysis (DEA) Approach. *Agricultural Economics Research Review, 22*, 215-224.

Nathan, A., & Neave, E. H. (1989). Competition and contestability in Canada's financial system: Empirical results. *The Canadian Journal of Economics, 22*(3), 576-594.

Noulas, A. G. (1997). Productivity growth in the Hellenic banking industry: state versus private banks *Applied Financial Economics, 7*, 223-228.

Nunamaker, T., R. (1985). Using data envelopment analysis to measure the efficiency of non-profit organisations: A critical evaluation. *Managerial and Decision Economics, 6*, 50-58.

Panzar, J. C., & Rosse, J. N. (1987). Testing for monopoly equilibrium. *The Journal of Industrial Economics, 35*, 443-456.

Parkan, C. (1987). Measuring the efficiency of service operations: An application to bank branches *Engineering Costs and Production Economics, 12*, 237-242.

Pasiouras, F. (2008). Estimating the technical and scale efficiency of Greek commercial banks: the impact of credit risk, off- balance sheet activities, and international operations. . *Research in International Business Finance, 22*(3), 301–318.

Pasiouras, F., Sifodaskalakis, E., & Zopounidis, C. (2007). Estimating and analysing the cost efficiency of Greek cooperative banks: an application of two-stage data envelopment analysis. *Working Paper, School of Management, University of Bath, available at: http://www.bath.ac.uk/management/research/papers.html*

Phillips, P. C. B., & Perron, P. (1988). Testing for a unit root in time series regression *Biometrica, 75*(2), 335-346.

Presbitero, A. F. (2005). The Debt-Growth Nexus: a Dynamic Panel Data Estimation *Università Politecnica delle Marche Department of Economics Working Paper*, No. 243.

Prescott, H., & McCall, A. (1975). Market power and structure and commercial bank instalment lending. *Journal of Money, Credit and Banking, 7*(4), 449-467.

PricewaterhouseCoopers. (2006). *Ghana Banking Survey*. Accra: PricewaterhouseCoopers

PricewaterhouseCoopers. (2009). *Ghana Banking Survey*. Accra: PricewaterhouseCoopers

PricewaterhouseCoopers. (2011). *Ghana Banking Survey*. Accra: PricewaterhouseCoopers

PricewaterhouseCoopers. (2012). *Ghana Banking Survey*. Accra: PricewaterhouseCoopers

Pruteanu-Podpiera, A., Weill, L., & Scobert, F. (2008). Banking competition and efficiency: A micro-data analysis on the Czeac banking industry. *Comparative Economic Studies, 50*, 253-273.

Rangan, N., Grabowski, R., Aly, H. Y., & Pasurka, C. (1988). The technical efficiency of US banks. *Economics Letters, 28*, 169–175.

Ray, S. C., & Das, A. (2010). Distribution of cost and profit efficiency: Evidence from Indian banking. *European Journal of Operational Research, 201*(1), 297-307.

Resti, A. (1997). Evaluating the cost-efficiency of the Italian banking system: What can be learned from the joint application of parametric and non-parametric techniques. *Journal of Banking & Finance, 21*(2), 221-250.

Roodman, D. (2003). XTABOND2: Stata module to extend xtabond dynamic panel data estimator, Statistical Software Components S435901. *Boston College Department of Economics*, revised 22 Apr 2005.

Roodman, D. (2006). How to do xtabond2: An introduction to difference and system GMM in Stata. *Center for Global Development Working Paper* No. 103.

Roodman, D. (2007). A short note on the theme of too many instruments. *Center for Global Development Working Paper*, No. 125.

Roodman, D. (2009). How to do xtabond2: An introduction to difference and system GMM in Stata. *The Stata Journal 9*(1), 86–136.

Roodman, D. (2009). A note on the theme of too many instruments *Oxford Bulletin of Economics and Statistics, 71*(1), 135-158.

Salas, V., & Saurina, J. (2003). Deregulation, market power and risk behaviour in Spanish banks. *European Economic Review, 47*, 1061–1075.

Saranga, H., & Phani, B. V. (2009). Determinants of operational efficiencies in the Indian pharmaceutical industry *International Transactions in Operational Research, 16*, 109-130.

Sargan, J. D. (1958). The estimation of economic relationships suing instrumental variables. *Econometrica, 26*, 393-415.

Sathye, M. (2001). X-efficiency in Australian banking: An empirical investigation. *Journal of Banking & Finance, 25*(3), 613-630.

Sathye, M. (2003). Efficiency of banks in a developing economy: The case of India. *European Journal of Operational Research, 148*(3), 662-671.

Schaeck, K., & Cihák, M. (2008). How does competition affect efficiency and soundness in banking? New empirical evidence. *ECB Working Papers Series*, No. 932.

Schmidt, P., & Sickles, R. C. (1984). Production frontiers and panel data. *Journal of Business & Economic Statistics, 2*(4), 367-374.

Sealey, C., & Lindley, J. (1977). Inputs, outputs and a theory of production and cost of depository financial institutions. *Journal of Finance, 32*, 1251–1266.

Seiford, L. M., & Thrall, R. M. (1990). Recent developments in DEA: The mathematical programming approach to frontier analysis. *Journal of Econometrics, 46*(1-2), 7-38.

Sengupta, J. K. (2000). Efficiency analysis by stochastic data envelopment analysis. *Applied Economics Letters, 7*(6), 379-386.

Sexton, T. R., Silkman, R. H., & Hogan, A. J. (1986). *Data envelopment analysis: critique and extensions, in: R.H. Silkman (Ed.), Measuring Efficiency: An Assessment of Data Envelopment Analysis*. San Fransisco, CA: Jossey-Bass.

Shaffer, S. (1993). A test of competition in Canadian banking. *Journal of Money, Credit and Banking, 25*(1), 49-61.

Shanmugam, K. R., & Das, A. (2004). Efficiency of Indian commercial banks during the reform period. *Applied Financial Economics, 14*(9), 681-686.

Sherman, D., & Gold, F. (1985). Branch operating efficiency: Evaluation with data envelopment analysis. *Journal of Banking & Finance, 9*, 297-315.

Sherman, H. D., & Zhu, J. (2006). Benchmarking with quality-adjusted DEA (Q-DEA) to seek lower-cost high-quality service: Evidence from a U.S. bank application *Annal Operational Research 145*, 301–319.

Simar, L., & Wilson, P. W. (2007). Estimation and inference in two-stage, semi-parametric models of production processes. *Journal of Econometrics, 136*(1), 31-64.

Simpasa, A. (2010). Characterising market power and its determinants in the Zambian banking indudstry. *MPRA Paper*, No. 27232.

Smith, A. C., Koper, N., Francis, C. M., & Fahrig, L. (2009). Confronting collinearity: comparing methods for disentangling the effects of habitat loss and fragmentation *Landscape Ecol 24*, 1271–1285.

Smith, P. (1997). Model misspecification in data envelopment analysis. *Annals of Operations Research, 73*, 233-252.

Smith, R., & Tripe, D. (2001). Competition and contestability in New Zealand's banking system. Paper presented at the 14th Australian Finance and Banking Conference

Soedarmono, W., Machrouh, F., & Tarazi, A. (2011). Bank market power, economic growth and financial stability: Evidence from Asian banks. *Journal of Asian Economics 22 22*, 460–470.

Soteriou, A. C., & Zenios, S. A. (1999). Using data envelopment analysis for costing bank products. *European Journal of Operational Research, 114*(2), 234-248.

Staub, R. B., da Silva e Souza, G., & Tabak, B. M. (2010). Evolution of bank efficiency in Brazil: A DEA approach. *European Journal of Operational Research, 202*(1), 204-213.

Stern, Z. S., Mehrez, A., & Barboy, A. (1994). Academic Departments Efficiency via DEA. *Computers and Operations Research, 21*, 543-556.

Sturm, J., & Williams, B. (2004). Foreign bank entry, deregulation and bank efficiency: Lessons from the Australian experience. *Journal of Banking & Finance, 28*(7), 1775-1799.

Sufian, F., & Habibullah, M. S. (2009). Asian financial crisis and the evolution of Korean banks efficiency: A DEA approach. *Global Economic Review, 38*(4), 335-369.

Sufian, F., & Habibullah, M. S. (2010). Bank-specific, industry-specific and macroeconomic determinants of bank efficiency: Empirical evidence from the Thai banking sector. *Margin: The Journal of Applied Economic Research, 4*(4), 427–461.

Sufian, F., & Majid, M. A. (2007). Bank mergers performance and the determinants of Singapore banks' efficiency. *International Journal of Business, 9*, 19-39.

Sun, L., & Chang, T. (2011). A comprehensive analysis of the effects of risk measures on bank efficiency: Evidence from emerging Asian countries. *Journal of Banking & Finance, 35*(7), 1727-1735.

Sun, Y. (2011). Recent developments in European bank competition *IMF Working Paper No. 11/146*.

Tabak, B. M., Fazio, D. M., & Cajueiro, D. O. (2011). Profit, cost and scale effciency for Latin American banks: Concentration-performance relationship. *Central Bank of Brazil Working Paper No. 244*, 1-37.

Tecles, P. L., & Tabak, B. M. (2010). Determinants of bank efficiency: The case of Brazil. *European Journal of Operational Research, 207*(3), 1587-1598.

TheGlobaleconomy.com. (2013). *Ghana: Non-performing loans*. Retrieved 11 July, 2013, www.theglobaleconomy.com,

Thompson, R. G., Langemeier, L. N., Lee, C. T., Lee, E., & Thrall, R. M. (1990). Thrall, The role of multiplier bounds in efficiency analysis with applications to Kansas farming. *Journal of Econometrics, 46*, 93-108.

Thompson, R. G., Singleton, J., F.D, Thrall, R. M., & Smith, B. A. (1986). Comparative site evaluations for locating a high-energy physics lab in Texas. *Interfaces, 16*(6), 35-49.

Turk-Ariss, R. (2009). Competitive behavior in Middle East and North Africa banking systems. . *Quarterly Review of Economics and Finance 49*, 693–710.

Turk-Ariss, R. (2010). On the implications of market power in banking: Evidence from developing countries. *Journal of Banking & Finance, 34*(4), 765-775.

Vennet, R. V. (2002). Cost and profit efficiency of financial conglomerates and universal banks in Europe. *Journal of Money, Credit and Banking, 34*(1), 254-282.

Vesala, J. (1995). Retail banking in European financial integration. *Journal of Banking & Finance, 20*(8), 1436-1437.

Weill, L. (2003). Banking efficiency in transition economies. *The Economics of Transition, 11*(3), 569-592.

Weill, L. (2004). Measuring cost efficiency in European banking: A comparison of frontier techniques. *Journal of Productivity Analysis, 21*, 133-152.

Wheelock, D. C., & Wilson, P. W. (1999). Technical progress, inefficiency, and productivity change in U.S. banking, 1984-1993. *Journal of Money, Credit and Banking, 31*(2), 212-234.

White, H. J. (1980). A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica, 48*, 817-838.

Williams, J. (2004). Determining management behaviour in European banking. *Journal of Banking & Finance, 28*(10), 2427-2460.

Wilson, J. O. S., Casu, B., Girardone, C., & Molyneux, P. (2010). Emerging themes in banking: Recent literature and directions for future research. *The British Accounting Review 42*, 153–169.

Windmeijer, F. (2005). A finite sample correction for the variance of linear efficient two-step GMM estimators. *Journal of Econometrics, 126*, 25–51.

World Bank. (1988). Financial sector adjustment project. Report and recommendation of the president of IDA to the executive directors. Report No. P4781, World Bank, Washington, DC.

World Bank. (1989). Ghana: Structural adjustment for growth. Report No. 7515-GH, World Bank, Washington, DC.

World Bank. (1994). Ghana financial sector review: Bringing savers and investors together. *Report No. 13423-GH*, 1-37, World Bank, Washington, DC

Yeh, Q. J. (1996). The application of data envelopment analysis in conjunction with financial ratios for bank performance evaluation. *Journal of the Operational Research Society, 47*, 980-988.

Yildirim, C. (2002). Evolution of banking efficiency within an unstable macroeconomic environment: the case of Turkish commercial banks. *Applied Economics, 34*(18), 2289(2213).

Yildirim, H. S., & Philippatos, G. C. (2007). Efficiency of banks: Recent evidence from the transition economies of Europe, 1993–2000. *The European Journal of Finance, 13*(2), 123-143.

Yuan, Y. (2006). The state of competition of the Chinese banking industry. *Journal of Asian Economics 17*, 519–534.

Yue, P. (1992). Data envelopment analysis and commercial bank performance: A primer with applications to Missouri banks. *Federal Reserve Bank of St. Louis Review,, 74*, 31–45.

Zaim, O. (1995). The effect of financial liberalisation on the efficiency of Turkish commercial banks. *Applied Financial Economics, 5*, 257-264.

Zhu, Q., Sarkis, J., & Lai, K. (2007). Green supply chain management: pressures, practices and performance within the Chinese automobile industry. *Journal of Cleaner Production, 15*, 1041-1052.