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The impact of banking regulations on banks' cost and profit efficiency: Cross-country evidence

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Abstract

This paper uses stochastic frontier analysis to provide international evidence on the impact of the regulatory and supervision framework on bank efficiency. Our dataset consists of 2,853 observations from 615 publicly quoted commercial banks operating in 74 countries during the period 2000-2004. We investigate the impact of regulations related to the three pillars of Basel II (i.e. capital adequacy requirements, official supervisory power, and market discipline mechanisms), as well as restrictions on bank activities, on cost and profit efficiency of banks, while controlling for other country-specific characteristics. Our results suggest that banking regulations that enhance market discipline and empower the supervisory power of the authorities increase both cost and profit efficiency of banks. In contrast, stricter capital requirements improve cost efficiency but reduce profit efficiency, while restrictions on bank activities have the opposite effect, reducing cost efficiency but improving profit efficiency.

Keywords: Banking, Efficiency, Regulations, Stochastic frontier analysis

JEL: G21, G28, D2, C24

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1. Introduction

As banks operate in one of the most heavily regulated environments, research in banking regulations and their effect on bank performance and stability has long attracted both theoretical and empirical interest. At the international level, Barth et al (2004a) investigate the effect of a broad range of regulatory and supervisory measures on bank stability, development and performance, while Demirguc-Kunt et al. (2006) and Pasiouras et al. (2006) study the effect of similar measures on banks' overall soundness, as measured by credit ratings. Similarly, other studies have examined the effect of regulations on banking sector crisis (Demirguc-Kunt and Detragiache, 2002; Beck et al., 2006a) and banks' risk taking behaviour (Gonzalez, 2005; Laeven and Levine, 2006). An issue that has received comparatively little attention, however, is what impact the regulatory environment has on bank efficiency, as opposed to other measures of bank performance. This paper seeks to address this issue by offering international evidence on the cost and profit efficiency of banks.

Prior studies in the literature have sought to account for the influence of banking regulations as part of the environmental factors affecting bank efficiency. Dietsch and Lozano-Vivas (2000), for example, highlight the impact of differences in the environmental conditions on banks' cost efficiency, using a sample of Spanish and French banks. Similarly, multi-country studies that examine sources of differences in bank efficiency account for country-specific differences in the economic, financial or technological environments using aggregate measures such as market capitalization, GDP growth, number of banks or ATMs per population, etc. In accounting for regulatory influences, however, these studies have, owing to data limitations, resorted to use of simple proxies such as the degree of market concentration, industry average capital, industry average profitability, and intermediation ratios (e.g. Dietsch and Lozano-Vivas, 2000). Similarly, Grigorian and Manole (2002), in examining bank efficiency differences for the transition countries of Eastern Europe and former Soviet Union, account for the influence of regulatory measures such as capital adequacy ratio, maximum exposure to single borrower and limits on foreign exchange open positions. Furthermore, a few recent studies, also focussing on transition countries, have used the European Bank for Reconstruction and Development (EBRD) index of

banking sector reform among the environmental factors affecting bank efficiency (e.g. Fries and Taci, 2005).¹

Most recently, Pasiouras (2008) tackles the issue at the cross-country level by employing a broad range of regulatory and supervision measures developed by the World Bank (Barth et al, 2001b) to investigate the technical efficiency of banks. Using data envelopment analysis (DEA) and Tobit regressions on a sample of 715 banks operating in 95 countries during 2003, he finds that banks' technical efficiency is positively influenced in some regressions by capital adequacy standards, powerful supervisory agencies and market discipline mechanisms (the latter being significant in all his regressions).

The present paper provides further international evidence in relation to the impact of the regulatory environment by focussing on the cost and profit efficiency of banks. The specific regulations of concern in this paper are related to restrictions on banks' activities and the three pillars of Basel II, namely capital requirements (Pillar 1), official supervisory power (Pillar 2), and market discipline mechanisms (Pillar 3). While around 100 countries have stated their intention to adopt Basel II, there is an ongoing debate about the costs and benefits of the proposed regulatory approaches (Barth et al., 2005). Hence, the importance of our study lies in providing cross-country analysis and evidence relating to some of the enduring questions about the impact of the new regulatory framework for the banking industry.²

While the present study is related to Pasiouras (2008) in studying the impact of regulations on bank efficiency, it is fundamentally different in three respects. The first and probably the most important is that we examine the impact on cost and profit efficiency of banks. Cost efficiency is a wider concept than technical efficiency, since

¹ In addition, there are numerous other studies, focussing on individual countries, which attempt to account for the impact of financial regulation (or deregulation) by using dummy variables in their empirical specifications, while studies for the US have incorporated proxies for differences in state regulations. However, these studies do not explicitly focus on the impact of regulatory policies and, more important, they are country specific. Barth et al. (2005), reflecting on their use of an international database, suggest that while lessons from individual countries provide important implications for the formation of banking policies, information on how different countries regulate banks and what works best (i.e. through empirical studies) is crucial in determining appropriate policy reforms.

² With regard to the practice of bank regulations and what works best, Barth et al. (2004a) quote "... there is no evidence: that any universal set of best practices is appropriate for promoting well-functioning banks; that successful practices in the United States, for example, will succeed in countries with different institutional settings; or that detailed regulations and supervisory practices should be combined to produce an extensive checklist of best practices in which more checks are better than fewer." (p. 206). Acknowledging their viewpoint, our cross-country analysis appropriately focuses on the regulatory framework of Basel II and restrictions on bank activities, attempting to shed light on the impact of these mechanisms on bank efficiency.

it refers to both technical and allocative efficiency. Profit efficiency is an even wider concept as it combines both costs and revenues in the measurement of efficiency.³ Maudos et al. (2002) point out that the estimation of profit efficiency and its comparison to cost efficiency, and international efficiency comparisons are two areas where the available evidence on bank efficiency is very limited. Thus, our study contributes in bridging this gap, while at the same time provides statistical evidence of the association of these two efficiency measures with capital requirements, official supervisory power, market discipline, and restriction on bank activities. Second, we use stochastic frontier analysis (SFA) rather than DEA. The main advantage of SFA over DEA is that it allows us to distinguish between inefficiency and other stochastic shocks in the estimation of efficiency scores (Yildirim and Philippatos, 2007). Finally, our sample is more representative as we use panel data over the period 2000-2004 rather than cross-section data at one point in time (i.e. 2003); it has been argued that efficiency is better studied and modelled with panels (Coelli et al., 2005).⁴

As noted in the introduction, our paper is also related in spirit to recent studies that provide international evidence on the impact of regulations and supervision on banks' performance (e.g. Barth et al., 2002, Demirguc-Kunt et al., 2004). In contrast to these studies, which mainly use financial ratios as indicators of performance, we measure bank efficiency using an efficient frontier technique. Berger and Humphrey (1997) emphasise that efficient frontier approaches are superior when compared to traditional measures of performance (e.g. return on assets, cost/revenue), since they account simultaneously for relevant inputs and outputs of a bank, as well as for

³ Technical efficiency (TE) indicates whether a bank uses the minimum quantity of inputs to produce given quantity of outputs. Allocative efficiency (AE) refers to the ability of a bank to use the optimum mix of inputs given their respective prices. Cost efficiency, which is the product of TE and AE, shows the ability of a bank to provide services without wasting resources as a result of technical or allocative efficiency. More detailed, cost efficiency indicates how close a bank's cost is to what a best practice bank's cost would be for producing the same outputs under the same conditions. Similarly, profit efficiency shows how close a firm is to earning the profit that a best-practice bank would earn under the same conditions. In other words, efficiency measures how close to the minimum cost or maximum profit a banks is, with the minimum and maximum being determined by the best performers in the sample. Maudos et al. (2002) argue: "*Computing profit efficiency, therefore, constitutes a more important source of information for bank management than the partial vision offered by analyzing cost efficiency*" (p. 34).

⁴ The use of panel data over a cross-section provides more degrees of freedom in the estimation of the parameters. Furthermore, and more importantly, the use of panel data accounts for time variations in efficiency given the possibility that managers might learn from previous experience in the production process, thereby indicating that inefficiency effects would change in some persistent pattern over time. Finally, there may be regulatory or environmental factors that affect the performance of banks over time.

differences in the input prices. Furthermore, they offer an overall objective numerical score and ranking that complies with an optimization mechanism.

The rest of the paper is structured as follows. Section 2 provides a brief background discussion on the impact of regulations on bank performance. Section 3 covers the methodological issues and data for our empirical work. Section 4 discusses the empirical results, and Section 5 concludes.

2. Theoretical background and discussion

In this section, we discuss some theoretical and empirical studies that examine the impact of Basel II type regulations on aspects of bank performance such as profitability, efficiency, soundness, and risk-taking. We also examine the theoretical implications and evidence with regard to restrictions on bank activities which, although not part of the new Basel framework, is another feature of efficiency affecting regulation that has traditionally attracted the attention of policy makers and researchers.

As mentioned already, and discussed further below in more detail, bank efficiency measures show how efficient banks are, relative to the best-practice frontier, in transforming their inputs (e.g. deposits) to outputs (e.g. loans). Therefore, capital requirements can affect bank efficiency by influencing: (i) the quantity and quality of lending, (ii) the decision of banks in allocating their asset portfolios, and (iii) the decision of banks regarding their sources of funds (i.e. equity, deposits). For instance, in relation to (i), the theoretical model of Kopecky and VanHoose (2006) predicts that the introduction of binding regulatory capital requirements on a previously unregulated banking system reduces aggregate lending, while loan quality may either improve or worsen. With regard to the latter, Berger and DeYoung (1997) argue that loan quality and efficiency can be related in several ways through the “*bad luck*”, “*bad management*”, “*skimping*” and “*moral hazard*” hypotheses. In relation to (ii), VanHoose (2007) argues that stricter capital standards may influence banks in substituting loans with alternative forms of assets. Obviously, this could influence their cost and profit efficiency, because different asset portfolios will generate different returns, and require different resources to be managed; furthermore, despite potential diversification benefits, there is the question of whether banks can manage efficiently a portfolio of different assets. Finally, in relation to (iii), capital requirements may influence the decisions of banks with regard to the mix of deposits

and equity, which bear different costs for banks. The results of Pasiouras (2008) indicate a positive association between capital requirements and technical efficiency, although this is not statistically significant in all cases. Studies that focus on other aspects of bank behaviour and performance generally indicate that capital requirements increase risk-taking (e.g. Blum, 1999), although that may happen only under specific circumstances (Kendall, 1992). Barth et al. (2004a) find that while stringent capital requirements are associated with fewer non-performing loans, capital stringency is not robustly linked with banking sector stability, development or bank performance (as measured by overhead and margin ratios) when controlling for other supervisory-regulatory policies. Finally, Pasiouras et al. (2006) find a negative relationship between capital requirements and banks' soundness as measured by Fitch ratings.

In theory, there tends to be support for both the *official supervision approach* and the *private monitoring approach* to bank supervision.⁵ The *official supervision approach* argues that official supervisors have the capabilities to avoid market failure by directly overseeing, regulating, and disciplining banks. Consequently, as Beck et al. (2006a) suggest, a powerful supervisor could enhance the corporate governance of banks, reduce corruption in bank lending, and improve the functioning of banks as financial intermediaries. By contrast, the *private monitoring approach* argues that powerful supervision might be related to corruption or other factors that impede bank operations, whereas regulations that promote market discipline through private monitoring from depositors, debt-holders and equity holders, will result in better outcomes for the banking sector. Thus, under the private monitoring empowerment view, we would expect that improved private governance of banks will boost their functioning (Levine, 2005) and consequently their efficiency. However, requirements for increased disclosures can also have a negative impact on efficiency due to direct costs of making additional disclosures, maintaining investor relations departments, additional time and efforts to prepare formal disclosure documents, and the release of sensitive information to competitors (Duarte et al., 2008).

The empirical results in relation to the above two arguments are mixed. Although Barth et al. (2004a) and Levine (2005) provide evidence that only private monitoring has an impact on banks' performance, Pasiouras (2008) finds that official

⁵ Barth et al. (2004a) and Levine (2005) provide discussions of these two approaches.

supervisory power also positively influences banks' technical efficiency in several cases. Beck et al. (2006a) find that empowerment of private monitoring assists efficient corporate finance and has a positive effect on the integrity of bank lending in countries with sound legal institutions. Demirguc-Kunt et al. (2008) show that the reporting of regular and accurate financial data to regulators and market participants results in sounder banks; however Pasiouras et al. (2006) find a negative relationship between credit ratings and disclosure requirements (though this is significant only at the 10% level and not robust across their specifications). Finally, Barth et al. (2004a) indicate that there is no evidence that regulations that foster private monitoring reduce the likelihood of suffering major banking crises. With respect to the power of supervisors, evidence suggests that it is associated with higher levels of non-performing loans (Barth et al., 2002), it can be harmful to bank development (Barth et al., 2003b) and it is also negatively associated with overall bank soundness (Pasiouras et al., 2006).

Finally, Barth et al. (2004a) summarize several theoretical reasons for restricting bank activities as well as alternative reasons for allowing banks to participate in a broad range of activities. For example, as moral hazard encourages riskier behaviour, banks will have greater opportunities to increase risk if allowed to engage in a broader range of activities. On the other hand, fewer regulatory restrictions permit the utilization of economies of scale and scope, whilst also increase the franchise value of banks and result in a more sensible behaviour. Thus, while their argument suggests ambiguous predictions, empirical evidence is relied upon. To this end, Barth et al. (2004a) find a negative association between restrictions on bank activities and banking sector development and stability. Barth et al. (2001a) also confirm that greater regulatory restrictions on bank activities are associated with higher probability of suffering a major banking crisis, as well as lower banking sector efficiency. In contrast, Fernandez and Gonzalez (2005) find that stricter restrictions on bank activities are effective at reducing banking risk, although they argue that this is mitigated by higher information disclosure and auditing requirements. Lower restrictions on bank activities have also been associated with higher credit ratings (Pasiouras et al., 2006), although Pasiouras (2008) finds no significant association with technical efficiency.

3. Methodology and data

3.1. Methodology

We use the Battese and Coelli (1995) model that provides estimates of efficiency in a single-step in which firm effects are directly influenced by a number of variables.⁶ This approach allows us to estimate a global frontier while accounting for cross-country differences.⁷ In its general form, the cost model can be written as follows:⁸

$$\ln C_{i,t} = C(q_{i,t}, p_{i,t}; \beta) + u_{i,t} + v_{i,t}, \quad i = 1, 2, \dots, N; \quad t = 1, 2, \dots, T \quad (1)$$

where: $C_{i,t}$ is the total cost of bank i at time t ; $q_{i,t}$ is a vector of outputs; $p_{i,t}$ denotes a vector of values of input prices associated with a suitable functional form; β is a vector of unknown scalar parameters to be estimated; $v_{i,t}$ s are random errors, assumed to be i.i.d. and have $N(0, \sigma_v^2)$; $u_{i,t}$ s are the non-negative inefficiency effects in the model which are assumed to be independently (but not identically) distributed, such that $u_{i,t}$ is obtained by truncation (at zero) of the $N(m_{i,t}, \sigma_u^2)$ distribution where the mean is defined by:

$$m_{i,t} = z_{i,t} \delta \quad (2)$$

where $z_{i,t}$ is a $(1 \times M)$ vector of observable explanatory variables that influence the inefficiency of bank i at time t ; and δ is an $(M \times 1)$ vector of coefficients to be estimated (which would generally be expected to include an intercept parameter). The parameters of equations (1) and (2) are estimated in one step using maximum likelihood.⁹ The individual bank (in)efficiency scores are calculated from the estimated frontiers as $CE_{kt} = \exp(u_i)$ and $PEF_{kt} = \exp(-u_i)$, the former taking a value

⁶ We use a single-step procedure instead of the two-step method for the following reasons: 1) predicted inefficiencies are only a function of environmental variables if the latter are included into the first step, which makes the second stage unnecessary; and 2) if the environmental variables will not be included in the first stage, one will obtain biased estimators of the parameters of the deterministic part of the frontier, resulting in biased estimators of efficiency as well (see Coelli et al., 2005).

⁷ An advantage of estimating a global frontier, instead of country-specific frontiers, is that it increases the number of available observations. Furthermore, as Berger and Humphrey (1997) argue, “a frontier formed from the complete data set across nations would allow for a better comparison across nations, since the banks in each country would be compared against the same standard” (p. 187-188).

⁸ For brevity of space, we present only the cost function here, noting that, under the alternative profit approach, we simply replace total costs by profit before taxes as the dependent variable and change the sign of the inefficiency term ($-u_{it}$) to estimate profit efficiency.

⁹ See Battese and Coelli (1995) and Coelli et al. (2005), for further details.

between one and infinity and the latter between zero and one. To make our results comparable, however, we calculate the index of cost efficiency as follows: $CEF_{kt} = 1/CE_{kt}$. Hence, in both cases our efficiency scores will be between 0 and 1 with values closer to 1 indicating a higher level of efficiency.

Concerning the specification of the efficiency frontier, we follow the value added approach which suggests using deposits as outputs since they imply the creation of value added. Thus, following Dietsch and Lozano-Vivas (2000), Maudos et al. (2002), and others, we choose the following three outputs: loans (Q_1), other earning assets (Q_2), and total deposits (i.e. customer and interbank) (Q_3). Furthermore, consistent with most previous studies on bank efficiency we select the following three input prices: cost of borrowed funds (P_1), calculated as the ratio of interest expenses to total deposits; cost of physical capital (P_2), calculated by dividing the expenditures on plant and equipment (i.e. overhead expenses net of personnel expenses) by the book value of fixed assets; and cost of labour (P_3), calculated by dividing the personnel expenses by total assets.¹⁰

As mentioned above, in the case of the cost frontier model, the explanatory variable is bank's total cost (TC) calculated as the summation of interest expenses and non-interest expenses. In the case of the profit frontier model, the variable to be explained is the profit before taxes (PBT). As in most previous studies, we estimate an alternative profit frontier that is specified in terms of input prices and output quantities. Berger and Mester (1997) outline a number of cases under which the alternative profit function may be more appropriate than the standard one. Furthermore, based on these arguments, Maudos et al. (2002) and Kasman and Yildirim (2006) point out that in international comparisons across a diverse group of countries and competition levels it seems more appropriate to estimate an alternative rather than a standard profit function.

To account for changes in technology over time, we include year dummies in the frontier.¹¹ Furthermore, in line with Berger and Mester (1997) among others, we use equity (E) to control for differences in risk preferences.¹² Finally, we impose

¹⁰ We use total assets rather than the number of employees due to several missing values for the latter. Our approach is consistent with several previous studies (e.g. Maudos et al., 2002).

¹¹ Estimating our models with a time trend, as an alternative to including year dummies, has no impact on our results. These alternative estimations are available from the authors upon request.

¹² Since a number of banks in the sample exhibit negative profits (i.e. losses), we added a constant value to every bank's profit so as to make them all positive, as it is common in the literature, thus

linear homogeneity restrictions by normalizing the dependent variables and all input prices by the third input price P_3 . As in several recent studies (e.g. Dietsch and Lozano-Vivas, 2000; Fries and Taci, 2005), we use the multi-product translog specification which results in an empirical cost frontier model of the following format:

$$\begin{aligned}
\ln \frac{TC}{P_3} = & \beta_0 + \beta_1 \ln(Q_1) + \beta_2 \ln(Q_2) + \beta_3 \ln(Q_3) + \beta_4 \ln\left(\frac{P_1}{P_3}\right) + \beta_5 \ln\left(\frac{P_2}{P_3}\right) + \beta_6 \frac{1}{2} (\ln(Q_1))^2 \\
& + \beta_7 \ln(Q_1) \ln(Q_2) + \beta_8 \ln(Q_1) \ln(Q_3) + \beta_9 \frac{1}{2} (\ln(Q_2))^2 + \beta_{10} \ln(Q_2) \ln(Q_3) + \beta_{11} \frac{1}{2} (\ln(Q_3))^2 \\
& + \beta_{12} \frac{1}{2} \left(\ln\left(\frac{P_1}{P_3}\right)\right)^2 + \beta_{13} \ln\left(\frac{P_1}{P_3}\right) \ln\left(\frac{P_2}{P_3}\right) + \beta_{14} \frac{1}{2} \left(\ln\left(\frac{P_2}{P_3}\right)\right)^2 + \beta_{15} \ln(Q_1) \ln\left(\frac{P_1}{P_3}\right) \\
& + \beta_{16} \ln(Q_1) \ln\left(\frac{P_2}{P_3}\right) + \beta_{17} \ln(Q_2) \ln\left(\frac{P_1}{P_3}\right) + \beta_{18} \ln(Q_2) \ln\left(\frac{P_2}{P_3}\right) + \beta_{19} \ln(Q_3) \ln\left(\frac{P_1}{P_3}\right) \\
& + \beta_{20} \ln(Q_3) \ln\left(\frac{P_2}{P_3}\right) + \beta_{21} \ln(E) + \beta_{22} \frac{1}{2} (\ln(E))^2 + \beta_{23} \ln(E) \ln(Q_1) + \beta_{24} \ln(E) \ln(Q_2) + \beta_{25} \ln(E) \ln(Q_3) \\
& + \beta_{26} \ln(E) \ln\left(\frac{P_1}{P_3}\right) + \beta_{27} \ln(E) \ln\left(\frac{P_2}{P_3}\right) + \beta_{28} D_{2004} + \beta_{29} D_{2003} + \beta_{30} D_{2002} + \beta_{31} D_{2001} + u_{i,t} + v_{i,t}
\end{aligned} \tag{3}$$

3.1.1 Determinants of inefficiency

To examine the impact of the regulatory variables on (in)efficiency while controlling for other country-specific characteristics, m_{it} in Equation (2) is specified as:

$$\begin{aligned}
m_{it} = & \delta_0 + \delta_1 CAPITRQ + \delta_2 OFFPR + \delta_3 MDISCIP + \delta_4 ACTRS + \delta_5 INFL \\
& + \delta_6 GDPGR + \delta_7 MACGDP + \delta_8 CLAIMS + \delta_9 GOVERN + \delta_{10} FOREIGN \\
& + \delta_{11} CONC + \delta_{12} DEVEL
\end{aligned} \tag{4}$$

where *CAPITRQ*, *OFFPR*, *MDISCIP* and *ACTRS* are the four regulatory variables; *INFL* and *GDPGR* control for the macroeconomic environment; *MACGDP* and *CLAIMS* are controls for financial development; *CONC*, *FOREIGN*, *GOVERN* are controls for market structure; and *DEVEL* is a dummy variable to control for the state of economic development. These control variables are discussed briefly below, while further information about the regulatory variables is provided in Appendix A.

allowing natural logarithms to be taken. We followed the same approach for equity as we had a small number of banks with negative equity values (see, e.g. Yildirim and Philippatos, 2007).

CAPITRQ is an index of capital requirements, accounting for both initial and overall capital stringency. The former indicates whether the sources of funds counted as regulatory capital can include assets other than cash or government securities and borrowed funds, as well as whether the regulatory or supervisory authorities verify these sources. The latter indicates whether risk elements and value losses are considered while calculating the regulatory capital. *CAPITRQ* can take values between 0 and 8 with higher values indicating more stringent capital requirements.¹³

OFFPR is a measure of the power of the supervisory agencies. It is calculated on the basis of the answers to 14 questions indicating the extent to which supervisors can change the internal organizational structure of the bank and/or take specific disciplinary action against bank management and directors, shareholders, and bank auditors.

MDISCIP is an indicator of market discipline that takes values between 0 and 8 with higher values indicating higher disclosure requirements and more incentives to increase private monitoring. For example, *MDISCIP* indicates among others whether subordinated debt is allowable or required as part of capital, whether banks must disclose their off-balance sheet items and their risk management procedures to the public, whether accrued, though unpaid interest/principal enter the income statement while loan is non-performing, and whether there is an explicit deposit insurance protection system.

ACTRS indicates the level of restrictions on banks' activities. It can take values between 0 and 4 with higher values indicating higher restrictions. It is determined by considering whether securities, insurance, real estate activities, and ownership of non-financial firms is unrestricted (=1), permitted (=2), restricted (=3) or prohibited (=4). We construct an overall index by calculating the average value over all four activities.

¹³ For the construction of the capital requirements (*CAPITRQ*), power of supervisory agencies (*OFFPR*) and market discipline (*MDISC*) indices, we use the summation of the 0/1 quantified answers as in Barth et al. (2001b), Fernandez and Gonzalez (2005), Pasiouras et al. (2006) and Pasiouras (2008). An alternative would be to use the principal component approach as in Levine (2005b). Barth et al. (2004a) have followed both approaches. They mention that the drawback of using the summation for the construction of the index is that it assigns equal weight to each of the questions, whereas the first principal component has the disadvantage of being less transparent in how a change in the response to a question changes the index. They confirm “*all this paper’s conclusions using both methods*” (p. 218), implying that there are no significant differences in the results, although they report only the results using the principal component method.

INFL is the annual inflation rate, and *GDPGR* is the real GDP growth. Both of these are used to control for the macroeconomic environment, as in Maudos et al. (2002), Kasman and Yildirim (2006) and Pasiouras (2008). *CLAIMS* is the ratio of bank claims to the private sector to GDP, which serves as an indicator of activity in the banking sector, while *MACGDP* is a measure of stock market size, calculated as the ratio of stock market capitalization to GDP. Same or similar measures have been used in other studies (e.g. Barth et al., 2003a, Kasman and Yildirim, 2006; Pasiouras, 2008). Also, following previous studies that focus on banks' performance (Barth et al., 2004a; Fries and Taci, 2005; Pasiouras, 2008), we control for cross-country differences in the national structure and competitive conditions of the banking sector, using the following measures: (i) the percentage of foreign-owned banks operating in the market, *FOREIGN*; (ii) the percentage government-owned banks operating in the market, *GOVERN*; and (iii) the percentage of assets held by the three largest commercial banks relative to the total assets of the commercial banking sector within the country, *CONC*. Finally, *DEVEL* is a dummy variable that takes the value one for developed countries and zero for developing countries.

3.2 Data

We construct our sample by considering all the publicly quoted commercial banks in the Bankscope database, giving a total of 1,008 banks from 113 countries.¹⁴ We exclude: (i) banks from countries not included in the World Bank (WB) database on regulations and supervision (Barth et al., 2001b, 2006); (ii) banks for which other country-specific variables are not available; (iii) bank-year observations for which at least one of the bank-specific variables is zero or missing. Our final sample consists of 615 banks from 74 countries, for which complete data for at least one year are available between 2000 and 2004. This results in an unbalanced dataset of 2,853 bank-year observations.

All bank-specific data were obtained from Bankscope and were converted to US dollars. Furthermore, we expressed the data in real (1995) terms using individual country GDP deflators. Data for country-specific variables were collected from the

¹⁴ We focus on publicly quoted banks because, as mentioned in Laeven and Levine (2006), it enhances comparability across countries. Furthermore, focusing on commercial banks allows us to examine a more homogenous sample in terms of services, and consequently inputs and outputs. Finally, it is more appropriate to use the sample for this type of banks since, as mentioned in Demirguc-Kunt et al. (2004), the regulatory data of the WB database are for commercial banks.

WB databases, the Global Market Information Database (GMID) and the International Monetary Fund (IMF). Specifically, data for the regulatory and supervisory variables (*CAPITRQ*, *OFFPR*, *MDISCIP*, *ACTRS*) and two market structure variables (*FOREIGN*, *GOVERN*) were obtained from the Barth et al. (2001b, 2006) WB database¹⁵, for *CONC* from the updated version of the WB database on financial development and structure (Beck et al., 2006b). Data for the indicators of macroeconomic (*GDPGR*, *INFL*) and financial development (*CLAIMS*, *MACGDP*) were obtained from GMID. Finally, information for the classification of the countries as developed or developing was obtained from the IMF. Tables 1 and 2 present the mean values for bank-specific and country-specific variables respectively.

[Insert Tables 1 and 2 Around Here]

4. Empirical results

4.1. Efficiency scores

Table 3 presents the estimates of the efficiency scores for the cost and profit frontier models, showing the results by year (Panel A) and geographical region (Panel B).

[Insert Table 3 Around Here]

The full sample overall mean cost efficiency score equals 0.8789, while that of profit efficiency is 0.7679. Thus, the average bank could reduce its costs by 12.11%, and improve its profits by 23.21% to match its performance with the most efficient bank. Thus the results show that, on average, banks experienced much higher profit inefficiency than cost inefficiency, confirming the findings of previous studies (e.g. Maudos et al., 2002; Yildirim and Philippatos, 2007).

¹⁵ The WB database on regulations and supervision is not available on an annual basis. The 2001 database (Barth et al., 2001b) describes the regulatory environment for the 1998-2000 period (1999 for most countries) while the 2003 database (Barth et al., 2006) describes the regulatory environment at the end of 2002. Therefore, we used information from the 2001 database for bank observations for 2000, and from the 2003 database for bank observations for the period 2001-2004. Whilst acknowledging this limitation, we note that other studies using these data across a number of years have followed a similar approach (e.g. Demirguc-Kunt and Detragiache, 2002; Demirguc-Kunt et al., 2004; Fernandez and Gonzalez, 2005).

Furthermore, as in Guevara and Maudos (2002), Berger and Mester (1997) and Rogers (1998) among others, we observe that the most cost efficient banks are not necessarily the most profit efficient and vice versa.¹⁶ Specifically, over the estimation period, banks had become, on average, more profit efficient but less cost efficient, since the efficiency scores for cost decreased each successive year from 0.8899 in 2000 to 0.8685 in 2004, while those for profit increased from 0.7592 to 0.7842 over the same period. Furthermore, our results reveal that geographical regions with the most cost efficient banks are also not the most profit efficient.¹⁷ This observation that cost efficient banks are not necessarily profit efficient is further confirmed by a correlation analysis of the cost and profit efficiency scores, yielding a low Pearson's coefficient of 0.075. As further evidence of confirmation that profit and cost efficiency do not move in tandem, we also calculated, as in Rogers (1998), the correlation coefficient of bank rankings rather than their efficiency scores, yielding a Spearman's rho of 0.019. One explanation for the differences in the results of cost and profit efficiency, as pointed out by Rogers (1998), is that profit efficiency is more likely driven by revenues rather than costs. Consequently, we support the argument of Guevara and Maudos (2002) that analysis of cost efficiency alone would offer only a partial view of bank efficiency and it is important to analyse profit efficiency as well.

4.2. Determinants of inefficiency

Table 4 shows the estimation results of the influence of country-specific variables on bank inefficiency. Comparing the results of cost and profit efficiency, as shown in columns 1 and 2 respectively, we observe both similarities and differences in the effects of the regulatory and environmental variables on cost and profit inefficiency.

[Insert Table 4 Around Here]

¹⁶ Guevara and Maudos (2002), investigating cost and profit efficiency in EU-15, find the "other bank institutions" group as the most cost efficient but also the most profit inefficient. Similarly, Berger and Mester (1997) and Rogers (1998) show that profit efficiency of US banks is not strongly correlated with cost efficiency.

¹⁷ Of the seven regions, North America has the most cost efficient banking system (0.9407), followed by Australasia (0.9178), while Eastern Europe (0.8389) and Latin America and Caribbean (0.8181) show the lowest scores. By contrast, the two most profit efficient banking regions are Asia Pacific (0.8201) and Africa and Middle East (0.8010), while Latin America and Caribbean (0.5987) and North America (0.6433) are the least profit efficient.

With regard to the impact of the regulatory variables, the results show that *OFFPR* and *MDISCIP* have a statistically significant and negative impact on both cost and profit inefficiency. The negative effect on inefficiency essentially implies that higher supervisory power and market discipline increase the cost and profit efficiency of banks, and is consistent with the findings of Pasiouras (2008) on technical efficiency. This evidence lends support to the argument of the *official supervision approach*, which suggests that powerful supervision can improve the corporate governance of banks, reduce corruption, and improve their functioning (Stigler, 1971; Beck et al., 2006a). Furthermore, it provides support for the *private monitoring approach* (i.e. market discipline) to supervision, which suggests that requirements related to disclosure of accurate information to the public will allow private agents to mitigate asymmetric information and transaction costs and monitor banks more effectively (Hay and Shleifer, 1998). Beck et al. (2006a) also argue that when market discipline is enhanced, the corruption of bank officials will be less of a constraint on corporate finance. Consequently, improved private governance of banks boosts their functioning (Levine, 2005), and potentially lead to higher cost and profit efficiency.¹⁸

CAPITRQ also has a statistically significant and negative impact on cost inefficiency, implying that higher capital requirements increase the cost efficiency of banks. On the other hand, the positive and statistically significant impact on profit inefficiency suggests that higher requirements lower profit efficiency. The increase in cost efficiency could be explained by two reasons. First, as suggested by Berger and Bonaccorsi di Patti (2006), higher capital requirements may result in higher levels of bank capital, lowering the probability of financial distress and thus reducing risk premia on otherwise potentially costly risk management activities. Second, higher capital requirements increase the cost of raising bank capital, however this may be offset by the fact that capital does not bear interest payments (Berger and Mester, 1997). The reduction in profit efficiency may be due to the fact that banks substitute

¹⁸ While these two approaches of supervision might reflect different attitudes towards the role of the authorities in monitoring banks, as Levine (2005) points out, they are not necessarily mutually exclusive, and countries could adopt regulations that enhance both the disclosure of accurate information and the creation of powerful supervisors. Under this combined approach, as argued by Fernandez and Gonzalez (2005), a greater quality of information provided by a system that enhances private monitoring through accounting and auditing requirements might boost supervisors' abilities to intervene in managerial decisions in the right way and at the right time.

loans with other forms of financial assets to meet stricter capital standards (VanHoose, 2007). To the extent that banks switch towards less risky assets, the risk-return hypothesis suggests lower profit efficiency.

The effect of ACTRS, representing restrictions on banking activity, is opposite to that of CAPITRQ, indicating that higher (lower) restrictions lead to lower (higher) cost efficiency and higher (lower) profit efficiency. This is consistent with the view that less regulatory control allows banks to engage in a diverse set of activities and consolidate on scale and scope economies. However, exploitation of cost efficiencies may not translate to higher profit efficiency because banks may systematically fail to manage their diverse activities, and hence experience lower profitability (Barth et al., 2003a). On the other hand, banks may trade-off cost inefficiencies associated with higher restrictions by potentially acquiring greater expertise and specialization in specific market segments, and hence become more profit efficient.

Turning to the impact of the environmental control variables, it appears that most results are in line with expectations. Higher inflation increases costs and reduces profits, and thus inflation has a statistically significant and positive impact on cost and profit inefficiency, as found by Kasman and Yildirim (2006). A negative effect of GDPGR on profit inefficiency, coupled with its positive (but insignificant) impact on cost inefficiency, is partially consistent with the findings of Maudos et al. (2002) who report that banks in expanding markets present higher levels of profit efficiency; however, under such expansive demand conditions, they are less inclined to control expenditure and therefore become less cost efficient. Financial development, as measured by activity in the banking sector (CLAIMS) influences positively both cost and profit efficiency; and while stock market development (MACGDP) affects cost efficiency positively, its effect on profit efficiency is negative. These findings are consistent with the view that, as financial and stock markets develop, improved information availability increases the potential pool of borrowers, making it easier for banks to identify and monitor them (Demirguc-Kunt and Huizinga, 1999), leading to improved cost efficiency. On the other hand, in well-developed stock markets, firms tend to rely more on equity rather than bank finance (Demirguc-Kunt and Huizinga, 1999), which could potentially reduce bank revenue and lower profit efficiency. Considering that profits are driven more by revenues rather than costs (Rogers, 1998), it is not surprising that financial development has a more pronounced and varying effect on profit efficiency.

Concerning the effect of other environmental variables, we find that higher concentration (CONC) improves both cost and profit efficiency, suggesting that banks in more concentrated markets are able to extract higher interest margins by offering lower deposit rates and higher loan rates. A higher share of government owned banks (GOVERN) contributes to higher cost efficiency but lower profit efficiency. In a sense, the former is associated with the view that government-owned banks contribute to economic development and welfare improvement (Stiglitz, 1994), while the latter is consistent with the view that government ownership contribute to financial repression with negative consequences for the economy (Barth et al., 2001a). The nominal but statistically significant impact of the presence of foreign banks (FOREIGN) suggests that a higher proportion of foreign banks has a positive impact on cost efficiency. Finally, the significance of the dummy variable DEVEL suggests that banks in developed countries are in a better position to achieve higher cost efficiency, whereas banks in developing countries are prone to greater profit efficiency. In general, with better access to state-of-the art technology that helps reduce screening and monitoring costs, banks in developed countries are able to attain higher cost efficiency. However, banks in developing countries are traditionally in a position to earn higher margins.

5. Conclusions

This paper presents international evidence on the impact of banking regulations on the cost and profit efficiency of banks, complementing the study of Pasiouras (2008) who investigates the impact of regulations on banks' technical efficiency. Our sample consists of a panel dataset of 2,853 observations from 615 publicly listed commercial banks operating in 74 countries, covering the period 2000-2004. Considering the conflicting theoretical views in the literature, the arguments on what regulations work best (Barth et al, 2005, 2006), and the on-going debate regarding the costs and benefits of Basel II, we focused on banking regulations related to the three pillars of Basel II (capital requirements, official supervisory power and market discipline) and restrictions on bank activities.

We modelled bank efficiency using a global best-practice frontier, which not only increases the number of available observations but also allows one to compare banks across countries against the same standard (Berger and Humphrey, 1997). We used the Battese and Coelli (1995) model which provides estimation of efficiency scores where firm level effects are influenced directly by other variables. Using this

approach, we compared banks' cost and profit efficiency levels, and simultaneously investigated their response to cross-country differences in banking regulations, while controlling for country-level environmental characteristics such as market structure, financial and overall economic development, and macroeconomic conditions.

Our results indicate that while cost efficient banks were not necessarily profit efficient, both cost and profit efficiency were influenced positively by higher official supervisory power and the requirements for disclosures and incentives that enhance market discipline. Related to the second and third pillars of Basel II, these approaches to regulation and supervision are not necessarily mutually exclusive, and therefore may explain the similarity in their effects. On the one hand, greater market discipline associated with accurate and timely disclosures could help private agents to monitor banks effectively and allow powerful supervisors to intervene if necessary. On the other hand, powerful supervisors can enforce conditions on accurate and timely disclosure that facilitates proper monitoring by private agents, thus enhancing market discipline. Stricter capital requirements, related to the first pillar of Basel II, had a positive impact on cost efficiency but a negative impact on profit efficiency. A possible explanation for the positive cost efficiency effect is that higher capital requirements reduce the likelihood of financial distress and thus lower the need for costly risk management activities, whereas the lower profit efficiency could be associated with a balance sheet tilt towards more liquid, lower return assets. We observed the opposite result with regard to restrictions on bank activities, having a negative effect on cost efficiency and a positive effect on profit efficiency. This suggests a potential trade-off where banks sacrifice cost efficiencies from not being able to engage in a diverse set of activities, but exploit opportunities for greater profit efficiency instead.

Although the above findings suggest that regulations empowering official supervisory power and market discipline mechanisms enhance banking efficiency, the literature also suggests that financial deregulation increases the degree of competition in the market, which thereby induce banks managers to undertake imprudent risks (e.g. Keeley, 1990).¹⁹ Hence, regulations must take account of the interactions between competition, efficiency, and financial stability. The recurrent episodes of late

¹⁹According to the "moral hazard" hypothesis, undercapitalized banks will increase their risk taking. Although this does not establish a direct link between risk and efficiency, Berger and DeYoung (1997) suggest that it could magnify the effects of the "bad luck", "bad management" and "skimping" hypotheses and affect efficiency.

20th century financial crises associated with financial liberalization motivated a number of researchers to investigate the link between regulations and the risk-taking incentives of banks. Empirical research has revealed that greater protection offered by a country's bank safety net (e.g. deposit insurance, bail outs, etc.) increases the risk of bank instability (Demirgic-Kunt and Detragiache, 2002) and that prudential bank regulation should focus on the importance of subjecting some bank liabilities to the risk of loss to promote discipline and limit risk taking (Barth et al, 2006). However, as Allen and Gale (2004) point out, the costs of financial crises occur infrequently, despite the losses being large and visible, while the costs of inefficiency are continuous. They argue that as regulation interacts dynamically with pervasive information asymmetries, the relationship between competition and stability is complex and multi-faced. Beck (2008) argues that while stability is inherently important the primary concern of policy makers should be on a regulatory framework to support a competitive and efficient financial market that will allocate savings to their best possible use and support real markets. Furthermore, the literature suggests a direct link between inefficiency and the risk of bank failure (Wheelock and Wilson, 2000), and between inefficiency and problem loans, the latter being associated with adverse selection problems (Berger and DeYoung, 1997). Seen in the above context, our study highlights the importance of designing an appropriate bank regulatory and supervisory framework that helps maintain the efficiency (and hopefully stability) of banks.

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