Regulations, supervision and banks' cost and profit efficiency around the world: a stochastic frontier approach

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Regulations, supervision and banks' cost and profit efficiency around the world: a stochastic frontier approach

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Abstract

This paper uses stochastic frontier analysis and Tobit regressions to provide international evidence on the impact of regulatory, supervision and environmental factors on bank efficiency. Our contribution is twofold. First, we use a newly constructed database of 3,086 observations from 677 publicly quoted commercial banks operating in 88 countries to provide cross-country evidence on the determinants of banks' cost and profit efficiency during the period 2000-2004. Second, we utilise the new database of the World Bank (WB), developed by Barth et al. (2004b), to investigate the impact of a broad range of regulatory and supervision measures, including capital requirements, restrictions on bank activities, private monitoring, official supervisory power of the authorities, and deposit insurance. Our results suggest a robust association of some of these measures with bank efficiency, despite being marginal in their impact compared to the influence of bank level capitalisation. We also reveal, in this context, some similarities and differences in the determinants of cost and profit efficiency, with plausible effects of the impact of the conditioning environmental factors on bank efficiency.

Keywords: Banking, Efficiency, Regulations, Stochastic frontier analysis, Supervision, Tobit

JEL: G21, G28, D2, C24

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1. Introduction

A number of studies have recently made use of available cross-country database constructed by Barth et al (2001a, 2004b) to provide international evidence on the impact of regulations and supervision of banks on their performance, stability and risk-taking behaviour. For example, Barth et al. (2002) examined the impact of the structure of bank supervision on various financial ratios. Barth et al. (2003a), Demirguc-Kunt et al. (2004) and Levine (2004) studied the impact of regulations on performance using profit, net interest margin and overhead ratios. Furthermore, Barth et al. (2004a), investigate the impact of a broad range of regulation and supervision measures on bank stability, development and performance. Demirguc-Kunt et al. (2006) and Pasiouras et al. (2006) examine the effect of regulations on banks' overall soundness, as measured by credit ratings. Demirguc-Kunt and Detragiache (2002) and Beck et al. (2006a) study the impact of regulations on banking sector crisis, while Gonzalez (2005) and Laeven and Levine (2006) examine their impact on banks' risk taking behaviour.

We build on this strand of the literature, but study the impact of the regulatory environment on banks' cost and profit efficiency, using efficient frontiers rather than financial ratios measuring performance[1]. The importance of specifying environmental variables while studying efficiency in the banking industry has been recognized in the literature (Dietsch and Lozano-Vivas, 2000; Cavallo and Rossi, 2002; Lozano-Vivas et al., 2002), and most of the studies that use cross-country data account for some measures of the environment in which banks operate, such as market capitalization, GDP growth, total assets of the banking system, income per capita, etc. However,

[1] Berger and Humphrey (1997) and Bauer et al. (1998) emphasise that efficient frontier approaches seem to be superior compared to the use of traditional financial ratios from accounting statements - such as return on assets (ROA) or the cost/revenue ratio – in terms of measuring performance. Berger and Humphrey (1997) also point out that the frontier approaches offer an overall objective numerical score and ranking, an efficiency proxy to comply with the economic optimization mechanism.

with regard to the regulatory aspects of the environment the empirical literature on bank efficiency so far has been constrained, owing to data limitations, to investigation of the use of simple measures such as the degree of market concentration, industry average capital, industry average profitability and intermediation ratios (e.g. Pastor et al., 1997; Dietsch and Lozano-Vivas, 2000; Lozano-Vivas et al., 2002; Carvallo and Kasman, 2005; Kasman and Yildirim, 2006). Dietsch and Lozano-Vivas (2000), Weill (2004) and Pasiouras (2007) summarise the existing literature on cross-country comparisons of banking efficiency.

Pasiouras (2007) takes the first step, to our knowledge, in extending the above literature by investigating the impact of a broad range of regulatory and supervision measures on banks' technical efficiency, using data envelopment analysis (DEA) on a sample of 715 banks operating in 95 countries during 2003. In this paper, by contrast, we concentrate in estimating cost and profit efficiency[2] of banks using stochastic frontier analysis (SFA). The main advantage of SFA over DEA is that it allows for uncertainty in the estimation of efficiency scores[3]. Furthermore, 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 (Baltagi and Griffin, 1988; Cornwell et al., 1990; Kumbhakar, 1993; Carbo et al., 2002), not least because the use of panel data over a cross-section provides more degrees of freedom in the estimation of the parameters. More importantly, the use of

[2]Cost efficiency is a wider concept than technical efficiency, since 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. Maudos et al. (2002) argue that "*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).

[3]Stochastic frontiers are estimated from parametric approaches that allow us to distinguish between inefficiency and other stochastic shocks, and therefore can be considered superior to non-parametric techniques (Yildirim and Philippatos, 2006), although they are not without criticisms since they require a particular function form to be estimated as well as assumptions about the distribution of efficiency. However, studies that compare different functions and models estimated under different assumptions point out that the results are not significantly different (e.g. Berger and Mester, 1997; Bauer et al, 1998; Vander Vennet, 2002).

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 (Coelli et al., 1999). Furthermore, there may be regulatory or environmental factors that affect the performance of banks over time. Thus, combining the use of SFA with panel data estimation, we attempt to identify the impact of the regulatory environment on banks' cost and profit efficiency. Maudos and Pastor (2001) and Maudos et al. (2002) point out that 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. Our study contributes in filling this gap, while at the same time provides statistical evidence of the association of these two efficiency measures with the regulation and supervision approaches around the world, using a cross-country dataset of 677 publicly quoted commercial banks representing 88 countries.

We employ a two-stage estimation procedure as in Hao et al. (2001), Carbo et al. (2002), Maudos et al. (2002), Weill (2003), Rao (2005), Bos and Kool (2006), Yildirim and Philippatos (2006) among others. In the first stage, SFA is used on the banks' financial information to obtain cost and profit efficiency scores. In the second stage, we use this information with other bank and country level data to estimate Tobit regressions in order to assess the impact of regulatory and environmental measures on efficiency.

The broad range of regulatory variables that we use in Tobit regressions are obtained from the Barth (2004b) database and are related to bank regulatory and supervision measures such as capital adequacy requirements, private monitoring, official disciplinary power of the authorities, diversification restrictions on banking activities, and deposit insurance schemes[4]. In assessing the impact of these measures, we control for bank size and bank capital, and check for robustness by adding country level environmental variables, replacing them as appropriate to account separately for cross-country differences in macroeconomic conditions, financial development, market structure, overall institutional development and access to banking services.

The results generally indicate that there are similarities and differences in the impact of regulatory, supervision and environmental measures on cost and profit efficiency. In particular, we find that diversification restrictions on banks' activities have a negative and statistically significant impact on both cost and profit efficiency. Furthermore, cost, but not profit, efficiency is influenced positively by capital adequacy requirements, and negatively by supervision measures related to private monitoring (i.e. information disclosure) and the official power of the authorities. The order of magnitude of these influences is small in relation to the impact of bank level capitalization, which contributes to cost inefficiency by about 25-35% and profit inefficiency by 0-2% across all our specifications. The impact of bank size is also relatively small and its significance is affected by the inclusion of other environmental variables. Overall, apart from deposit insurance, the impact of the regulatory related variables is robust to changes in the environmental conditions, some of which also have plausible effects on bank efficiency.

The rest of the paper is structured as follows. Section 2 provides a background discussion associating our study with the recent literature focussing on the impact of regulations in banking, as briefed in the introductory paragraph. Section 3 covers the methodological issues and data for our empirical work. Section 4 discusses the empirical results, and Section 5 concludes.

[4] The WB database on bank regulations was originally constructed by Barth et al. (2001a) and the data were available from 1999. It was updated in early 2004 with data from 2003 (henceforth referred to as Barth et al., 2004b).

2. Background discussion

The banking crises around the world over the last thirty years along with evidence that economic growth is related to the development of the financial sector have attracted the attention of policy makers on the construction of an appropriate regulatory and supervision framework (Levine, 1997, 2005; Barth et al. 2003a, 2004a). At an international level, the best known examples are the 1988 Capital Accord (or Basel I) and the new capital adequacy framework (Basel II) of the Basel Committee on Banking Supervision. While the basic element of the 1988 Capital Accord was to maintain a minimum capital ratio, which can account for risk-weighted assets and off-balance sheet exposures, the new framework emphasizes two additional elements, supervision by the authorities (Pillar 2) and market discipline (Pillar 3).

While many countries are in the process of upgrading their bank regulation and supervision approaches, this is a complex and difficult process because there is no clear answer on what exactly is good regulation and supervision (Demirguc-Kunt et al., 2006) or on how specific regulations affect the performance and stability of the banking sector. More precisely, Barth et al. (2004a) point out that economic theory provides conflicting predictions about the effect of regulations and supervisory practices on bank development, performance and stability, while it also makes subtle predictions about the precise conditions under which regulations and supervisory practices will achieve the desired outcomes. At the same time, only very recently have researchers conducted international comparisons of bank supervision and regulation (Barth et al., 2003b). Hence, cross-country empirical evidence is rather limited on which of the many different regulations and supervisory practices adopted around the world promote bank development and stability (Barth et al., 2004a), and we attempt to provide such evidence associating their effect on banking sector efficiency.

The traditional view of the impact of bank regulation is that higher capital requirements will have a positive effect on the banking sector, although the literature suggests that this is not always the case. Some studies indicate that capital requirements increase risk-taking behaviour (e.g. Koehn and Santomero, 1980; Besanko and Kanatas, 1996; Blum, 1999; Calem and Rob, 1999), while others argue that this happens only under specific circumstances (Kendall, 1992; Beatty and Gron, 2001; Fernandez and Gonzalez, 2005). 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 (measured with overhead and margin ratios) when controlling for other supervisory-regulatory policies. However, Pasiouras (2007) reports a positive association between technical efficiency and capital requirements, although this is not statistically significant in all cases.

In theory, there tends to be support for both the *official supervision approach* and the *private monitoring approach*[5] to bank supervision. The *official supervision approach* argues that official supervisors have the capabilities to avoid market failure by directly overseeing, regulating, and disciplining banks. By contrast, the *private monitoring approach* argues that powerful supervision might be related to corruption or other factors that impede bank operations, and regulations that promote private monitoring will result in better outcomes for the banking sector. While these two approaches of supervision might reflect different attitudes towards the role of government in monitoring banks, they are not necessarily mutually exclusive (Levine, 2004). Consequently, in practice countries could adopt regulations that force banks to disclose accurate information to the public, while also create powerful official

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

supervisory agencies (Levine, 2004). Under this combined approach, 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 (Fernandez and Gonzalez, 2005). Although Barth et al. (2004a) and Levine (2004) provide evidence that only private monitoring has an impact on banks' performance, Pasiouras (2007) finds that official supervisory power can also influence banks' technical efficiency.

In addition to the regulatory approaches discussed above, which are related to the three pillars of Basel II, we also comment briefly on two other measures deemed to have an impact on banks' cost and profit efficiency, namely restrictions on bank activities and deposit insurance schemes.

Barth et al. (2004a) outline 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, emphasising the argument by Boyd et al. (1998), they suggest that as moral hazard encourages riskier behaviour, banks will have 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 (Claessens and Klingebiel, 2000), whilst also increase the franchise value of banks and result in a more sensible behaviour. Thus, while theory 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. (2001b) 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 these authors indicate that restrictions are only effective at controlling risk when information disclosure and auditing requirements are poorly developed. In particular, Gonzalez (2005) reports that fewer regulatory restrictions are associated with greater bank risk-taking after isolating (i) the effect of regulatory restrictions on bank charter value, and (ii) the influence of bank charter value on risk-taking. Lower restrictions on bank activities have also been associated with higher credit ratings (Pasiouras et al., 2006), although Pasiouras (2007) finds no significant association with technical efficiency.

Finally, as pointed out by Demirguc-Kunt and Detragiache (2002), several countries have established a system of national deposit insurance over the last 25 years, this being viewed in theory at least as a way of avoiding bank runs and thereby contributing to bank stability[6]. However, it can also create moral hazard problems and encourage excessive risk-taking behaviour, as supported by evidence from several studies (Bhattacharya and Thakor, 1993; Bhattacharya et al., 1998; Hendrickson and Nichols, 2001; Demirguc-Kunt and Kane, 2002); or adversely affect the stability of the banking systems as a whole (Demirguc-Kunt and Detragiache, 2002; Barth et al., 2004a). Pasiouras et al. (2006) find that banks operating in countries with an explicit deposit insurance scheme are assigned lower credit ratings. With regard to bank development and efficiency, Barth et al. (2004a) find no such strong association with deposit insurance schemes, while the results of Pasiouras (2007) are mixed.

3. Methodology, Variables and Data

3.1. Methodology

The stochastic frontier approach (Aigner et al., 1977; Meeusen and van den Broeck, 1977) has been applied to several recent studies in banking (e.g. Bonin et al., 2005;

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[6]For information on the design features of deposit insurance around the world, see Demirguc-Kunt and Detragiache (2002) and Demirguc-Kunt et al. (2005).

Beccalli et al., 2006; Kwan, 2006), and as already mentioned we use it in our first stage to estimate cost and profit efficiency of banks, treating the underlying objective as cost minimization or profit maximization respectively. As in Casu and Girardone (2004) and Beccalli et al. (2006) among others, this approach is applied to obtain the efficiency scores by adopting the Battese and Coelli (1992) model for panel data, with individual firm effects assumed to be distributed as truncated normal variables, and permitted to vary systematically with time.

Starting with the specification of the cost frontier, we follow the value added approach (Berger and Humphrey, 1992), which suggests using deposits as outputs since they imply the creation of value added. Hence, following Dietsch and Lozano-Vivas (2000), Maudos and Pastor (2001), Maudos et al. (2002), Cavallo and Rossi (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 baking efficiency we select the following three input prices: cost of loanable 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[7]. Using the multi-product translog specification[8] gives our empirical cost frontier model as follows:

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[7] We use total assets rather than the number of employers due to several missing values for the later. Our approach is consistent with several previous studies such as Carbo et al. (2002), Maudos et al. (2002), Weill (2004), Carvallo and Kasman (2005), Beccalli et al. (2006).

[8]Some other studies rely on the Fourier Flexible specification to estimate efficiency (e.g. DeYoung and Hasan, 1998; Carbo et al., 2002; Akhigbe and McNulty, 2003). Berger and Mester (1997) found that both the translog and the FF function form yielded essentially the same average level and dispersion of measure efficiency, and both ranked the individual banks in almost the same order. Vander Vennet (2002) also finds similar results but reports the ones obtained from the translog model. However, Altunbas and Chakravarty (2001) compare the FF and translog specifications and urge caution about the growing use of the former to investigate bank efficiency. We therefore use the tranlog specification as in several other recent studies such as Dietsch and Lozano-Vivas (2000) Cavallo and Rossi (2002),

$$\ln TC_{kt} = a_0 + \sum_{i=1}^{3} \alpha_i \ln Q_{ikt} + \frac{1}{2}\sum_{i=1}^{3}\sum_{j=1}^{3} a_{ij} \ln Q_{ikt} \ln Q_{jkt} + \sum_{j=1}^{3} \beta_i \ln P_{ikt}$$

$$+ \frac{1}{2}\sum_{i-1}^{3}\sum_{j=1}^{3} \beta_{ij} \ln P_{ikt} \ln P_{jkt} + \sum_{i=1}^{3}\sum_{j=1}^{3} \gamma_{ij} \ln Q_{ikt} \ln P_{jkt} + v_{kt} + u_{kt} \qquad (1)$$

where TC_{kt} is total cost (i.e. interest expenses plus non-interest expenses) of bank k in period t ($t=1, 2, ..., T$); Q_{ikt} corresponds to the output i (Q_i, $i=1, ..., 3$) of bank k in period t; P_{ikt} represents the input price (P_i) for input factor i ($i=1, ..., 3$) of bank k in period t; v_{kt} are random errors assumed to be iid and $N(0,\sigma_v^2)$; u_{kt} being non-negative random variables accounting for cost inefficiency and assumed to be iid with truncations at zero on the $N(\mu,\sigma_u^2)$ distribution, and $u_{kt} = (u_k \exp(-\eta(t-T)))$, where η is an unknown scalar parameter; and α_i,α_{ij}, β_i, β_{ij} γ_{ij} are the parameters to be estimated.

In the case of the profit frontier model, the variable to be explained is the profit before taxes (*PBT*). In principle, the selection of output price variables in the profit function would depend on whether we assume the existence of market power in the setting of output price or not (Berger and Mester, 1997). The standard profit frontier approach assumes the existence of perfect competition in the markets for outputs and inputs, and requires information on the prices of the output vector, which in most cases is not available. Hence, most of the empirical studies estimate an alternative profit frontier, which assumes that due to imperfect competition banks take as given the quantity of output and the price of inputs and maximise profits by adjusting the price of the output and the quantity of inputs. Hence, this approach does not require output price data for the estimation of the profit frontier. Consequently, the specification of the profit frontier model is the same as that of the cost frontier

Bonin et al. (2005), Bos and Kolari (2005), Carvallo and Kasman (2005), Fries and Taci (2005), Bos and Kool (2006).

(equation (1)) with PBT_{kt} replacing TC_{kt} as the dependent variable. However, the sign of the inefficiency term now becomes negative ($-u_{kt}$).

We also impose linear homogeneity restrictions by normalizing the dependent variable and all input prices by the third input price P_3. Hence, without loss of generality we subtract the logarithm of the cost of labour from both sides of the cost and profit models. Additionally, since a number of banks in the sample exhibit negative profits, the dependent variable in the profit model is transformed to $\ln\left(PBT/P_3 + \left|(PBT/P_3)^{\min}\right| + 1\right)$, where $\left|(PBT/P_3)^{\min}\right|$ is the minimum absolute value of (PBT/P_3) over all banks in the sample. This transformation is necessary to estimate the profit frontier without excluding all banks with negative profits from the sample[9].

All bank-specific data for the estimation of the efficient frontiers were directly converted to US dollars, in Bankscope, prior to downloading. Furthermore, as in Altunbas et al. (2001), Casu and Molyneux (2003), and Hauner (2005) among others, we expressed the data in real 1995 terms using individual country GDP deflators. Table 1 presents the mean of the variables discussed above by year (Panel A) and geographical region (Panel B)[10].

[Insert Table 1 Around Here]

The parameters of the stochastic frontier models are estimated using maximum likelihood[11]. 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

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[9] So that the dependent variable is $\ln(1) = 0$ for the bank with lowest *PBT*, and positive for all other banks.

[10] In assigning countries in regions we follow the classification of Global Market Information Database (GMID) of Euromonitor International.

[11] See Battese and Coelli (1992), Coelli (1996), and Coelli et al. (1999) for further details.

between one and infinity and the latter between zero and one[12]. To make our results comparable, therefore, we calculate the index of cost efficiency as follows: $CEF_{kt} = 1/ CE_{kt}$. Hence, in both cases the efficiency scores will be between 0 and 1 with values closer to 1 indicating a higher level of efficiency.

3.2. Explanatory variables in Tobit Regressions

In testing the impact of the regulatory environment on bank efficiency, we control for other country-specific and bank-specific characteristics well known in the literature. Our second stage in the analysis therefore involves use of Tobit regressions with the dependent variable as the cost or profit efficiency score, regressed on empirical proxies for the regulatory factors discussed in section 2 and other control variables. This allows for identification of the regulatory variables that are significant on bank efficiency, conditional on other bank specific factors, as well as market environment and economic conditions. The rest of this sub-section briefly outlines the set of regulatory and appropriate control variables used, while Appendix A provides further details on their calculations and sources of information.

3.2.1 Regulations and supervision related variables

We construct these variables from information available in the Barth (2004b) database to represent the key aspects of regulation and supervision framework, namely capital adequacy, private monitoring, official supervision, diversification restrictions and deposit insurance.

CAPRQ is an index of capital requirements, accounting for both initial and overall capital stringency. The former indicates whether the source of funds counted as regulatory capital can include assets other than cash or government securities and

[12] In both cases, values closer to one indicate higher efficiency.

borrowed funds, as well as whether these sources are verified by the regulatory or supervisory authorities. The latter indicates whether risk elements and value losses are considered while calculating the regulatory capital. CAPRQ is calculated on the basis of nine questions and can therefore range between 0 and 9, with higher values indicating higher capital stringency.

PRMONIT is an index of private monitoring. The index is constructed by adding 1 if the answer is yes and 0 otherwise to ten questions that indicate the degree of information that is released to officials and the public, auditing related requirements and whether credit ratings are required. PRMONIT can take values between 0 and 10, with higher values indicating more private oversight.

OFPR indicates the ability of supervisors to exercise their power and get involved in banking decisions. It is calculated on the basis of 10 questions relating to supervisory power in terms of prompt corrective action, declaring insolvency, and restructuring. Theoretically, it can take values between 0 and 10, with higher values indicating more power.

ACTRS is a proxy for the restrictions on the activities that banks can undertake. This variable is determined on the basis of whether securities, insurance and real estate activities are unrestricted, permitted, restricted or prohibited, as well as whether banks can own non-financial firms. Depending on the answer, the level of restrictions in each activity is quantified between 1 (unrestricted) and 4 (prohibited). We then construct an overall index by calculating the average value of restrictions over the four activities, with higher values of ACTRS indicating more restrictions.

Finally, DEPINS is a dummy variable indicating whether the country has an explicit deposit insurance scheme or not.

3.2.2 Control variables

We use the logarithm of total assets (SIZE) and the equity to assets ratio (EQAS) to control for bank size and capitalization. However, we do not control for other bank-specific characteristics such as loans to assets or deposits to assets ratios, as these elements (i.e. deposits, loans) were considered during the estimation of the efficiency frontiers. Their inclusion in the second stage of the analysis could therefore lead to potential endogeneity bias that is difficult to be deal with in Tobit regressions.

In addition, we draw upon the relevant literature to select appropriate control variables in accounting for differences in various country level characteristics. Annual GDP growth (GRDGR) and annual inflation (INF) are commonly used measures to control for the country-specific macroeconomic environment (Grigorian and Manole, 2002; Maudos et al., 2002; Hauner, 2005; Pastor and Serrano, 2005; Kasman and Yildirim, 2006; Pasiouras, 2007).

To control for financial sector development across countries, we incorporate the following measures: (i) ASSGDP is a measure of size of the banking system, calculated by dividing the assets of deposit money banks with GDP, (ii) CLAIMS is an indicator of activity in the banking sector and is the ratio of bank claims to the private sector to GDP, and (iii) MACGDP is a measure of size of the stock market, calculated as the ratio of stock market capitalization to GDP[13]. Same or similar measures have been used in other studies (e.g. Demirguc-Kunt and Huizinga, 2000, Barth et al., 2003a, 2004a, Kasman and Yildirim, 2006, Pasiouras, 2007).

Also, following previous studies that focus on banks' performance (Claessens et al., 2001; Barth et al., 2002, 2004a; Demirguc-Kunt et al., 2004; Fries and Taci, 2005; Dietsch and Lozano-Vivas, 2000; Carvallo and Kasman, 2005; Pasiouras et al.,

[13] Further discussion can be found in Beck et al. (2000).

2006; Pasiouras, 2007), we control for cross-country differences in the national structure and competitive conditions of the banking sector, using the following measures: (i) FOREIGN is the percentage of foreign-owned banks operating in the market; (ii) GOVERN is the percentage government-owned banks operating in the market; and (iii) CONC is the percentage of assets held by the three largest commercial banks relative to the total assets of the commercial banking sector within the country.

Furthermore, we follow La Porta et al. (1998), Levine (1998) and others who have studied the effects of different legal environments on the financial system, and control for differences in the institutional environment using: (i) PRIGHT as an indicator of the protection of property rights, and (ii) GOVINT as an indicator of government intervention in the economy. Barth et al. (2004a) find that better developed private property rights and greater political openness mitigate the negative association of moral hazard and bank fragility. Fernandez and Gonzalez (2005) report that banks in a poor legal system with improper enforcement of rules carry a higher risk. Demirguc-Kunt et al. (2004) report a negative impact of property rights protection on bank margins, whereas Pasiouras (2007) finds a positive effect on technical efficiency.

Finally, following Dietsch and Lozano-Vivas (2000), Maudos et al. (2002), Pastor and Serrano (2005) and Pasiouras (2007), we control for access to banking services using: (i) BRAKM which corresponds to the number of branches per 1,000 sq km, and (ii) ATMKM which corresponds to the number of ATMs per 1,000 sq km.

3.3. Data and summary statistics

Our final sample consists of 677 publicly quoted commercial banks[14], operating in 88 countries, for which data for at least one year are available between 2000 and 2004. This sample was determined as follows. We started by considering all the publicly quoted commercial banks in the Bankscope database, giving a total of 1,008 banks from 113 countries. We then excluded 72 banks from 15 countries (i.e. Bahamas, Bangladesh, Barbados, Bermuda, Indonesia, Iran, Ivory Coast, Jamaica, Malawi, Monaco, Nepal, Palestinian Territory, Uganda, Uzbekistan, Zambia) not included in the Barth et al. (2004b) database. We further excluded 28 bank-year observations that corresponded to 15 banks operating in Bosnia-Herzegovina, Liechtenstein, and Serbia and Montenegro, for which GDP deflators where not available in the Global Market Information Database (GMID) of Euromonitor International. Finally, we excluded any bank-year observation, for which at least one of the dependent or explanatory bank-specific variables was zero or missing. This resulted in an unbalanced dataset of 3,086 bank-year observations. Table 2 presents the observations by year and geographical region.

[Insert Table 2 Around Here]

During the above procedure, we selected unconsolidated data where available, but otherwise relied on consolidated data. Specifically, where both unconsolidated and consolidated reports were available, but missing values were observed in the unconsolidated reports, we used consolidated data. Furthermore, where possible, we used reports prepared under the international accounting standards (IAS), or relied on

[14] We focus on publicly quoted banks because, as mentioned in Laeven and Levine (2006), it enhances comparability across countries. Furthermore, it allows us to examine a more homogenous sample in terms of services, and consequently inputs and outputs, enhancing further the comparability across countries. 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 Barth et al. (2004b) are for commercial banks.

those prepared under the local generally accepted accounting principles (GAAP) where these were available instead. In particular, where IAS data were only available for one or two years while GAAP data were available for more years, we used the latter ones.

As shown in Appendix A, data for country-specific variables were collected from the WB databases, GMID and the Heritage Foundation. Specifically, data for the regulatory and supervisory variables (CAPRQ, PRMONIT, OFPR, ACTRS, DEPINS) and two market structure variables (FOREIGN, GOVERN) were obtained from Barth et al. (2004b), for indicators of access to banking services (BRAKM, ATMKM) from Beck et al. (2005), and for CONC from the updated version of the WB database on financial development and structure (Beck et al., 2006b), initially constructed by Beck et al. (2000). Data for the indicators of macroeconomic (GDPGR, INF) and financial development (ASGDP, CLAIMS, MACGDP) were obtained from GMID, and for the overall institutional environment (PRIGHT, GOVINT) from the Heritage Foundation. Table 3 presents the sample means of the independent variables by geographical region.

[Insert Table 3 Around Here]

4. Results

4.1 Stage 1- SFA results

Tables 4 and 5 present estimates of the cost and profit frontier models[15]. The negative value of η in the cost function indicates a decreasing trend in cost efficiency, the opposite being the case for profit efficiency. This seemingly anomalous result in fact suggests that banks operate at higher cost in order to achieve a higher level of profitability.

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[15]These were obtained using the Frontier 4.1 computer program discussed in Coelli (1996).

[Insert Tables 4 and 5 Around Here]

As shown in Table 5, the full sample overall mean profit efficiency score (PEF) equals 0.9402, while that of cost efficiency (CEF) is 0.8499, and the table also provides information about the level of banking efficiency by year (Panel A) and region (Panel B). As expected from the sign of η discussed above, the results confirm that over the period of estimation, banks have become more profit efficient albeit less cost efficient. More specifically, PEF increases each successive year from 0.9235 in 2000 to 0.9548 in 2004, while CEF declines over the corresponding period from 0.8568 to 0.8448. Of the seven regions, Australia has the most profit efficient banking system (with PEF equal to 0.9495), followed by Eastern Europe (0.9481), while North America (0.9378) and Western Europe (0.9373) show the lowest scores. However, the latter two are the most cost efficient banking systems with CEF scores of 0.9329 and 0.8910 respectively. By contrast, the less cost efficient banking sectors are those of Latin America and Caribbean (0.7855) and Eastern Europe (0.8068). Hence, as in previous studies, we observe that the most cost efficient banks are not necessarily the most profit efficient banks and visa versa,[16] and our findings confirm this anomalous trend for the time period 2000-2004. Consequently, we support the argument of Guevara and Maudos (2002) that the analysis of cost efficiency offers only a partial view of banks' efficiency and it is therefore important to analyze profit efficiency as well.

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[16]Casu and Girardone (2004) report that over the period 1996-1999 the most cost efficient banking groups in Italy seem to be also the least profitable. Guevara and Maudos (2002) examine cost and profit efficiency in EU-15, and indicate that the "other bank institutions" group is the most efficient in terms of costs but the most inefficient in terms of profits. Berger and Mester (1997) also show that profit efficiency is not positively correlated with cost efficiency.

4.2. Stage 2- Tobit regression results

In the second stage, as already mentioned, we investigate the determinants of bank efficiency by estimating Tobit regressions using the efficiency scores CEF and PEF as the dependent variables. Since these scores range between 0 and 1, Tobit regressions[17] are more appropriate than OLS.

We estimate several specifications of the Tobit model, while controlling for two bank-specific attributes and various country characteristics discussed in Section 3. For each specification, our approach to estimation involves first examining the impact of individual regulatory related variables on the efficiency scores (columns 1-5). However, since Barth et al. (2004a) and Fernandez and Gonzalez (2005) among others indicate that many regulations can be substitutes or complements and countries will probably not select these policies in isolation, we also estimate a specification that includes all the policy variables (column 6). However, we do not simultaneously include all the control variables for two reasons. First, such an approach would considerably reduce the degrees of freedom and presumably affect the significance of the estimates[18]. Second, including many regressors increases the potential for multicollinearity.

The regression results obtained with different sets of control variables are presented in Tables 6 to 11. In each table, Panel A shows the estimates for cost efficiency and Panel B the same for profit efficiency. Depending on data availability, the estimation sample ranges between 2,366 and 3,082[19] observations. Since use of estimated scores as dependent variables in a two-stage process can render

[17]Tobit regressions were performed in E-Views 5.1.

[18] Simultaneously considering all variables would significantly decrease the number of available observations due to different missing observations for different countries.

[19]In this second stage, we also excluded from the sample the bank with the lowest PBT/P_3. This bank had an efficiency score (i.e. dependent variable) considerably lower than all the other scores in the sample, and this outlier could potentially bias the regression estimates.

heteroskedasticity (Saxonhouse, 1976), we follow Hauner (2005) and Pasiouras (2006, 2007) in reporting QML (Huber/White) standard errors and covariates.

[Insert Table 6 Around Here]

Table 6 shows the estimated results after controlling for bank size (SIZE) and capitalization (EQAS), with no other conditioning variables. We find that higher size results in higher cost efficiency in most of the specifications, but not in higher profit efficiency. In contrast, EQAS has a negative and statistically significant impact on both CEF and PEF, its effect more dominant on the former. The coefficient values on this term indicate that EQAS affects CEF by roughly 30% and PEF by 1.5% (Column 6). Although this result contradicts some previous studies[20], it is consistent with Allen and Rai (1996) who report that higher stockholders' equity (relative to total assets) increases inefficiency for small universal banks and large banks in countries that prohibit functional integration of commercial and investment banking.

Similarly, Cavallo and Rossi (2002) report a positive and significant relationship between capitalization and cost inefficiency for Germany and Italy. One potential explanation is that more skilful managers can generate profits and achieve efficient use of inputs while operating with higher leverage. Another explanation, potentially related to *moral hazard theory,* is that banks with lower capital levels may increase their risk-taking. Hence, by investing in more risky but potentially more profitable activities, these banks may turn out to be more efficient in the short term, although they will probably pay the consequences of their risky behaviour in the long term. Furthermore, Berger and Bonaccorsi di Patti (2006) mention that under the

[20] Some of the studies that report a positive relationship between equity to assets ratios and efficiency in the second stage of the analysis have also used equity during the estimation of efficiency in the first stage. Hence, the results might have been biased due to endogeneity problems.

efficiency-risk hypothesis, more efficient firms tend to choose relatively low equity ratios, as higher expected returns from greater profit efficiency substitutes to some degree for equity capital in protecting the firm against financial distress. In their extended US banks' study investigating the relationship between profit efficiency and capital structure, they find that lower equity capital ratio is associated with higher profit efficiency, an effect that is economically and statistically significant. However, while interpreting our results, it should be kept in mind that our sample consists of only publicly quoted banks, which are typically the larger ones in a given country. This might be a critical factor in the negative effect of EQAS, since McAllister and McManus (1993) and Demsetz and Strahan (1997) also find evidence to suggest that large banks tend to use their advantage in the diversification process to increase risky lending and to operate with lower capital ratios, rather than at lower levels of risk.

Turning to the impact of the regulatory variables, we observe one similarity but otherwise significant differences in the results between cost and profit efficiency. More precisely, only ACTRS has a statistically significant impact on both CEF and PEF. The negative sign of its coefficient indicates that higher (lower) restrictions on the activities than banks undertake reduce (increase) bank efficiency. This is consistent with the view that less regulatory control allows banks to engage in various activities which result in exploitation of economies of scale and scope and generate income from several sources, thus increasing both cost and profit efficiency.

The other regulatory variables have a statistically significant impact only on CEF. The effect of CAPRQ is positive indicating that more stringent regulations related to capitalization result in higher cost efficiency. While one may expect the effect of CAPRQ and EQAS to be of the same sign, this is not necessarily so for two reasons. First, the construction of CAPRQ is mostly related to the way the capital ratios are calculated rather than to their absolute values (Appendix A). Second, while capital adequacy requirements refer to risk-weighted ratios, we have used the equity to assets ratio as a measure of capitalization (EQAS) as in most previous studies[21].

We also find that the existence of a deposit insurance scheme (DEPINS) has a positive influence on cost efficiency, but this is statistically significant only when included with the other regulatory variables. To some extent this result is consistent with previous studies examining the performance, stability, and risk-taking in the banking industry, which indicate that the impact of deposit insurance depends on other regulations and the overall environment in which banks operate (Demirguc-Kunt and Detragiache, 2002; Barth et al., 2004a; Pasiouras et al., 2006).

As with ACTRS, the effect of PRMONIT is negative, as expected, suggesting that higher requirements related to private monitoring reduce cost efficiency. This effect might be associated to higher costs required to meet increased disclosure requirements, such as consolidated accounts, disclosure of off-balance sheet items to supervisors and to the public, disclosure of risk management procedures to the public, auditing by certified auditors, as well as further expenses to obtain credit ratings from external agencies. Alternatively, it could be associated to possible differences between reported figures and actual costs. Assuming that banks in less developed accounting and auditing environments have more incentives to hide part of their expenditures for tax reasons, it is plausible that higher requirement of private monitoring could present higher cost efficiency.

[21]Data unavailability or many missing values in Bankscope precluded the use of risk-weighted ratios such as Tier 1 ratio or total capital ratio. According to Valkanov and Kleimeir (2007), the use of risk-weighted ratios might imply different results, in contrast to the ones we obtained with the equity to assets ratio. They mention that the denominator of regulatory ratios consists of risk-weighted assets, rather than average total assets. Consequently, more risk-averse banks having their portfolios invested in less risky assets, will have lower risk-adjusted assets and, consequently, higher regulatory capital ratios than an otherwise similar but less risk-averse banks. In addition, the more risk-averse a bank is, the higher its risk-based capital ratios will be relative to its equity-to-assets ratio. While examining acquisitions they argue that this can explain why target banks have, on average, higher regulatory capital ratios but at the same time lower equity capitalization rates than other institutions.

Similarly, the impact of OFPR is negative and statistically significant on CEF. Hence, as in Levine (2004), we find that official supervisory power of the authorities exerts a negative influence on the functioning of banks. Barth et al. (2003b) also indicate that official government power is particularly harmful to bank development in countries with closed political systems. That higher supervisory power increases cost inefficiency, as in our case, is also consistent with the view that powerful supervisors may use their power to induce banks to lend politically-connected firms on advantageous terms[22].

[Insert Table 7 Around Here]

The next sets of results attempt to check for robustness by re-estimating the model with additional variables to control for the specific environment. The results in Table 7 show that controlling for the macroeconomic environment (using GDPR and INF) does not significantly change the impact of the regulatory variables on CEF and PEF. In addition, the influence of EQAS remains significant and negatively related to both CEF and PEF. However, with respect to the impact of SIZE the results are now mixed, this effect being displaced partly by the impact of inflation (INF). In other words, higher inflation has a more significant influence on increasing costs and reducing profits, implying lower cost and profit efficiency, as found by Kasman and Yildirim (2006). In addition, GDPGR has a positive and statistically significant effect on PEF. Hence, as in Maudos et al. (2002) we find that banks operating in expanding markets present higher levels of profit efficiency. Furthermore, Maudos et al. (2002)

[22]As Barth et al. (2004a) summarize powerful supervisors may use their power to benefit favored constituents, attract camain donations and extract bribes (Shleifer and Vishny, 1998; Djankov et al., 2002; Quintyn and Taylor, 2002). Both Barth et al. (2004a) and Levine (2004) report positive and statistically significant relationships between corruption and official supervisory power using international datasets.

report that under expansive demand conditions, banks feel less pressured to control their expenses and become less cost efficient. However, although we find a negative impact of GDPGR on CEF, this is statistically significant in only one of the six specifications (Panel A).

[Insert Table 8 Around Here]

Controlling for the development of the financial sector makes the effect of DEPINS individually significant on CEF, but otherwise does not significantly alter the impact of the other regulatory variables (Table 8). However, of the three variables chosen to control for financial sector development, only stock market capitalisation (MACGDP) has a significant impact on both CEF and PEF (in the latter case displacing the significance of EQAS in some specifications). Kasman and Yildirim (2006) also find that both cost and profit efficiency increases as market capitalization increases, while Pasiouras (2007) confirms the same for technical efficiency. Demirguc-Kunt and Huizinga (1999) also find a positive relationship between stock market capitalization and net interest margin, attributing it to a complementarity effect between debt and equity financing. Furthermore, Barth et al. (2003a) report a positive and significant relationship between stock market capitalization and return on assets in half of their specifications. These findings support the view that, as stock markets develop, improved information availability increases the potential pool of borrowers, making it easier for banks to identify and monitor them, which can obviously have a positive impact on both cost and profit efficiency. Appropriately we also find a significantly positive impact of the level of activity in the banking sector (CLAIMS) on CEF, although its effect on PEF is negative (but insignificant). We also find a marginally negative impact of the size of the banking sector (ASSGDP) on CEF, although this is only statistically significant in the presence of the other conditioning variables.

[Insert Table 9 Around Here]

Table 9 reports the results after including the three market structure indicators (GOVERN, FOREIGN and CONC). In this case, with regard to the bank-specific and regulatory variables, the results are consistent with those obtained earlier (Table 6), with CAPRQ now having a significant impact on both cost and profit efficiency. However, all three control variables have opposite effects on CEF and PEF. But the effects differ in terms of magnitude and significance. The significance of GOVERN on both implies that a higher share of government owned banks contributes to higher CEF, but results in lower PEF (and its effect here is very marginal). In a sense, the positive effect on CEF is consistent with the view that government-owned banks contribute to economic development and improvement of welfare (Stiglitz, 1994), whereas the opposite effect on PEF can be associated with the claim that government ownership can have negative consequences for the financial and banking sectors (Barth et al., 2001b; La Porta et al., 2002). The negative and significant impact of the presence of foreign banks in the market (FOREIGN) on cost efficiency is consistent with Ataullah and Le (2006).[23] We also find some evidence (although very limited and marginal in this case) to support the opposite view that a higher proportion of foreign banks has a positive impact on the banking sector, consistent with prior studies that report a positive association with profitability (Demirguc-Kunt and Huizinga, 1999; Barth et al., 2002, 2003a) and credit ratings (Pasiouras et al., 2006). Also, higher concentration (CONC) results in higher cost efficiency, as in Ataullah

[23]Our sample includes banks from several less developed countries, where the recent and rapid entry of foreign banks has led to an increase in costs of domestic banks in the short-run in order to set up advanced information systems and risk management practices introduced by foreign banks.

and Le (2006) and others. This effect is quite significant relative to the effects of GOVERN and FOREIGN and suggests that larger banks operating in more competitive markets (with foreign and state banks) are under increased pressure to control their costs. However, this does not translate into higher or lower profit efficiency, since the effect of CONC on PEF is insignificant.

[Insert Table 10 Around Here]

Controlling for institutional development within each country (using PRIGHT and GOVINT - Table 10) we find that the results for CEF are robust and, as in Table 9, CAPRQ has a positive and significant on PEF when considered in conjunction with the other regulatory variables (column 6). However, the significance of OFPR is now displaced, although on its own remains significant in influencing PEF (column 3). The most significant change in the results for PEF is the positive and statistically significant impact of bank SIZE, associated mainly with the impact of the property rights variable (PRIGHT). In turn, this contributes to the insignificance of OFPR, but at the same time we uncover a positive and statistically significant effect of DEPINS on PEF. In Table 8, we controlled for financial sector development and observed a statistically significant (and negative) effect of DEPINS on CEF. Here, the impact of DEPINS on CEF is insignificant (although remains negative), this being displaced by the inclusion of the environmental variables, both of which are significant on CEF. Together, these results indicate that deposit insurance has a discernible effect on bank cost or profit efficiency, but the effect seems to depend on financial sector and institutional development. As regards the impact of PRIGHT, this is positive on CEF but negative on PEF. This seemingly anomalous result may be due to factors such as country laws that protect private property, and court systems that enforce contracts, which contribute to cost efficiency, but otherwise the reduction in profit efficiency may be due to high levels of corruption and expropriation in developing countries. However, the positive effect of PRIGHT on CEF is consistent with that found by Pasiouras (2007) on technical efficiency, and the negative impact on profit efficiency is consistent with the findings of Demirguc-Kunt et al. (2004). Another way of explaining the opposite effects may be the due to the degree to which banks can increase the gap between what they pay savers (i.e. minimizing cost inefficiency) and what they receive from borrowers (maximizing profit efficiency), which is dependent upon the state of the economy or the institutional environment. Furthermore, banks' risk taking capabilities can potentially vary with the institutional environment[24].

[Insert Table 11 Around Here]

Table 11 shows the results of our regressions while conditioning for access to the banking system through branch services and ATMs. It should be noted that the sample in this case has been reduced by approximately 700 banks observations owing to the absence of data on ATMKM and BRAKM for several countries, and therefore comparisons with previous results need to be treated with caution. However, despite the smaller sample, we observe only minor differences in the results for CEF (Panel A) such as the insignificant impact of SIZE in most specifications, but otherwise the results are robust with ATMKM and BRAKM being statistically significant. The sign of these coefficients indicates that, contrary to expectations, cost efficiency rises as the number of branches per 1,000 square km increases and falls with the increase in

[24] Fernandez and Gonzalez (2005) report that banks in a poor legal system with improper enforcement of rules carry a higher risk.

ATMs. However, the magnitude of these effects is very small and the effects are not robust to alternative specifications[25]. None of these two effects are significant on PEF (Panel B)[26], and so the results in this case resemble those of Table 6 indicating that profit efficiency is driven mainly by EQAS and ACTRS in the absence of other significant environmental factors.

5. Conclusions

This paper takes a step forward in extending the literature on bank efficiency by providing empirical evidence on the association between cost and profit efficiency and regulation and supervisory approaches around the world. In investigating this association, we used a panel dataset of 3,086 financial observations covering the period 2000-2004, comprising 677 publicly listed commercial banks operating in 88 countries. We used this data, available in Bankscope, along with country level data on bank regulatory, supervision and other environmental measures, obtained from other sources (Appendix A). We employed stochastic frontier analysis on bank financial information to estimate cost and profit efficiency, and then performed Tobit regressions to investigate the impact on these measures of regulations related to capital adequacy, private monitoring, disciplinary power of the authorities, restrictions on banks' activities, and deposit insurance, subject to changes in the environmental conditions to account for macroeconomic factors, financial development, market structure, overall institutional development, and access to banking services.

[25] We estimated alternative specifications, with ATMKM and BRAKM entered individually, and found that BRAKM remained statistically significant and positively related to CEF, but the effect of ATMKM became positive and significant on CEF in some specifications. In any case, the magnitude and hence the economic significance of these coefficients remains very marginal. We also replaced ATMKM and BRAKM by the ratio of BRAKM/ATMKM, and obtained some inconsistent results. For example, BRAKM/ATKM was positive and statistically significant in specifications 2, 4 and 5 (only at the 10% level at the case of the later 2) but negative and statistically significant in specifications 3 and 6. Hence, we conclude that the effects of these variables are not robust.

[26] In this case, both variables were insignificant in alternative specifications too, and no statistically significant association was found between BRAKM/ATMKM and PEF.

The empirical results show a robust association of some of the regulatory and environmental measures with cost efficiency, and to a limited extent with profit efficiency, after accounting for bank size and capitalization as bank-specific control factors. In this context, our results reveal some similarities and differences in the determinants of cost and profit efficiency. In most specifications, cost efficiency is influenced by regulations related to capital requirements, private monitoring (i.e. information disclosure), official power of the authorities, and restrictions on banking activities. However, profit efficiency is affected only by restrictions on the activities that banks can undertake. The impact of these measures is marginal compared to the influence of bank level capitalization, but is invariant to robustness checks conducted by changing the conditioning environmental variables.

Our results also indicate that the significance of some regulatory measures is governed by the conditioning variables. For example, capital adequacy requirements improve profit efficiency in market environments where the effect of government ownership of banks is also significant. Similarly, the impact of deposit insurance on banks efficiency depends on the financial and institutional development of the countries. Similarly, the impact of bank size on cost efficiency is either positive or negative, depending on the state of the economy. The impact of bank size on profit efficiency is found to be positive and statistically significant only with better protection of property rights.

We also find that some of the conditioning variables have plausible effects on the two measures of efficiency, in some cases similar and in others opposite. In particular, financial development (specifically stock market capitalization) aids both cost and profit efficiency, while higher inflation erodes both. GDP growth influences profit, but not cost, efficiency, while market concentration influences cost, but not profit, efficiency. The impact of property rights protection is positive on cost but negative on profit efficiency. Finally, access to banking services has a statistically significant (but very marginal) effect on cost, but not profit, efficiency.

Whilst providing comprehensive cross-country evidence on the impact of regulatory and environmental factors on bank efficiency, it seems appropriate to conclude by addressing some of the data-related issues that have constrained the scope of this study. First, since the World Bank (WB) database on bank regulations (Barth et al., 2001a, 2004b) is available for only two points in time, we have assumed that regulatory policies within each country remained constant over the time period of our analysis. This, however, does not seem unreasonable, since Barth et al. (2004a) point out that such regulations change very little over time and control of these influences in their study did not alter their findings.[27] Second, in obtaining efficiency scores we used general proxies for input prices, as missing values for the number of employees precluded calculation of an accurate measure of cost per employee. Furthermore, in the absence of detailed information on expenditures relating to depreciation, we used non-interest expenses (net of personnel expenses) in calculating the cost of physical capital. A further criticism highlighted by Berger and Mester (2003) and Bos and Kool (2006) is that exogenous rather than endogenous prices (i.e. calculated from own accounts) should be used. However, exogenous prices were not available in our case, and therefore we had to rely on prices calculated from banks own accounts. Nevertheless, our approach to estimating efficiency scores is consistent with a majority of previous studies (e.g. Altunbas et al., 2000, 2001; Maudos et al., 2002; Weill, 2004; Yildirim and Philippatos, 2006) and we believe that, despite these data based limitations, our study represents an advance on the existing literature

[27] Consequently, other studies using this database (e.g. Focarelli and Pozzolo, 2001; Demirguc-Kunt and Detragiache 2002; Demirguc-Kunt et al., 2004; Buch and DeLong, 2004a,b; Fernandez and Gonzalez, 2005; Beck et al., 2006a), have implicitly made the same assumption.

advance in uncovering international evidence suggesting an association between the regulatory environment and bank efficiency.

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Table 1: Mean of variables used in Stochastic Frontier Analysis (SFA)

	TC	PBT	Q1	Q2	Q3	P1	P2	P3
Panel A: Sample means by year								
2000	873.074	118.615	8,381.672	6,613.135	13,152.846	0.054	0.998	0.018
2001	809.363	83.396	8,176.305	6,606.077	13,077.034	0.050	1.021	0.017
2002	734.972	95.210	8,783.130	6,975.897	13,799.882	0.047	1.133	0.017
2003	748.285	139.979	10,322.076	8,662.502	16,532.132	0.038	1.214	0.016
2004	761.867	173.618	11,495.451	9,835.891	18,294.350	0.035	1.308	0.015
Panel B: Sample means by geographical region								
Africa & Middle East	163.619	49.453	1,592.864	1,382.395	2,744.158	0.049	0.861	0.015
Asia Pacific	392.060	77.288	9,885.413	5,365.697	14,315.382	0.032	0.637	0.010
Australia	2,569.739	773.507	37,049.115	8,974.930	37,235.083	0.046	3.817	0.008
Eastern Europe	79.724	19.264	516.102	461.126	871.469	0.049	0.743	0.022
Lat America & Carrib	282.308	44.403	1,577.219	1,515.927	2,714.908	0.077	1.246	0.031
North America	2,775.936	512.131	26,212.362	18930.098	41,758.425	0.027	1.910	0.016
Western Europe	2,044.246	242.530	19,536.757	21,593.398	34,087.559	0.040	1.903	0.015
Total sample average	783.620	123.004	9,478.266	7,786.108	15,048.130	0.045	1.140	0.016

Notes: TC: Total Cost, PBT: Profits before taxes; Q1: Loans, Q2: Other earning assets, Q3: Deposits; P1: Interest expenses/Deposits, P2: Other overhead expenses/Fixed assets, P3: Personnel expenses/total assets; TC, PBT, Q1, Q2, Q3 are in $ millions expressed in real 1995 terms; In assigning countries in regions we follow the classification of Global Market Information Database (GMID) of Euromonitor International.

Table 2: Observations by year and geographical region

Region	2000	2001	2002	2003	2004	Total
Africa & Middle East	95	101	106	109	106	517
Asia Pacific	181	197	199	211	214	1,002
Australia	9	9	9	9	9	45
Eastern Europe	55	57	63	66	62	303
Latin America & Caribbean	85	83	85	84	95	432
North America	17	18	19	21	21	96
Western Europe	133	137	140	141	140	691
Total	575	602	621	641	647	3,086

Note: In assigning countries in regions we follow the classification of Global Market Information Database (GMID) of Euromonitor International

Table 3: Sample means of independent variables*

	Africa & Middle East	Asia Pacific	Australia	Eastern Europe	Latin America & Caribbean	North America	Western Europe	Total
Number of bank observations	517	1,002	45	303	432	96	691	3,086
Number of countries	23	14	1	14	15	2	19	88
CAPRQ	6.4197	5.5212	7.0000	5.2541	5.4375	4.0625	5.9667	5.7103
PRMONIT	7.4004	7.5544	8.0000	7.1155	7.1644	7.4688	7.4443	7.4096
OFPR	8.6230	8.9912	8.0000	7.8977	7.8109	7.1250	5.9334	7.8643
ACTRS	2.5048	2.7740	2.7500	2.2170	2.7471	2.2813	2.1378	2.5123
DEPINS**	249	842	45	176	242	96	528	2178
SIZE	3.0032	3.6495	4.3517	2.3088	2.6336	3.8168	3.5990	3.2715
EQAS	0.1083	0.0704	0.0688	0.1453	0.1269	0.0808	0.0954	0.0979
INF	4.2018	2.1226	3.3940	6.5025	10.5950	2.4685	3.5280	4.4310
GDPGR	5.0716	3.9521	3.2400	4.7099	2.9657	2.7563	2.2454	3.6462
MACGDP	0.7794	0.6030	1.0464	0.1678	0.2798	1.1854	0.7046	0.5946
ASSGDP	0.2212	0.2454	0.0797	0.1225	0.0472	0.1302	0.5797	0.2737
CLAIMS	0.4681	0.7391	0.9327	0.3056	0.2420	0.5577	1.1238	0.6642
GOVERN	16.1829	22.9417	0.0000	12.0947	13.3284	0.0000	9.6867	15.4736
FOREIGN	28.9724	15.0973	17.0000	64.9881	28.1187	12.3438	8.2068	22.9962
CONC	0.6497	0.4398	0.6399	0.5964	0.5466	0.3979	0.6666	0.5575
GOVINT	3.7327	2.4104	2.0000	2.7295	2.9028	2.1875	2.8466	2.8141
PRIGHT	3.3228	3.6056	5.0000	2.6199	2.7847	5.0000	4.5137	3.6183
BRAKM	28.2294	30.8635	0.7731	12.5345	4.2154	5.9428	71.0701	33.2955
ATMKM	55.2819	262.1683	1.6616	23.6609	8.3641	22.5915	98.4612	116.6114

Notes: *Sample means for country-specific variables have been calculated on the basis of bank observations (e.g. N = 3,086) and not country observations (e.g. N =88). In some cases, the sample number is lower than the one mentioned in the second line due to missing values; **In the case of DEPINS the figure corresponds to the number of observations (i.e. banks) operating under an explicit deposit insurance scheme. Variables are defined in Appendix A.

Table 4: Parameters of the SFA functions estimated on the full sample

		Cost efficiency		Profit Efficiency	
	Parameter	coefficient	t-ratio	coefficient	t-ratio
	β_0	1.339	37.651	14.309	196.776
ln(Q1)	β_1	0.058	2.899	0.340	7.079
ln(Q2)	β_2	0.268	16.583	0.214	5.941
ln(Q3)	β_3	0.555	20.319	-0.575	-8.279
ln (P1/P3)	β_4	0.289	26.776	0.0586	2.101
ln (P2/P3)	β_5	0.162	12.514	-0.064	-2.337
$(\ln Q1)^2 / 2$	β_6	0.001	0.087	0.050	2.544
ln (Q1)x ln(Q2)	β_7	-0.011	-1.725	0.039	2.960
ln (Q1) x ln(Q3)	β_8	0.001	0.091	-0.094	-3.624
$(\ln Q2)^2 / 2$	β_9	0.095	20.410	0.014	1.376
ln (Q2) x ln(Q3)	β_{10}	-0.096	-14.005	-0.048	-3.099
$(\ln Q3)^2 / 2$	β_{11}	0.125	8.308	0.149	4.389
$(\ln(P1/P3))^2 /2$	β_{12}	0.171	77.437	-0.020	-3.323
ln(P1/P3) x ln(P2/P3)	β_{13}	-0.003	-1.609	-0.019	-3.440
$(\ln(P2/P3))^2 / 2$	β_{14}	-0.021	-6.748	0.014	1.999
ln (Q1) x ln(P1/P3)	β_{15}	-0.072	-14.625	-0.021	-2.125
ln (Q1) ln (P2/P3)	β_{16}	0.048	9.334	-0.065	-5.246
ln (Q2) ln (P1/P3)	β_{17}	-0.035	-9.313	-0.026	-3.221
ln (Q2) ln (P2/P3)	β_{18}	0.012	3.156	-0.054	-5.670
ln (Q3) ln (P1/P3)	β_{19}	0.109	17.707	0.047	3.409
ln (Q3) ln (P2/P3)	β_{20}	-0.056	-7.515	0.113	5.944
	σ^2	0.248	9.434	0.077	26.752
	γ	0.983	477.648	0.298	9.401
	μ	-0.988	-9.034	-0.302	-9.890
	η	-0.017	-3.756	0.150	5.330

Notes: Q1: Loans, Q2: Other earning assets, Q3: Deposits; P1: Interest expenses/Deposits, P2: Other overhead expenses/Fixed assets, P3: Personnel expenses/total assets; $\sigma^2=\sigma_V^2+\sigma_U^2$, $\gamma=\sigma_U^2/(\sigma_V^2+\sigma_U^2)$, μ is the transaction of a normal density function, η indicates the time-variance of inefficiency.

Table 5: Cost and Profit efficiency estimates

	Cost Efficiency (CEF)	Profit Efficiency (PEF)
Panel A: Mean by year		
2000	0.8568	0.9235
2001	0.8540	0.9320
2002	0.8493	0.9405
2003	0.8457	0.9481
2004	0.8448	0.9548
Panel B: Mean by region		
Africa & Middle East	0.8706	0.9406
Asia Pacific	0.8421	0.9410
Australia	0.8894	0.9495
Eastern Europe	0.8068	0.9417
Latin America & Caribbean	0.7855	0.9411
North America	0.9329	0.9378
Western Europe	0.8910	0.9373
Overall mean (N = 3,086)	0.8499	0.9402

Note: The means by year and region are calculated from the total sample, and do not correspond to cross-section or region specific estimates.

Table 6: Regulations and cost and profit efficiency (controlling for bank size and capitalization) – Tobit regression results

Panel A: Dependent variable – CEF						
SIZE	0.0071***	0.0127***	0.0046**	4.80E-05	0.0048**	0.0089***
	(0.0007)	(0.0000)	(0.0297)	(0.9806)	(0.0181)	(0.0000)
EQAS	-0.2885***	-0.2803***	-0.2910***	-0.3540***	-0.2968***	-0.2977***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
CAPRQ	0.0095***	---	---	---	---	0.0066***
	(0.0000)					(0.0000)
PRMONIT	---	-0.0252***	---	---	---	-0.0207***
		(0.0000)				(0.0000)
OFPR	---	---	-0.0088***	---	---	-0.0072***
			(0.0000)			(0.0000)
ACTRS	---	---	---	-0.0366***	---	-0.0301***
				(0.0000)		(0.0000)
DEPINS	---	---	---	---	0.0029	0.0072*
					(0.4622)	(0.0983)
Constant	0.8088***	1.0298***	0.9412***	0.9842***	0.8694***	1.0992***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Panel B: Dependent variable- PEF						
SIZE	0.0002	0.0002	0.0002	0.0000	0.0003	-7.79E-05
	(0.6629)	(0.6656)	(0.5113)	(0.9720)	(0.4416)	(0.8365)
EQAS	-0.0113*	-0.0113*	-0.0107*	-0.0154**	-0.0112*	-0.0150**
	(0.0657)	(0.0656)	(0.0930)	(0.0126)	(0.0663)	(0.0191)
CAPRQ	-1.46E-05	----	----	----	----	4.05E-05
	(0.9397)					(0.8418)
PRMONIT	----	-4.83E-07	----	----	----	0.0001
		(0.9989)				(0.7243)
OFPR	----	----	-0.0001	----	----	-8.08E-06
			(0.3627)			(0.9612)
ACTRS	----	----	----	-0.0020***	----	-0.0022***
				(0.0002)		(0.0001)
DEPINS	----	----	----	----	-0.0003	0.0001
					(0.6233)	(0.8295)
Constant	0.9428***	0.9427***	0.9435***	0.9488***	0.9426***	0.9480***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
No. of obs.	3,072	3,072	2,974	3,082	3,082	2,974

***Statistically significant at the 1% level, **Statistically significant at the 5% level, *Statistically significant at the 10% level; p-values in parentheses; CEF: cost efficiency, PEF: Profit efficiency; Independent variables are defined in Appendix A; QML (Huber/White) standard errors and covariates have been calculated to control for heteroscedacity.

Table 7: Regulations and cost and profit efficiency (controlling for bank characteristics and macroeconomic conditions) – Tobit regression results

Panel A: Dependent variable – CEF						
SIZE	0.0003	0.0064***	-0.0014	-0.0058***	-0.0014	0.0023
	(0.8891)	(0.0022)	(0.4956)	(0.0046)	(0.5069)	(0.2893)
EQAS	-0.2679***	-0.2622***	-0.2694***	-0.3371***	-0.2794***	-0.2697***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
GDPGR	-0.0012**	-0.0009	-3.40E-05	-0.0004	-0.0006	-0.0009
	(0.0472)	(0.1623)	(0.9565)	(0.4541)	(0.3624)	(0.1606)
INF	-0.0029***	-0.0027***	-0.0028***	-0.0025***	-0.0026***	-0.0030***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
CAPRQ	0.0113***	----	----	----	----	0.0087***
	(0.0000)					(0.0000)
PRMONIT	----	-0.0267***	----	----	----	-0.0200***
		(0.0000)				(0.0000)
OFPR	----	----	-0.0087***	----	----	-0.0074***
			(0.0000)			(0.0000)
ACTRS	----	----	----	-0.0356***	----	-0.0279***
				(0.0000)		(0.0000)
DEPINS	----	----	----	----	0.0037	0.0071*
					(0.3366)	(0.0925)
Constant	0.8355***	1.0749***	0.9707***	1.0118***	0.9007***	1.1131***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Panel B: Dependent variable- PEF						
SIZE	0.0001	0.0001	0.0002	1.94E-05	0.0003	-0.0001
	(0.7015)	(0.7099)	(0.6392)	(0.9569)	(0.4753)	(0.7253)
EQAS	-0.0108*	-0.0107*	-0.0100	-0.0148**	-0.0104*	-0.0141**
	(0.0751)	(0.0770)	(0.1120)	(0.0155)	(0.0849)	(0.0256)
GDPGR	0.0006***	0.0006***	0.0005***	0.0006***	0.0006***	0.0005***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
INF	-0.0001***	-0.0001***	-0.0001***	-0.0001***	-0.0001***	-0.0001***
	(0.0007)	(0.0004)	(0.0000)	(0.0017)	(0.0006)	(0.0001)
CAPRQ	-9.43E-05	----	----	----	----	2.28E-05
	(0.6221)					(0.9100)
PRMONIT	----	5.46E-05	----	----	----	0.0002
		(0.8776)				(0.5202)
OFPR	----	----	-0.0002	----	----	-0.0001
			(0.1563)			(0.5389)
ACTRS	----	----	----	-0.0020***	----	-0.0020***
				(0.0002)		(0.0003)
DEPINS	----	----	----	----	-5.24E-05	0.0003
					(0.9293)	(0.6966)
Constant	0.9418***	0.9408***	0.9430***	0.9470***	0.9408***	0.9464***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
No. of obs.	3,072	3,072	2,974	3,082	3,082	2,974

***Statistically significant at the 1% level, **Statistically significant at the 5% level, *Statistically significant at the 10% level; p-values in parentheses; CEF: cost efficiency, PEF: Profit efficiency; Independent variables are defined in Appendix A; QML (Huber/White) standard errors and covariates have been calculated to control for heteroscedacity.

Table 8: Regulations and cost and profit efficiency (controlling for bank characteristics and financial sector development) – Tobit regression results

Panel A: Dependent variable- CEF						
SIZE	-0.0116***	-0.0091***	-0.0118***	-0.0172***	-0.0135***	-0.0109***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
EQAS	-0.2139***	-0.2277***	-0.1940***	-0.2769***	-0.2254***	-0.2365***
	(0.0000)	(0.0000)	(0.0003)	(0.0000)	(0.0000)	(0.0000)
MACGDP	0.0106***	0.0081***	0.0124***	0.0099***	0.0113***	0.0094***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
ASSGDP	-0.0016	-0.0003	0.0000	-0.0094***	-0.0038	-0.0073**
	(0.4111)	(0.8629)	(0.9961)	(0.0033)	(0.1439)	(0.0360)
CLAIMS	0.0757***	0.0805***	0.0752***	0.0792***	0.0832***	0.0804***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
CAPRQ	0.0049***	----	----	----	----	0.0017
	(0.0002)					(0.1829)
PRMONIT	----	-0.0189***	----	----	----	-0.0147***
		(0.0000)				(0.0000)
OFPR	----	----	-0.0070***	----	----	-0.0049***
			(0.0000)			(0.0000)
ACTRS	----	----	----	-0.0405***	----	-0.0336***
				(0.0000)		(0.0000)
DEPINS	----	----	----	----	-0.0160***	-0.0092**
					(0.0001)	(0.0297)
Constant	0.8291***	0.9886***	0.9078***	0.9806***	0.8702***	1.0807***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Panel B: Dependent variable- PEF						
SIZE	-0.0001	-0.0002	-0.0002	-0.0003	-0.0002	-0.0005
	(0.7415)	(0.5597)	(0.6469)	(0.3997)	(0.6744)	(0.2849)
EQAS	-0.0102	-0.0104	-0.0113	-0.0137**	-0.0103	-0.0144**
	(0.1251)	(0.1164)	(0.1031)	(0.0465)	(0.1194)	(0.0421)
MACGDP	0.0014***	0.0015***	0.0014***	0.0014***	0.0014***	0.0015***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
ASSGDP	0.0006	0.0006	0.0007	0.0002	0.0006	0.0002
	(0.3300)	(0.3522)	(0.2759)	(0.7246)	(0.3578)	(0.7344)
CLAIMS	-0.0004	-0.0004	-0.0006	-0.0004	-0.0004	-0.0006
	(0.5826)	(0.6209)	(0.4928)	(0.6169)	(0.6616)	(0.4783)
CAPRQ	8.58E-05	----	----	----	----	0.0002
	(0.6799)					(0.4786)
PRMONIT	----	0.0003	----	----	----	0.0006
		(0.5340)				(0.2280)
OFPR	----	----	-0.0002	----	----	-9.88E-05
			(0.2569)			(0.5690)
ACTRS	----	----	----	-0.0018***	----	-0.0019***
				(0.0033)		(0.0028)
DEPINS	----	----	----	----	-0.0001	0.0002
					(0.8564)	(0.7584)
Constant	0.9425***	0.9411***	0.9448***	0.9485	0.9431***	0.9445***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
No. of obs	2,760	2,760	2,676	2,760	2,760	2,676

***Statistically significant at the 1% level, **Statistically significant at the 5% level, *Statistically significant at the 10% level; p-values in parentheses; CEF: cost efficiency, PEF: Profit efficiency; Independent variables are defined in Appendix A; QML (Huber/White) standard errors and covariates have been calculated to control for heteroscedacity.

Table 9: Regulations and cost and profit efficiency (controlling for bank characteristics and market structure) – Tobit regression results

Panel A: Dependent variable- CEF						
SIZE	0.0096***	0.0132***	0.0063***	0.0028	0.0082***	0.0077***
	(0.0000)	(0.0000)	(0.0052)	(0.1949)	(0.0002)	(0.0007)
EQAS	-0.2882***	-0.2939***	-0.3109***	-0.3375***	-0.2932***	-0.3335***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
GOVERN	0.0007***	0.0005***	0.0008***	0.0009***	0.0007***	0.0006***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
FOREIGN	-0.0005***	-0.0006***	-0.0005***	-0.0007***	-0.0006***	-0.0006***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
CONC	0.1453***	0.1506***	0.1485***	0.1376***	0.1558***	0.1261***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
CAPRQ	0.0071***	----	----	----	----	0.0030**
	(0.0000)					(0.0249)
PRMONIT	----	-0.0221***	----	----	----	-0.0175***
		(0.0000)				(0.0000)
OFPR	----	----	-0.0030***	----	----	-0.0017
			(0.0024)			(0.1012)
ACTRS	----	----	----	-0.0370***	----	-0.0319***
				(0.0000)		(0.0000)
DEPINS	----	----	----	----	-0.0006	-0.0024
					(0.8901)	(0.5934)
Constant	0.7324***	0.9259***	0.8095***	0.8996***	0.7740***	1.0060***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Panel B: Dependent variable- PEF						
SIZE	3.91E-06	-5.43E-05	-7.83E-05	-0.0003	-9.78E-05	-0.0001
	(0.9916)	(0.8863)	(0.8339)	(0.4558)	(0.7904)	(0.7906)
EQAS	-0.0144**	-0.0148**	-0.0149**	-0.0171***	-0.0152**	-0.0165***
	(0.0177)	(0.0137)	(0.0151)	(0.0055)	(0.0111)	(0.0093)
GOVERN	-4.01E-05***	-3.59E-05**	-3.69E-05**	-3.01E-05**	-3.61E-05**	-4.02E-05**
	(0.0052)	(0.0129)	(0.0152)	(0.0362)	(0.0120)	(0.0157)
FOREIGN	2.34E-05**	1.85E-05*	1.66E-05	1.51E-05	1.59E-05	1.75E-05
	(0.0285)	(0.0760)	(0.1150)	(0.1460)	(0.1305)	(0.1178)
CONC	-0.0015	-0.0009	0.0002	-0.0014	-0.0009	-0.0009
	(0.3861)	(0.5810)	(0.8910)	(0.4153)	(0.5814)	(0.6360)
CAPRQ	0.0005**	----	----	----	----	0.0004*
	(0.0256)					(0.0842)
PRMONIT	----	-0.0002	----	----	----	-0.0001
		(0.5826)				(0.7620)
OFPR	----	----	0.0002	----	----	0.0002
			(0.3001)			(0.2711)
ACTRS	----	----	----	-0.0012**	----	-0.0013**
				(0.0458)		(0.0367)
DEPINS	----	----	----	----	-0.0006	-9.04E-05
					(0.3540)	(0.8951)
Constant	0.9414***	0.9456***	0.9420***	0.9482***	0.9447***	0.9449***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
No. of obs	2,948	2,948	2,859	2,948	2,948	2,859

***Statistically significant at the 1% level, **Statistically significant at the 5% level, *Statistically significant at the 10% level; p-values in parentheses; CEF: cost efficiency, PEF: Profit efficiency; Independent variables are defined in Appendix A; QML (Huber/White) standard errors and covariates have been calculated to control for heteroscedacity.

Table 10: Regulations and cost and profit efficiency (controlling for bank characteristics and institutional development) – Tobit regression results

Panel A: Dependent variable- CEF						
SIZE	-0.0066***	-0.0024	-0.0067***	-0.0090***	-0.0070***	-0.0036*
	(0.0006)	(0.2181)	(0.0005)	(0.0000)	(0.0002)	(0.0789)
EQAS	-0.3825***	-0.3583***	-0.3597***	-0.4089***	-0.3870***	-0.3508***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
PRIGHT	0.0342***	0.0363***	0.0347***	0.0328***	0.0346***	0.0377***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
GOVINT	0.0346***	0.0324***	0.0343***	0.0338***	0.0354***	0.0286***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
CAPRQ	0.0026**	---	---	---	---	-0.0007
	(0.0201)					(0.5208)
PRMONIT	---	-0.0206***	---	---	---	-0.0255***
		(0.0000)				(0.0000)
OFPR	---	---	-0.0052***	---	---	-0.0039***
			(0.0000)			(0.0000)
ACTRS	---	---	---	-0.0187***	---	-0.0184***
				(0.0000)		(0.0000)
DEPINS	---	---	---	---	-0.0033	-0.0044
					(0.3412)	(0.2198)
Constant	0.6812***	0.8307***	0.7335***	0.7607***	0.6966***	0.9580***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Panel B: Dependent variable- PEF						
SIZE	0.0015***	0.0014***	0.0015***	0.0013***	0.0016***	0.0011***
	(0.0001)	(0.0004)	(0.0001)	(0.0007)	(0.0000)	(0.0057)
EQAS	-0.0058	-0.0064	-0.0068	-0.0112*	-0.0050	-0.0117*
	(0.3540)	(0.3056)	(0.2920)	(0.0721)	(0.4287)	(0.0682)
PRIGHT	-0.0023***	-0.0023***	-0.0025***	-0.0026***	-0.0025***	-0.0029***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
GOVINT	1.42E-05	0.0001	5.45E-05	-0.0001	0.0001	3.04E-05
	(0.9643)	(0.7448)	(0.8549)	(0.6969)	(0.6436)	(0.9236)
CAPRQ	6.03E-05	---	---	---	---	0.0004*
	(0.7644)					(0.0790)
PRMONIT	---	0.0004	---	---	---	0.0011***
		(0.3447)				(0.0086)
OFPR	---	---	-0.0003*	---	---	-0.0002
			(0.0599)			(0.3162)
ACTRS	---	---	---	-0.0028***	---	-0.0029***
				(0.0000)		(0.0000)
DEPINS	---	---	---	---	0.0010*	0.0017**
					(0.0924)	(0.0132)
Constant	0.9458***	0.9437***	0.9490***	0.9559***	0.9451***	0.9474***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
No. of obs	3,046	3,046	2,948	3,056	3,056	2,948

***Statistically significant at the 1% level, **Statistically significant at the 5% level, *Statistically significant at the 10% level; p-values in parentheses; CEF: cost efficiency, PEF: Profit efficiency; Independent variables are defined in Appendix A; QML (Huber/White) standard errors and covariates have been calculated to control for heteroscedacity.

Table 11: Regulations and cost and profit efficiency (controlling for bank characteristics and access to banking services) – Tobit regression results

Panel A: Dependent variable- CEF						
SIZE	0.0038*	0.0073***	0.0014	-0.0030	0.0018	0.0010
	(0.0934)	(0.0011)	(0.5466)	(0.1791)	(0.4072)	(0.6856)
EQAS	-0.3303***	-0.3591***	-0.3257***	-0.3770***	-0.3451***	-0.3330***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
ATMKM	-0.0001***	-8.57E-05***	-6.97E-05***	-7.25E-05***	-0.0001***	-2.05E-06
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.9113)
BRAKM	0.0005***	0.0005***	0.0004***	0.0004***	0.0006***	0.0003***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
CAPRQ	0.0050***	---	---	---	---	0.0033***
	(0.0002)					(0.0073)
PRMONIT	---	-0.0252***	---	---	---	-0.0239***
		(0.0000)				(0.0000)
OFFPR	---	---	-0.0061***	---	---	-0.0071***
			(0.0000)			(0.0000)
ACTRS	---	---	---	-0.0377***	---	-0.0323***
				(0.0000)		(0.0000)
DEPINS	---	---	---	---	0.0252***	0.0226***
					(0.0000)	(0.0000)
Constant	0.8399***	1.0460***	0.9216***	0.9877***	0.8573***	1.1505***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Panel B: Dependent variable- PEF						
SIZE	3.19E-05	3.87E-05	-8.56E-05	-0.0001	0.0002	-0.0004
	(0.9392)	(0.9264)	(0.8402)	(0.7620)	(0.6917)	(0.3425)
EQAS	-0.0102	-0.0104	-0.0110	-0.0132*	-0.0101	-0.0140*
	(0.1536)	(0.1436)	(0.1336)	(0.0706)	(0.1561)	(0.0667)
ATMKM	6.86E-07	7.09E-07	2.12E-06	2.12E-06	2.21E-07	3.79E-06
	(0.7809)	(0.7805)	(0.4201)	(0.3932)	(0.9296)	(0.2041)
BRAKM	1.22E-06	1.30E-06	-2.24E-06	-3.85E-06	1.67E-06	-7.02E-06
	(0.8841)	(0.8772)	(0.7920)	(0.6390)	(0.8393)	(0.4694)
CAPRQ	6.38E-05	---	---	---	---	7.41E-05
	(0.7721)					(0.7430)
PRMONIT	---	-0.0001	---	---	---	0.0002
		(0.8451)				(0.7799)
OFFPR	---	---	-0.0002	---	---	-0.0001
			(0.2981)			(0.5123)
ACTRS	---	---	---	-0.0018***	---	-0.0023***
				(0.0051)		(0.0010)
DEPINS	---	---	---	---	-2.54E-05	0.0003
					(0.9721)	(0.7548)
Constant	0.9424***	0.9436***	0.9447***	0.9482***	0.9424***	0.9492***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
No. of obs	2,450	2,450	2,366	2,460	2,460	2,366

***Statistically significant at the 1% level, **Statistically significant at the 5% level, *Statistically significant at the 10% level; p-values in parentheses; CEF: cost efficiency, PEF: Profit efficiency; Independent variables are defined in Appendix A; QML (Huber/White) standard errors and covariates have been calculated to control for heteroscedacity.

Appendix A- Information on independent variables

Variable	Category	Description	Source/Database
Regulatory variables			
CAPRQ	Capital requirements	This variable takes values between 0 and 9, with higher values indicating grater stringency. It is determined by adding 1 if the answer is yes to questions 1-7 and 0 otherwise, while the opposite occurs in the case of questions 8 and 9 (i.e. yes=0, no =1). (1) Is the minimum required capital asset ratio risk-weighted in line with Basle guidelines? (2) Does the ratio vary with individual bank's credit risk? (3) Does the ratio vary with market risk? (4-6) Before minimum capital adequacy is determined, which of the following are deducted from the book value of capital: (a) market value of loan losses not realized in accounting books? (b) unrealized losses in securities portfolios? (c) unrealized foreign exchange losses? (7) Are the sources of funds to be used as capital verified by the regulatory/supervisory authorities? (8) Can the initial or subsequent injections of capital be done with assets other than cash or government securities? (9) Can initial disbursement of capital be done with borrowed funds?	WB (Barth et al., 2004b)
PRMONIT	Private monitoring	This variable takes values between 0 and 10, with higher values indicating policies that promote private monitoring. It is determined by adding 1 if the answer is yes and 0 otherwise, for each one of the following ten questions: (1) Does accrued, though unpaid interest/principal enter the income statement while loan is non-performing? (2) Are financial institutions required to produce consolidated accounts covering all bank and any non-bank financial subsidiaries? (3) Are off-balance sheet items disclosed to supervisors? (4) Are off-balance sheet items disclosed to public? (5) Must banks disclose their risk management procedures to public? (6) Are directors legally liable for erroneous/misleading information? (7) Is an external audit compulsory? (8) Are there specific requirements for the extent of audit? (9) Are auditors licensed or certified? (10) Do regulations require credit ratings for commercial banks?	WB (Barth et al., 2004b)
OFPR	Official disciplinary power	This variable takes values between 0 and 10, with higher values indicating higher power of the supervisory authorities. It is determined by adding 1 if the answer is yes and 0 otherwise, for each one of the following ten questions: (1) Can the supervisory authorities force a bank to change its internal organizational structure? (2) Are there any mechanisms of cease-desist type orders whose infraction leads to automatic imposition of civil & penal sanctions on banks directors & managers? (3) Can the supervisory agency order directors/management to constitute provisions to cover actual/potential losses? (4) Can the supervisory agency suspend director's decision to distribute dividends? (5) Can the supervisory agency suspend director's decision to distribute bonuses? (6) Can the supervisory agency suspend director's decision to distribute management fees? (7) Can the supervisory agency supersede bank shareholder rights and declare bank insolvent? (8) Does banking law allow supervisory agency to suspend some or all ownership rights of a problem bank? (9) Regarding bank restructuring & reorganization, can supervisory agency remove and replace management? (10) Regarding bank restructuring & reorganization, can supervisory agency remove and replace directors?	
ACTRS	Restrictions on	The score for this variable is determined on the basis of the level of regulatory restrictiveness for bank	WB (Barth et al.,

	banks activities	participation in: (1) securities activities (2) insurance activities (3) real estate activities (4) bank ownership of non-financial firms. These activities can be unrestricted, permitted, restricted or prohibited that are assigned the values of 1, 2, 3 or 4 respectively. We use an overall index by calculating the average value over the four categories. Obviously, a higher value indicates greater restrictiveness.	2004b)
DEPINS	Deposit insurance scheme	Dummy variable that takes the value of one if there is an explicit deposit insurance scheme and zero otherwise.	WB (Barth et al., 2004b)
Control variables			
Bank-specific			
SIZE	Bank size	Logarithm of total assets	
EQAS	Bank capitalization	Equity / total assets	
Macroeconomic conditions			
GDPGR	Overall economic conditions	Real GDP growth	GMID
INF	Inflation	Annual rate of Inflation	GMID
Financial development			
ASSGDP	Size of the banking system	Assets of deposit money banks/ GDP	GMID
CLAIMS	Activity in the banking sector	Bank claims to the private sector / GDP	GMID
MACGDP	Size of the stock market	Stock market capitalization / GDP	GMID
Market structure			
FOREIGN	Presence of foreign banks	Fraction of the banking system's assets in banks that are 50% or more foreign-owned	WB (Barth et al., 2004b)
GOVERN	Presence of government-owned banks	Fraction of the banking system's assets in banks that are 50% or more foreign-owned	WB (Barth et al., 2004b)
CONC	Concentration	Percentage of assets held by the three largest commercial banks in the country	WB (Beck et al., 2006b)
Institutional environment			
PRIGHT	Property rights	This is an index of property rights that indicates the degree to which a country's laws protect property rights and the degree to which its government enforces those laws. It also assesses the likelihood that private property will be expropriated and analyzes the independence of the judiciary, and the ability of individuals and business to enforce contracts. The index takes values between 1 and 5, with higher values indicating higher property rights protection. (See note below).	Heritage Foundation

GOVINT	Government intervention in the economy	This is an index of government intervention in the economy. It measures government's direct use of scarce resources for its own purposes and government's control over resources through ownership. The index takes values between 1 and 5, with higher values indicating higher levels of government consumption in the economy and higher share of revenues received from state-owned enterprises and property.	Heritage Foundation
Access to banking services			
BRAKM	Extent of branch network	Number of branches per 1,000 sq km	WB (Beck et al., 2005).
ATMKM	Extent of ATMs	Number of ATMs per 1,000 sq km	WB (Beck et al., 2005).

Notes: WB: World Bank; GMID: Global Market Information Database of Euromonitor International; In its original form, as published by the Heritage Foundation, higher values for the property rights index indicate lower protection of private property. Hence, a score of 5 would imply very low protection whereas a score of 1 would indicate very high protection. For the purposes of the present study, for easiness of interpretation, we have reversed this scale. Thus, we replaced original values of 5 with 1 and visa versa, as well as original values of 4 with 2 and visa versa. Obviously, values of 3 have remained unchanged. Consequently, in our case higher values indicate more protection.

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