FINANCIAL INFORMATION EFFECTS ON THE MEASUREMENT OF COMMERCIAL BANKS' EFFICIENCY

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23 January 2007

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ABSTRACT:
Using Stochastic Frontier Analysis (SFA) in a sample of commercial banks from 107 countries for the period 1996-2003, we obtain a mean cost efficiency score of 0,84, which supports the evidence found in other works, suggesting an improvement of efficiency scores over the ones obtained in the previous decade. Adding some data on the financial information framework (Bank Regulation and supervision Database), our study shows that financial information rules produce significant bias in reported efficiency. Following less conservative standards, IAS or USGAAP, banks show lower levels of efficiency than banks in countries with more conservative standards. Also, in countries where disclosure of risk management policies is mandatory, banks seem to be less efficient.

1 Introduction

In the standard practice of banking, managers usually inform and make decisions based on ratio analysis, in which the efficiency ratio measures the costs expended to generate a dollar of revenue. Its purpose is to evaluate the overhead structure of a financial firm, even though it is unable to inform on the distance that separates one bank's efficiency from that of another bank with similar levels of inputs and outputs.

In other words, inefficiency should be assessed by measuring how far a firm's costs (or inputs) are from a "best practice" set of firms that conforms the "efficient frontier". But the true frontier is unknown and must be estimated from levels found in the data set. Frontier analysis provides an overall, objectively determined, numerical efficiency value (also called X-efficiency[1] in the economics literature) and ranking of firms that is not otherwise available.

A considerable amount of research has taken place on X-efficiency (or inefficiencies), and great strides have been made in developing techniques to measure it. But, once inefficiency is known, the question is why some firms are more efficient than others. However, relatively little empirical research has been devoted to developing an understanding of those factors which influence a bank's efficiency. The most common explanation relates efficiency with better management practices. Marshack and Andrews (1944) pointed out technical knowledge, effort, and luck as factors on which technical efficiency relies. But global management or these other more certain conditions are difficult to quantify. Variables used as proxies, such as education, experience or age, have been found not so explanatory.

Some studies focused on the impact of regulation and organizational form on costs and scale and scope efficiencies, but these earlier studies did not relate these factors directly to X-efficiency (i.e. Mester, 1991). Berger et al. (1993) grouped factors that are likely to influence a firm's X-efficiency into (1) agency problems between owners and managers, (2) regulation and organizational and legal structures, and (3) scale and scope of operations. Since that paper, much research has been done in connection with these factors, but no one has addressed the certain type of regulation that determines the quantity and the quality of the inputs of the models: the rules on financial information.

Financial information is the result of a systematic process in which the economic activity of an entity is measured, valued, and reflected. The primary objective of this information is to provide useful information to those who make business and economic decisions. But standards are different across the world. Each country may apply different forms of classification of financial information, different levels of disclosure and different values for the same items. However, to date the effects of these differences over efficiency measures remain unexplained, perhaps because the question links two quite separated literature strands: accounting standards and banking performance. Our study tries to fill this void for commercial banks across the world by relating the impact of the accounting system in which financial statements (inputs of the stochastic frontier

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[1] The term 'X-efficiency' was introduced in 1966 by Leibenstein. It is similar to technical efficiency but factors on demotivation of workers are explicitly included.

models) are disclosed over the efficiency reported (outputs of stochastic frontier models).

In a literature review we find that Berger and Humphrey (1997) classify USA among the countries with less efficient banks in several multiple country studies; Fecher and Pestieau (1993) highlight that banks in US and UK are relative inefficient; and Pastor et al. (1997) find that banks from France, Spain or Belgium are more efficient than those from UK, US or Germany, among others. These surprising results have led us to think that measures on efficiency could be deviated starting from the inputs: the certain items taken from the public financial accounting information. After a detailed checking of the efficiency scores in those works, we realized that banks in some developed countries seemed to get efficiency scores worse than expected, and this fact may be taking place in countries with less conservative accounting. Therefore, we hypothesize that differences in financial information play a decisive role in efficiency scores.

The results of our analysis, on a sample of commercial banks from 107 countries in the 1996-2003 time period, provide new insights into the two mentioned branches of existing research. First, this paper contributes to the bank efficiency research, providing new evidence from more than a hundred countries. Our results show that banks in France are more efficient than in U.S. and U.K., supporting what previous studies had shown without a satisfactory explanation.

Second, we confirm that financial information rules matter and produce significant bias in reported efficiency. Countries applying IAS, US GAAP or similar standards show apparently lower efficiency levels than countries with different standards. And we conjecture that this is due to the presence of more conservatism and more incentives for earnings management. Recent accounting research has documented cross-country variation in the conservatism, timely and value relevance between countries with common law countries (strong legal protection) and code law countries (weak legal protection). Furthermore, banks in countries where risk management practices must be disclosed show lower efficiency levels as well.

Considering our findings, the input data comparability should be borne in mind before making international comparisons, because rapid changes in the financial industry structure are occurring around the globe, and it is important to analyze differences in the managerial ability to control costs or maximize revenues.

We contribute to a growing literature on the effects of international accounting differences, including Alford et al. (1993), Joos and Lang (1994) and Pope and Walker (1999). We also contribute to the literature on institutional and legal differences across the world, La Porta et al. (1997). We also contribute to a strand of banking literature examining the differences in cross-country efficiency[2] including Berger et al. (1993), Fecher and Pastineau (1993), Allen and Rai (1996), Pastor et al. (1997), Dietsch (2000) and Lozano and Pastor (2006) among others. This study is the first to analyze the impact of the financial information framework in reported efficiency.

The next section provides a review of literature related to previous research on bank efficiency and stochastic frontiers, as well as international differences in financial

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[2] Berger and Humphrey (1997) highlight the lack of efficiency comparisons among countries.

information; Section 3 develops the methodology and the research hypotheses; Section 4 provides details on sample selection, variable measurement and efficiency estimations, presenting the results of the empirical tests; and Section 5 concludes.

2 Efficiency and Differences in Financial Information

The concept of efficiency is based on the comparison between optimum costs or profits and those realised. It is assumed that any deviation from the optimum can only be due to inefficiency. In practice, relative bank efficiency may be influenced by factors such as differences in size, institutional and legal determinants, type of business, markets the bank operates in, management know-how, and differences in the economic environment.

When estimating stochastic frontiers for the banking sector, X-efficiency is typically compared under the assumption that banks disclose their financial statements under a common basis. The interpretation of the efficiency scores relies on the validity of this assumption.

Disclosed financial information, elaborated under different frameworks, does not change real efficiency, but just the resulting measure of it, that is, the measures used by efficiency analysts. Consequently, the more different the standards affecting the items we use to compute efficiency, the less comparable the scores. If this is the case, the assumption of a common frontier in cross country efficiency may be misleading.

2.1 Bank Efficiency

Traditionally, banks' estimation of efficiency has been calculated on a ratio basis. Not all banks calculate the efficiency ratio in the same way, but however the ratio is calculated, its purpose is to evaluate the overhead structure of a financial institution.

Aside from this professional estimation, measuring bank efficiency is difficult because there is not a satisfactory definition of bank output. International comparisons based on operating costs and margins are fraught with problems. These stem from substantial differences in capital structure (leverage), business or product mix, range and quality of services, inflation rates, and accounting conventions (especially about the valuation of assets, the level of loan loss provisioning, and the use of hidden reserves). Facile and uncritical use of ratios cannot substitute for detailed knowledge and understanding of banking structure and practice (Vittas, 1991).

A more elaborated measure should be based on how far a firm's costs or inputs are from a "best" set of banks. Farrell (1957) was the first to measure productive efficiency empirically, showing how to define cost efficiency, and how to decompose it. The production function describes the technical relationship between the inputs and outputs of a production process. A production function defines the maximum outputs attainable from a given vector of inputs. One may either estimate a parametric function using econometric methods (ie. Stochastic Frontier Analysis), or a non-parametric function using mathematical programming (i.e. Data Envelopment Analysis).

Berger and Humphrey (1997) point out five different types of approaches that have been employed in evaluating the efficiency of financial institutions and branches. These approaches differ primarily in how much shape is imposed on the frontier and the distributional assumptions imposed on random error and inefficiency. Nonparametric approaches, such as Data Envelopment Analysis (DEA) and Free Disposal Hull (FDH), put relatively little structure on the specification of the best-practice frontier, whereas parametric frontiers, such as Stochastic Frontier Approach (SFA), Distribution-Free Approach (DFA) and Thick Frontier Approach (TFA) specify some functional form and make assumptions regarding the inefficiencies.

Stochastic Frontier Analysis (SFA) is useful because we are concerned with the estimation of frontiers, which envelop data, rather than with functions, which intersect data. The SFA approach modifies the standard production function, assuming that inefficiency takes part of the error term. The compound error term includes both a random effect component and an inefficiency term (Maudos, 1996; Alvarez Pinilla, 2001), because we maintain the traditional econometric belief in the presence of external forces contributing to random statistical noise, in addition to an asymmetric error term, measuring the distance to the estimated frontier, which is assumed to reflect inefficiency.

The objectives pursued by the producers can be purely technological or economic in nature, so we are concerned with the estimation of production frontiers as well as the estimation of cost and profit frontiers to get the degree of efficiency.

A growing number of papers in recent years have measured the X-efficiency[3] of non-US commercial banks. However, there is no consensus on the best method for estimating X-efficiency, or on the average level of X-efficiency of the banking industry, and there is limited evidence on cross-country comparisons.

Some studies measure and compare the efficiency of banks across international borders. Thus, Berg, Forsund, Hjalmarsson and Suominen (1993) provide evidence of the relative competitiveness of the banking industries in three Nordic countries using Data Envelopment Analysis of productivity on the national and the pooled data sets. The analysis produces a detailed account of how well banks from different countries and different sizes may be prepared to meet the more intense competition of a common European banking market. Also, Bergendahl (1998) and Bukh et al. (1995) study the bank efficiency in Nordic countries.

Fecher and Pestieau (1993) had found that banks in U.S. and U.K. are relatively inefficient, whereas France shows a high level of efficiency. In the same line, the study of Pastor et al. (1997) uses a non-parametric approach together with the Malmquist index, to compare the efficiency, productivity and differences in technology of different European and US banking systems for the year 1992, obtaining that France, Spain and Belgium appear as the countries with the most efficient banking systems, whereas the UK, Austria, US and Germany show the lowest efficiency levels.

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[3] X-inefficiencies are increases in production costs due to errors in management and/or organization. They can be technological, when the current production level could be obtained with a fewer quantity of inputs, or allocative, when the mix of inputs used does not minimize costs, given the relative prices (Maudos, 1996).

Allen and Rai (1996) use DFA and Stochastic Frontier Approach (SFA) for a systematic comparison of X-inefficiency measures across 15 developed countries under different regulatory environments. They find that large banks in separated banking countries (that prohibit the functional integration of commercial and investment banking) had the largest measure of input inefficiency amounting to 27.5 percent of total costs as well as significant levels of diseconomies of scale. All other banks have X-inefficiency levels ranging in the area of fifteen percent of total costs with slight economies of scale for small banks. More specifically, they found that large banks are significantly more (less) X-inefficient than small banks in Australia, Canada, Italy, Japan, and the U.S. (Austria, Switzerland, Spain, and France).

Differences have been found even in similar countries. Altunbas et al. (1998) argue that a comparison of bank efficiency across national frontiers entails an examination of the difference between countries in the institutional structure of the banking system. They believe that banks may not necessarily perform the same function in every country.

When a bank decides to operate in any other country, adverse environmental conditions are a positive factor for the home banking industry and being technically efficient appears to be a significant deterrence to foreign competition (Lozano, Pastor and Hasan, 2001). The environment comprises a set of variables with a significant contribution to the difference in efficiency scores between countries. The work of Dietsch and Lozano, (2000) suggests that, without environmental variables, the cost-efficiency scores of Spanish banks are quite low compared to those of French banks. However, when environmental variables are included in the model, the differences between both banking industries are reduced substantially. In particular, the specific environmental conditions of each country play an important role in the definition and specification of the common frontier of different countries. They take into account three categories of environmental variables: (i) those that describe the main macroeconomic conditions, which determine the banking product demand characteristics, (ii) those that describe the structure and regulation of the banking industry, and (iii) those that characterize the accessibility of banking services.

Moreover, Lozano, Pastor and Pastor (2002) investigate the operating efficiency differences of a sample of commercial banks across 10 European countries using DEA techniques, finding that country-specific environmental conditions exercise a strong influence over the behavior of each country's banking industry. Furthermore the environment exercises an important role in explaining the differences in intercountry banking productivity. Chaffai et al. (2001) find that productivity gaps between countries are very sensitive to environmental conditions. Even the effect of a hostile environment may dominate over better technology.

The wave of mergers and acquisitions of the last decades has attracted academic attention. However it is not clear which part of the results might depend on the country, the industry and the time period analyzed. Amel et al. (2004) find that consolidation in the financial sector is beneficial up to a relatively small size, but there is little evidence that mergers yield economies of scope or gains in managerial efficiency.

Recently some researchers have focused on transition countries, and the findings suggest that privatization by itself is not sufficient to increase bank efficiency as government-owned banks are not appreciably less efficient than domestic private banks.

Foreign-owned banks are more cost-efficient than other banks and they also provide better service, in particular if they have a strategic foreign owner (Bonin et al., 2005).

Much more research on efficiency is claimed (Berger et al., 1993; Maudos et al., 2002) due to several reasons:
1) The integration of European markets, as well as the general globalization of financial markets, means that the most efficient institutions may eventually dominate world markets.
2) The cross-country comparisons may also shed some light on the efficiency effects of various regulatory policies
3) Substantial differences in efficiency across nations would tend to suggest that regulatory policies be coordinated and made roughly equal (e.g., the Basle-risk-based capital accord) to allow for fairer competition.

Overall, several methods can be used to measure bank efficiency, but to date there is no consensus on the best method. Besides, it is clear that cross-country comparisons are needed even though they are difficult to interpret because the regulatory and economic environments faced by financial institutions are likely to differ importantly across countries and because the level and quality of service associated with deposits and loans may differ in ways that hardly can be measured. Such cross-country differences have not been specified when a 'common' frontier was being estimated and this give effects on the interpretation of the results.

2.2 International Differences in Financial Information

Theoretically, in comparing one bank's efficiency to another's, the comparison should be between banks producing the same output quality, as Berger and Mester (1997) say. But it is likely to be unmeasured differences in quality because the banking information does not succeed in capturing the whole heterogeneity in bank output.

As not all information is created equal, differences in information quality across firms come from several sources in three levels: the information, the managers, and the standards.
1) Information may be unable to reflect all the aspects of the business transactions, or even may be unable to reflect all the transactions;
2) The managers may select different options on what information they offer and how to do it;
3) The diverse standards across countries may contain different rules for disclosing the same economic transaction. Consequently, items and values may be reflected differently in financial statements.

Levels one and three are linked because transactions must be measured and valued to be reflected, but standards prescribe a part of these measurement and valuation conditions. Level two is related to the grade of harmonization and enforcement reached.

As for the third level, greater consistency and uniformity of accounting rules and disclosures is what standards setters have got as their main goal to achieve. This is because regulation affects the quality and quantity of final disclosures, but besides, the

information disclosed may have welfare and policy implications in the presence of externalities.

The principle of conservatism affects the setting and implementation of accounting standards, being the main way to introduce systematic bias in book value. Traditionally, conservatism has been expressed by the rule "anticipate no profits but anticipate all losses". Put in another way, conservatism is the tendency to require a higher degree of verification to recognize good news as gains than to recognize bad news as losses. With this idea in mind, Basu (1997) defines conservatism saying that "earnings reflect bad news more quickly than good news" and he finds that this asymmetry in recognition leads to systematic differences between bad news and good news periods in the timeliness and persistence of earnings. In the same strand, Watts (2003) reviews the existing research on conservatism, defining this term as the differential verifiability required for recognition of profits versus losses and finding that alternative explanations for conservatism are contracting, shareholder litigation, taxation, and accounting regulation.

From a cross-country point of view, Pope and Walker (1999) analyze differences in the timeliness of income recognition between the U.S. and U.K. GAAP financial reporting regimes, concluding that U.S. GAAP earnings are more timely with respect to bad news than U.K. GAAP earnings, however, additional tests suggest that U.K. firms recognize bad news faster than U.S. firms, but that they classify the bad news differently.

As Ohlson (1995) pointed out, growth plays a prominent role in determining the relation between earnings and economic income: when there is no growth, they are equal (asymptotically), but in the presence of a positive growth accounting earnings are on average less than economic income. Following Beaver and Ryan (2000) and Zhang (2001), Penman and Zhang (2002) develop diagnostic measures of the joint effect of investment and conservative accounting: growth in investment reduces reported earnings and creates reserves, while reducing investment increases earnings releasing those reserves.

Garcia and Mora (2004) provide evidence on the existence of both balance sheet and earnings conservatism in Europe, finding that code-law-based countries are more balance sheet conservative. Also, they suggest that balance sheet conservatism reduces earnings conservatism.

Despite European integration, substantial differences in financial information exist (Joos and Lang, 1994), probably due to socioeconomic and cultural differences. Some works have shown that differences in capital markets (accounting standards, disclosure practices, and corporate governance) lead to significant differences in the usefulness of disclosed earnings. For instance, Alford et al. (1993) find that annual disclosed earnings from Denmark, Germany, Italy, Singapore, and Sweden reflect less timely or less value-relevant information, than U.S. disclosed earnings.

In connection with corporate governance, Ball et al. (2000) characterize the 'shareholder' and 'stakeholder' models of common and code law countries respectively as resolving information asymmetry by public disclosure and private communication. Code law directly links accounting income to current payouts (to employees, managers, shareholders and governments). Consequently, code law accounting income is less

timely, particularly in incorporating economic losses. Many studies have found that variations among common law countries are due to differences in regulation, taxation and litigation. For example, stronger shareholder protection, an institutional factor characterizing a country's corporate governance environment, improves the effectiveness of the accrual system (Hung, 2000).

La Porta et al. (1997, 1998) document that common law countries have stronger investor protection laws and more developed financial markets than civil law countries. Also, Francis et al. (2003) document that national accounting standards are more timely (accrual-based) and transparent in common law countries, which is consistent with a greater role played by the public disclosure of accrual-based financial information in corporate governance in these countries. There is also greater demand for auditing as an enforcement mechanism when financial information is more timely and transparent.

Focusing on the value relevance of financial reports, Ali and Hwang (2000) find lower relevance for countries where the financial systems are bank-oriented rather than for those market-oriented; where private sector bodies are not involved in standard setting process; where accounting practices follow the Continental model as opposed to the British-American model; where tax rules have a greater influence on financial accounting measurements; and where spending on auditing services is relatively low.

Existing evidence reports that firms in countries characterized by high state involvement in the economy recognize good news faster and bad news slower than firms in countries with less state involvement (Bushman and Piotroski, 2006). Besides, both capital market pressure and regulatory impact seem to lead to more conservatism (Raonic et al. 2004)

Total comparability of financial statements would require a common set of manager and auditor incentives internationally, which in turn would require worldwide integration of economic, legal and political systems (Ball et al., 2003), as the three groups of variables corresponding to these systems profoundly affect financial reporting practice.

Overall, prior studies find that both balance sheet and earnings conservatism persist in Europe, despite of the integration of rules on financial information beneath the Directives; that differences in conservatism level exist between code law countries and common law countries; that some possible sources of those differences are: disclosure practices (transparency), corporate governance, capital market development and pressure, regulation (shareholder protection, law enforcement), taxation and litigation; that earnings are more timely and financial information reflects higher relevance in common law countries; that code law countries generally have weaker laws and enforcement; and finally that financial markets variations occur when supplemental data on risk are disclosed. Therefore, regulatory enforcement is positively associated with the bias towards conservatism.

2.3 The Role of Information Disclosure

"Financial reporting" is an elusive concept, particularly in view of the multiplicity of uses of financial statement information. Financial statements are the end result of the information process on the economic functioning of the firm, whose primary goal is to

provide decision makers with useful information. And comparability is one of the main characteristics that information requires to be useful.

Differences in disclosure come from the second level of sources mentioned in the previous section: the discretion of managers in applying the rules and describing the economic reality of the firm.

Regulation not only affects the quality and quantity of the information contained in financial statements, but it also affects the wealth of various parties. Principles on valuation have economic consequences because of implementation costs, compensation plans, debt contracts, and political costs. Furthermore, as Fields, Lys and Vincent (2001) say, an accounting choice influences (in form or substance) not only the financial statements published in accordance with accounting principles but also tax returns and regulatory filings.

Provided that standards affect the image of current and potential wealth of a firm and its managers, the managers have an obvious incentive to select the principles that increase their own wealth. Managers, therefore, have certain preferences for principles that are not necessarily related to the inherent quality of the resulting information. Such an incentive may be in conflict with the notion that managers select principles to provide useful information, what can be summed up as the agency theory applied to financial information (Lambert, 2001). Accordingly, care must be taken in interpreting both financial statements and managers' recommendations about standards on financial information.

For example, Beatty et al. (1995) document how banks alter the timing and magnitude of transactions and accruals to achieve primary capital, tax, and earnings goals in a sample of US banks. They found that managers' accrual decisions are complicated by other capital-rising activities, suggesting that financing and accounting discretion are mutually dependent.

Earnings management occurs when managers use judgment in financial reporting and in structuring transactions to alter financial reports to either mislead some stakeholders about the underlying economic performance of the company or to influence contractual outcomes that depend on reported numbers (Healy and Wahlen, 1999). Based on a view of accounting numbers as information, Schipper (1989) defines "earnings management" as "disclosure management" in the sense of a purposeful intervention in the external financial reporting process, with the intent of obtaining some private gain (as opposed to, say, merely facilitating the neutral operation of the process).

A higher use of accruals provides managers with more opportunities to manage earnings and poor shareholder protection exacerbates this managerial propensity. Leuz, Nanda and Wysocki (2003) reach similar conclusions, finding that countries with relatively dispersed ownership, strong investor protection, and large stock markets exhibit lower levels of earnings management than countries with relatively concentrated ownership, weak investor protection, and less developed stock markets.

Earnings management incentives exist if bank managers can lower their costs by using earnings to convey private information to investors (Scholes, Wilson and Wolfson,

1990). Alternatively, such incentives may arise because regulators monitor banks based on earnings (Shipper, 1989).

Under an informational perspective, earnings are one of many signals which may be used to make certain decisions and judgments. The informational perspective on earnings management assumes that managers have private information which they can use when they choose elements from a feasible set of reporting rules.

Voluntary disclosure is another relevant factor. Previous research suggests that supplemental data regarding default risk and interest-rate risk explain variations in banks' market-to-book ratios of common equity (Beaver et al., 1989). It must be taken into account that countries differ even in the information that firms obey to disclose.

In this sense, a growing body of research documents that those country-level differences in legal systems with respect to investor protection and the law enforcement are associated with systematic variations in financial markets. The main findings are that countries based on English common law generally have stronger laws and enforcement, than those based on Roman civil law which generally have weaker laws and enforcement (La Porta et al., 1998).

In explaining disclosure differences, securities laws matter because they facilitate private contracting rather than provide for public regulatory enforcement (La Porta et al, 2006) and managers are more likely to behave opportunistically in an environment with weak shareholder protection (La Porta et al., 1997).

Overall, accounting disclosure varies due to the earnings management; a higher use of accrual accounting, a poor shareholder protection, and small stock markets make earnings management easier; common law countries generally have stronger laws and enforcement, than those based on civil law which generally have weaker laws and enforcement. Therefore, equity market exposure appears to be positively associated with greater timeliness in earnings recognition.

3 Methodological Approach

The main concern of this work is that the common frontier is built by pooling all cross-country banks without considering that financial information conditions affect the measures of efficiency differences between countries. In other words, to the belief that efficiency differences across countries are attributable to managerial decisions within banks or to environmental conditions, we add the consideration that one of the environmental conditions, the financial information framework, originates cross-country differences in efficiency as it generates differences in the inputs used to compute the efficiency value.

Therefore, we propose a comparison of the cost-efficiency of the banking industries across the world, introducing financial information differences in the cost frontier estimations. We begin by outlining a popular benchmark cost model on the basis of multioutput approach.

The first step to measure X-inefficiency in any parametric empirical application is to select an appropriate functional form for the production function. A variety of functional forms have been used in applied production analyses: from the simple Cobb-Douglas function to more complex forms, such as the translog. We apply the translog functional form because it has been widely used in bank efficiency studies due to its generally accepted higher flexibility when approximating any unknown function.

As we have indicated before, in the basic stochastic econometric frontier model, the observed cost of a bank may deviate from the cost frontier due to random noise and/or due to inefficiency. For N banks in the sample the cost function in logarithmic terms is expressed as:

$$(1) \quad \ln C_i = \ln C(y_i, w_i; B) + u_i + v_i$$
$$i = 1, ..., N$$

Where C_i is the observed cost for firm i, y_i is a vector of output levels for firm i, w_i is the vector of input prices for firm i, B is a vector of parameters, $\ln C(y_i, w_i; B)$ is the predicted log cost function of a cost-minimizing firm operating at ouput level y_i and input prices w_i, v_i is a two-sided error term representing the statistical noise, and u_i is a one-sided error term representing inefficiency.

On the evaluation of the efficiency of financial institutions and branches, Berger and Humphrey (1997) find five different types of approaches, which can be grouped in nonparametric and parametric frontiers. In this study we apply the parametric methodology, using the Stochastic Frontier Approach (SFA), proposed in 1977 by Aigner, Lovell and Schmidt, to measure the X-inefficiency of individual commercial banks. These models allow for technical inefficiency, but they also acknowledge the fact that random shocks outside the control of managers can affect the output. To separate the two components, the inefficiency term is assumed to follow an asymmetrical probability distribution.

$$(2) \quad \ln(c_{it}) = f(\ln y_{it}, \ln w_{jt}) + \ln(u_{it}) + \upsilon_{it}$$

Where f denotes some functional form. We define the cost efficiency of bank i as the estimated cost needed to produce bank $i's$ output vector if the bank were as efficient as the best-practice bank in the sample facing the same exogenous variables divided by the actual cost of bank i, adjusted for random error.

To specify the cost function in equation (2), we employ the following multiproduct translog cost function:

(3)

$$\ln\left(c_{it}\right) = \beta_0 + \sum_{k=1}^{3} \beta_k \ln(y_{kit}) + \frac{1}{2} \sum_{k=1}^{3} \sum_{j=1}^{3} \beta_{kj} \ln(y_{kit}) \ln(y_{jit}) + \sum_{n=1}^{3} \gamma_n \ln(w_{nit}) + \frac{1}{2} \sum_{n=1}^{3} \sum_{m=1}^{3} \gamma_{nm} \ln(w_{nit}) \ln(w_{mit})$$

$$+ \sum_{k=1}^{3} \sum_{n=1}^{3} \lambda_{kn} \ln(y_{kit}) \ln(w_{nit}) + \delta_E \ln(E) + \frac{1}{2} \delta_{EE} \ln(E)^2 +$$

$$+ \sum_{k=1}^{3} \rho_{Ek} \ln(E) \ln(y_{kit}) + \sum_{k=1}^{3} \tau_{En} \ln(E) \ln(w_{nit}) + \ln \upsilon_i + \ln u_{it}$$

Where y is the output vector, w the price of input vector and E the equity capital.

Following Berger and Mester (1997), we define the cost efficiency of bank i as the estimated cost needed to produce output vector if the bank were as efficient as the best-practice bank in the sample. That is,

$$(4) \qquad ef^i = \frac{\hat{C}^{min}}{\hat{C}^i} = \frac{\hat{u}_c^{min}}{\hat{u}_c}$$

Consequently, cost efficiency ranges over the interval (0, 1], and is the proportion of costs that have been used efficiently. Put in another way, the $(1-ef)\cdot 100$ is the percentage of costs that are wasted relative to the most efficiency bank. That is, a bank with $ef = 0.70$ is 70% efficient or wastes 30% of its costs, relative to a best-practice bank in the same conditions. Therefore, the lower the ef ratio, the greater inefficiency the bank shows.

Once the efficiency concepts have been selected, the next issue is how to go about measuring them. To obtain a measure of efficiency, we use a time invariant model in which the inefficiency term is assumed to have a half-normal distribution[4]. We apply the Battese-Coelli (1992) parametrization of time effects, where the inefficiency term is modeled as a half-normal random variable multiplied by a specific function of time. However, the estimate of eta is very close to zero, and the other estimates are not too far from those of the time-invariant model.

4 Sample and Results

In this section, we explain the sources of the data used to build the sample of our empirical work, the final sample contents, and the various data disaggregations made to apply the different tests of the study. Then, we show two types of results: those on the efficiency measurement, obtained through the using of SFA, and those on the comparison of efficiency scores across different financial information regimes with several levels of disclosure.

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[4] For more details, see Kumbhakar and Novell (2000).

4.1 Data

All the information necessary for estimating cost efficiency is contained in the BankScope Database. The final sample contains 5847 observations, corresponding to 1280 banks over the period 1996-2003, from 107 countries.

Our first problem is the definition and measurement of output. We are restricted by the disaggregation of information contained in the financial statements as provided by BankScope. Following Maudos, Pastor, Pérez and Quesada (2002), we consider six variables. The first three are balance sheet items that have been selected as good indicators of output, adopting the intermediation approach. The second three variables are ratios computed relating some items from the income statement with some items from the balance sheet. They represent the prices of some productive factors. The seventh variable is Equity. With it we try to capture the bank's global risk[5] through the financial capital:

1. $y_1 = $ Loans
2. $y_2 = $ Other Earning Assets
3. $y_3 = $ Deposits
4. $w_1 = $ Cost of Loanable Funds
5. $w_1 = $ Cost of Labour
6. $w_1 = $ Cost of Physical Capital
7. $E = $ Equity

Definitions of the seven variables are gathered in Table 1. As it can be seen, the Cost of Labour variable should be interpreted as 'Overhead cost per worker adjusted for differences in labour productivity', but due to restrictions in data availability, we compute it with the total costs instead of the costs per worker, as is common in studies that employ IBCA Data[6].

Table 2 reports sample descriptives. The average value of total costs is 13 millions of Euros, however the sample presents a great dispersion, with a maximum value of 3,156 millions. Also, 75% of the cases are below of 487 thousand euros. This great dispersion is also observed in the variables that define the outputs and the one representing the equity. It is caused by considering countries with heterogeneous levels of development. Defined as ratios, variables measuring the output's prices show smaller dispersion, as expected, although they are influenced by interest rates and inflation spreads across countries.

Banks differ in size and financial capital by large amounts. Average levels of capital and total assets are 21,344 millions and 238,070 millions respectively, although 75% of the cases are below of those levels.

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[5] Berger and Mester (1997) advise the introduction of this variable to capture the bank's insolvency risk. But a good risk management system put Equity close to the firm's Capital at risk, which includes not only the insolvency risk but the whole risks of the entity.

[6] $\dfrac{\text{Overheads}}{\text{Total Assets}} = \left(\dfrac{\text{Overheads}}{\text{Labour}}\right) \times \left(\dfrac{\text{Labour}}{\text{Total Assets}}\right)$

Table 3 shows correlations of each variable, and we can observe high (and positive) levels of correlation between outputs and total costs. Also, the use of capital is correlated with total cost.

4.2 Empirical Results of Efficiency Measurement

In Table 4 we show the results of SFA using maximum likelihood techniques.

Table 5 presents cost efficiency means grouped by country. Our sample indicates that the most efficient countries are Belarus, Monaco and Tunisia, whereas Republic of Georgia, Brunei Darussalam, and Suriname are the least efficient countries. These results are surprising since it doesn't seem coherent to find the most efficient banks in countries with poverty, underdevelopment, and higher levels of corruption.

Contrary to what previous research has shown, we find that US banks report a relatively higher efficiency, even higher than that reported by banks from some continental European countries. This result may be due to the size of the US sample (only two banks across time). But consistent with evidence found in previous works, if we consider the countries with more data available, banks in Germany and France are more efficient than those in UK.

At bank level, the mean cost efficiency of 0.84 suggests that about 16% of costs are wasted on average relative to a best-practice, with a wide range and high standard deviation, suggesting that these efficiencies are quite dispersed. If we take a country level approach, mean cost efficiency is lightly superior while the standard deviation is much smaller. These values are within the range found in the literature (Berger and Mester, 1997), suggesting an improvement over the efficiency results obtained in the previous decade.

4.3 Comparison of Efficiency across Different Financial Information Frameworks

To shed light on the surprising results across countries, we take four items from the 2003 Bank Regulation and Supervision Database[7]. More specifically, we use one item from Database Section 3 (Capital) which shows if financial information practices for banks are in accordance with International Accounting Standards (IAS), or if they are in accordance with US GAAP, respectively.

As a result, we have got a sample with some new categories:
1) Countries in which IAS are applied and countries in which they are not;
2) Countries with financial information in accordance with US GAAP and those that apply national GAAP.

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[7] This WorldBank project includes cross-country surveys (covering 151 countries) on how banks are regulated and supervised, including requirements and regulatory powers regarding bank entry, ownership, capital, powers and activities, auditing, organization, liquidity, provisioning, accounting and disclosure, incentives for supervisors, deposit insurance, and disciplining powers including bank exit. http://www.worldbank.org/research/interest/2003_bank_survey/2003_bank_regulation_database.htm

Figures 1 and 2 depict both classifications. We observe that the efficiency scores in non-IAS countries reach a higher level than in IAS countries. Figure 2 confirms this conclusion, and overall, these findings suggest that IAS and US GAAP generate smaller levels of efficiency, probably due in part to a less conservative system.

Also, we take two items from Database Section 10 (Accounting/information disclosure requirements). The first shows if banks disclose their risk management procedures in each country, and the second indicates if financial institutions are required to produce consolidated accounts covering only bank subsidiaries or both bank and non-bank subsidiaries. The existence of consolidated accounts covering all bank and non-bank subsidiaries, and the risk disclosures improve the quantity and quality of bank public information and add pressure on managers, especially in the case of listed banks because shareholders require value creation.

We transform these items in three dummy variables (1 if answer is affirmative and 0 if negative) and combine them with our efficiency estimates. Resultant database allows us to divide efficiency averages at a country level in two samples, then, we perform a t-test to determine if accounting measures and risk information makes a difference in reported efficiency or not.

Figures 3 and 4 summarize efficiency data by type of financial information system showing the shape of the distribution, its central value, and variability. The median for each dataset is indicated by a line through the box, and the first and third quartiles are the edges of the box area, which is known as the inter-quartile range (IQR). The extreme values (within 1.5 times the inter-quartile range from the upper or lower quartile) are the ends of the lines extending from the IQR. Points at a greater distance from the median than 1.5 times the IQR are plotted individually. These points represent potential outliers.

The inter-quartile range decreases from IAS/US GAAP to non-IAS/non-US GAAP, indicating reduced variability of efficiency, likely due to less conservatism and more earnings management. In addition, countries with national GAAP show extreme values closer to the median.

Another important finding is the statistically significant and negative correlation between efficiency and IAS, GAAP and risk disclosures. As we can see in Table 7, banks operating in countries with IAS or US GAAP and put under the obligation to disclosure their risk management practices, tend to appear more inefficient in comparison with banks in other accounting framework. However, we do not find differences between countries in which financial institutions are obliged to produce consolidated accounts with one or both types of subsidiaries.

To test the significance of differences in the measurement of efficiency across the different financial information systems considered, we apply a t-test. Table 8 shows that mean efficiency is similar in countries in which financial institutions are required to produce consolidated accounts covering all bank and any non-bank subsidiaries. However, if banks must disclose their risk management procedures to the public their efficiency indexes are lower than banks without this obligation.

Finally, banks with financial information practices in accordance with IAS and/or US GAAP shows more inefficiency than banks following other standards (Table 8, Panels C and D). These differences are around 4% (US GAAP) and 5% (IAS).

5 Conclusions

Our study builds on recent advances on two streams of research: bank efficiency and financial information, trying to identify the role of the international differences on the second, over the measurement of the first: the commercial bank efficiency across the world.

Some papers have studied various bank, market, and regulatory characteristics that are at least partially exogenous to efficiency in order to help explain the observed large differences in bank efficiency across firms and countries. A two-step procedure is typically used, whereby firm efficiency is estimated using one of the techniques described above and is then regressed on, or tested for correlation with, a set of variables describing the characteristics being investigated. Some econometric issues make such analyses suggestive but not conclusive, mainly because none of the variables used in the regressions is completely exogenous. The answer to this question has important implications for public policy, research, and bank management, but more work is needed before a complete picture of financial institution efficiency emerges, and this paper tries to help complete the picture.

We have used the SFA proposed by Aigner, Lovell and Schmidt (1977) to measure the X-efficiency of 1280 individual commercial banks from 107 countries (BankScope data for the period 1996-2003), applying the Battese-Coelli (1992) parametrization of time effects. Following Maudos, Pastor, Pérez y Quesada (2002) we consider seven variables taken from the balance sheet and the income statement: loans, other earning assets, deposits, cost of loanable funds, cost of labour, cost of physical capital and equity. In general, efficiency estimates are consistent with evidence found in previous studies: Germany and France get better scores than UK. Although US banks report a relatively high efficiency, the size of the sample for this country may have biased the result.

At bank level, the mean cost efficiency is 84%. The wide range and high standard deviation was expected considering the number and variety of countries included in the sample. At country level, the standard deviation is much smaller and the scores are within the range found by other researchers (Berger and Mester, 1997), suggesting better efficiency results than in previous decade.

Theoretically, when comparing efficiency scores, inputs to compute efficiency should have been expressed in the same language. As inputs come from financial statements, accounting standards across countries should be so similar that the same economic transactions would be reflected with the same items and the same values.

Financial information plays an important role to allow making international comparisons and analyzing the performance of companies in different countries, however we know that financial information frameworks diverge from one country to another. Therefore, we hypothesize that accounting standards may bias efficiency estimates often calculated in banking literature.

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Existing research has shown that IAS and US GAAP exhibit significantly greater timeliness and earnings conservatism than other accounting regimes, probably due to greater sensitivity to economic losses (income conservatism) and lesser earnings management. This result has important implications for international comparisons of commercial bank performance across the world.

More especifically, our second part of the study analyses the previous obtained cost efficiency jointly with the financial information system applied by banks, available from a World Bank database.

Using a panel data frontier approach, we find higher levels of inefficiency in costs in countries with IAS or US GAAP, verifying the importance of financial information data available to obtain an efficiency measure. Also, the low and negative correlation between the rankings of cost and IAS (and US GAAP) is indicative of poor efficiency related with the accounting standards but not with bank performance. Our results are consistent with the belief that accounting rules generate differences and transforms cross-country comparisons in a difficult task. We have found an explanation for the relatively low bank efficiency identified in some well developed countries (i.e. USA or UK) in previous research works. Thereby, our findings suggest the importance of considering accounting setting factors such as conservatism, timely and disclosure when formulating international rankings of bank efficiency using frontier analysis.

In IAS/USGAAP countries public disclosures play a greater role and there is also greater demand for auditing as an enforcement mechanism. Data show that countries with risk disclosures exhibit more inefficiency and we conjecture that more information available and stronger property rights, as distinct from opaque accounting data, increase managers' incentives to manage financial information. Thus, conservatism facilitates monitoring of managers and is an important feature of corporate governance in common-law countries.

From these results, we can conclude that countries with low demand from published financial reports and low legal protection tend to employ accounting practices that produce data less timely and earnings more conservative than countries with IAS or US GAAP. Thus, some differences in reported efficiency appear, making cross country comparisons difficult and biased if this factor is not considered.

There are several limitations to interpreting the results. First, the conflict between the nonparametric and parametric approaches is important because both types of methods tend to have different degrees of dispersion and rank the same financial institutions somewhat differently.

Second, some studies show that alternative profit efficiency is closer to reality whenever the assumption of perfect competition in pricing is questionable, or when there are differences of production quality among the banks in the sample (Berger and Mester, 1997). Higher (lower) costs do not necessarily imply lower (higher) profits, indicating the potential importance of the revenue side in the valuation of efficiency (Maudos et al., 2004).

Third, we only consider the accounting system, however, future works should consider the entire institutional structure on the financial reporting process and the framework in which the bank operates.

Finally, our sample includes a diverse group of countries with different levels of competition.

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Appendix

Table 1 Variable Definitions

Variable	Name	Description (BakScope Items)
ef	Efficiency	Stochastic Frontier Analysis
tc	Total Costs (Financial + Operating)	= Total Operating Expense + Non-Operating Expense
y1	Loans	= Loans
y2	Other Earning Assets	= Other Earning Assets
y3	Deposits	= Deposits & Short Term Funding + Other Funding
w1	Cost of Loanable Funds	= Interest Expense / (Deposits & Short Term Funding + Other Funding)
w2	Cost of Labour	= Overheads / Total Assets
w3	Cost of Physical Capital	= Other Operating Expenses / Fixed Assets
e	Equity	= Equity

Source: World Commercial Banks with C2 Code Consolidation (1996-2003) from BankScope

Table 2 Descriptives (Cross-Sectional Level)

Variable	Mean	St.Dev.	Max	Min	p25	p50	p75
$tc_{thd€}$	13,202.18	121,307.90	3,156,515.00	0.00	24.70	113.90	487.10
$y1_{thd€}$	128,111.10	1,094,139.00	29,500,000.00	-101.00	249.70	1,793.40	9,984.00
$y2_{thd€}$	77,571.16	583,788.70	14,900,000.00	0.00	189.40	1,138.40	5,763.60
$y3_{thd€}$	202,678.50	1,652,064.00	46,000,000.00	0.00	513.70	3,088.50	14,883.50
w1	0.08	0.84	53.00	-0.01	0.03	0.05	0.07
w2	0.04	0.04	0.70	0.00	0.02	0.03	0.04
w3	1.16	9.49	606.00	-11.19	0.17	0.37	0.78
$e_{thd€}$	21,344.60	195,045.40	5,243,627.00	0.00	63.80	246.90	964.70
$assets_{thd€}$	238,070.90	1,923,433.00	51,600,000.00	0.02	635.20	3,584.25	16,888.00

Table 3 Correlations

	tc	y1	y2	y3	w1	w2	w3	e
tc	1							
y1	0.9604*	1						
y2	0.8778*	0.8789*	1					
y3	0.9656*	0.9882*	0.9337*	1				
w1	0.0112	0.0353*	0.0098	0.0038	1			
w2	0.0319*	0.0133	0.0055	0.0123	0.1964*	1		
w3	-0.0084	-0.0089	-0.0094	-0.0093	0.0092	0.0827*	1	
e	0.9049*	0.9057*	0.8944*	0.9114*	0.0288*	0.0148	-0.0077	1

Table 4 SFA Results

Cost Efficiency: Time-invariant inefficiency model

Log C	Coefficient	Std. Error
$\log(w_1)$	0.131***	[0.025]
$\log(w_2)$	0.872***	[0.036]
$\log(w_3)$	-0.0284	[0.017]
$\frac{1}{2}\log(w_1)^2$	0.0193***	[0.0046]
$\frac{1}{2}\log(w_2)^2$	-0.0284***	[0.011]
$\frac{1}{2}\log(w_3)^2$	0.00204	[0.0025]
$\frac{1}{2}\log(w_1)\log(w_2)$	-0.0244	[0.015]
$\frac{1}{2}\log(w_1)\log(w_3)$	-0.0240***	[0.0066]
$\frac{1}{2}\log(w_2)\log(w_3)$	0.0209**	[0.0083]
$\log(y_1)$	-0.0144	[0.047]
$\log(y_2)$	-0.00686	[0.036]
$\log(y_3)$	0.515***	[0.063]
$\frac{1}{2}\log(y_1)^2$	0.0592***	[0.0081]
$\frac{1}{2}\log(y_2)^2$	0.0292***	[0.0060]
$\frac{1}{2}\log(y_3)^2$	0.170***	[0.026]
$\frac{1}{2}\log(y_1)\log(y_2)$	0.00638	[0.027]
$\frac{1}{2}\log(y_1)\log(y_3)$	-0.102***	[0.030]
$\frac{1}{2}\log(y_2)\log(y_3)$	-0.0704**	[0.029]
$\log(w_1)\log(y_1)$	-0.00124	[0.0076]
$\log(w_1)\log(y_2)$	-0.00270	[0.0087]
$\log(w_1)\log(y_3)$	-0.0284**	[0.013]
$\log(w_2)\log(y_1)$	-0.0371***	[0.010]
$\log(w_2)\log(y_2)$	-0.0207***	[0.0063]
$\log(w_2)\log(y_3)$	0.0380***	[0.014]
$\log(w_3)\log(y_1)$	-0.00977*	[0.0056]
$\log(w_3)\log(y_2)$	0.00351	[0.0030]
$\log(w_3)\log(y_3)$	0.00646	[0.0077]
$\log(Equity)$	0.453***	[0.032]
$\frac{1}{2}\log(Equity)^2$	0.0739***	[0.0074]
$\log(y_1)\log(Equity)$	0.00637	[0.0091]
$\log(y_2)\log(Equity)$	0.0136*	[0.0082]
$\log(y_3)\log(Equity)$	-0.102***	[0.013]
$\log(w_1)\log(Equity)$	0.0305***	[0.0064]
$\log(w_2)\log(Equity)$	0.00922	[0.0079]
$\log(w_3)\log(Equity)$	0.00500	[0.0045]
Constant	0.951***	[0.086]
μ	0	
$\log(\sigma^2)$	-1.966***	[0.042]
/ilgtgamma	0.843***	[0.066]
σ^2	0.1400804	[0.006]
gamma	0.6992	[0.014]
σ^2_u	0.0979	[0.006]
σ^2_v	0.0421	[0.001]
Log likelihood	121.2443	
Observations	5847	
Number of Banks	1280	
Wald chi^2(35)	290589.62	
Prob > chi^2	0.0000	

Iteration 0: log likelihood = -186.25056
Iteration 1: log likelihood = 29.570941
Iteration 2: log likelihood = 120.00659
Iteration 3: log likelihood = 121.24333
Iteration 4: log likelihood = 121.24426
Iteration 5: log likelihood = 121.24426

Standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Table 5 Mean Efficiency by Country

Code	Country	Mean	Banks	Code	Country	Mean	Banks
BY	BELARUS	0.9746	1	PK	PAKISTAN	0.8614	4
MC	MONACO	0.9728	1	JO	JORDAN	0.8566	2
TN	TUNISIA	0.9514	1	ID	INDONESIA	0.8562	10
MA	MOROCCO	0.9412	4	GB	UNITED KINGDOM	0.8535	68
KY	CAYMAN ISLANDS	0.9408	1	EC	ECUADOR	0.8521	4
SN	SENEGAL	0.9408	1	LU	LUXEMBOURG	0.8506	6
LI	LIECHTENSTEIN	0.9346	2	LT	LITHUANIA	0.8482	8
MX	MEXICO	0.9328	20	ZA	SOUTH AFRICA	0.8474	10
ZM	ZAMBIA	0.9327	3	SE	SWEDEN	0.8459	5
UZ	UZBEKISTAN	0.9325	1	HU	HUNGARY	0.8451	10
AG	ANTIGUA AND BARBUDA	0.9321	1	LK	SRI LANKA	0.8437	7
ZW	ZIMBABWE	0.9278	2	UA	UKRAINE	0.8417	6
ET	ETHIOPIA	0.9255	1	KN	ST. KITTS AND NEVIS	0.8397	2
CA	CANADA	0.9253	1	PT	PORTUGAL	0.8365	16
MW	MALAWI	0.9220	3	PG	PAPUA NEW GUINEA	0.8363	2
MU	MAURITIUS	0.9217	2	SG	SINGAPORE	0.8317	13
SK	SLOVAKIA	0.9206	4	BH	BAHRAIN	0.8295	2
SZ	SWAZILAND	0.9176	2	PA	PANAMA	0.8288	15
SI	SLOVENIA	0.9163	8	BR	BRAZIL	0.8257	68
FI	FINLAND	0.9129	10	BW	BOTSWANA	0.8247	1
FR	FRANCE	0.9126	90	TR	TURKEY	0.8209	27
LV	LATVIA	0.9117	6	DO	DOMINICAN REPUBLIC	0.8183	2
US	USA	0.9108	2	EE	ESTONIA	0.8182	9
TZ	TANZANIA	0.9013	2	CH	SWITZERLAND	0.8181	37
NZ	NEW ZEALAND	0.9011	6	CL	CHILE	0.8153	17
VN	VIETNAM	0.8939	1	MK	MACEDONIA (FYROM)	0.8136	2
IE	IRELAND	0.8938	12	VE	VENEZUELA	0.8129	8
LS	LESOTHO	0.8929	1	SV	EL SALVADOR	0.8104	6
BE	BELGIUM	0.8911	23	KZ	KAZAKHSTAN	0.8103	2
BI	BURUNDI	0.8899	1	TW	TAIWAN	0.8080	8
CR	COSTA RICA	0.8892	4	AT	AUSTRIA	0.8066	17
IL	ISRAEL	0.8884	12	NG	NIGERIA	0.8056	9
NL	NETHERLANDS	0.8879	26	IN	INDIA	0.8052	17
HR	CROATIA	0.8852	5	AR	ARGENTINA	0.8030	20
JM	JAMAICA	0.8829	5	CY	CYPRUS	0.8024	12
MT	MALTA	0.8824	2	CS	SERBIA AND MONTENEGRO	0.7988	3
PH	PHILIPPINES	0.8821	17	NO	NORWAY	0.7889	9
GR	GREECE	0.8795	19	CN	CHINA-PEOPLE'S REP.	0.7867	6
KE	KENYA	0.8788	14	KR	KOREA REP. OF	0.7862	27
HN	HONDURAS	0.8783	1	PE	PERU	0.7816	5
UG	UGANDA	0.8765	1	MY	MALAYSIA	0.7807	27
AU	AUSTRALIA	0.8761	31	RO	ROMANIA	0.7793	5
CO	COLOMBIA	0.8749	2	JP	JAPAN	0.7780	142
DK	DENMARK	0.8741	18	OM	OMAN	0.7705	1
NA	NAMIBIA	0.8735	3	TT	TRINIDAD AND TOBAGO	0.7689	6
RU	RUSSIAN FEDERATION	0.8727	34	HK	HONG KONG	0.7608	23
ES	SPAIN	0.8702	46	IS	ICELAND	0.7370	3
BB	BARBADOS	0.8697	1	MO	MACAU	0.7338	2
DE	GERMANY	0.8679	35	GH	GHANA	0.7251	5
IT	ITALY	0.8673	37	MZ	MOZAMBIQUE	0.7097	2
CZ	CZECH REPUBLIC	0.8665	4	TH	THAILAND	0.7067	10
PL	POLAND	0.8629	12	SR	SURINAME	0.6793	2
LB	LEBANON	0.8621	6	BN	BRUNEI DARUSSALAM	0.5470	1
		(next column...)		GE	GEORGIA REP. OF	0.4885	1
				Total		**0.8421**	**1280**

Table 6 Efficiency Statistics by Bank and by Country

	Bank Level	Country Level
Cases	1280	107
Mean	0.8421	0.8482
Std. Dev.	0.1230	0.0754
Min	0.2031	0.4885
Max	1	0.9746

Figure 1 Bank efficiency by accounting system: IAS vs. Non-IAS
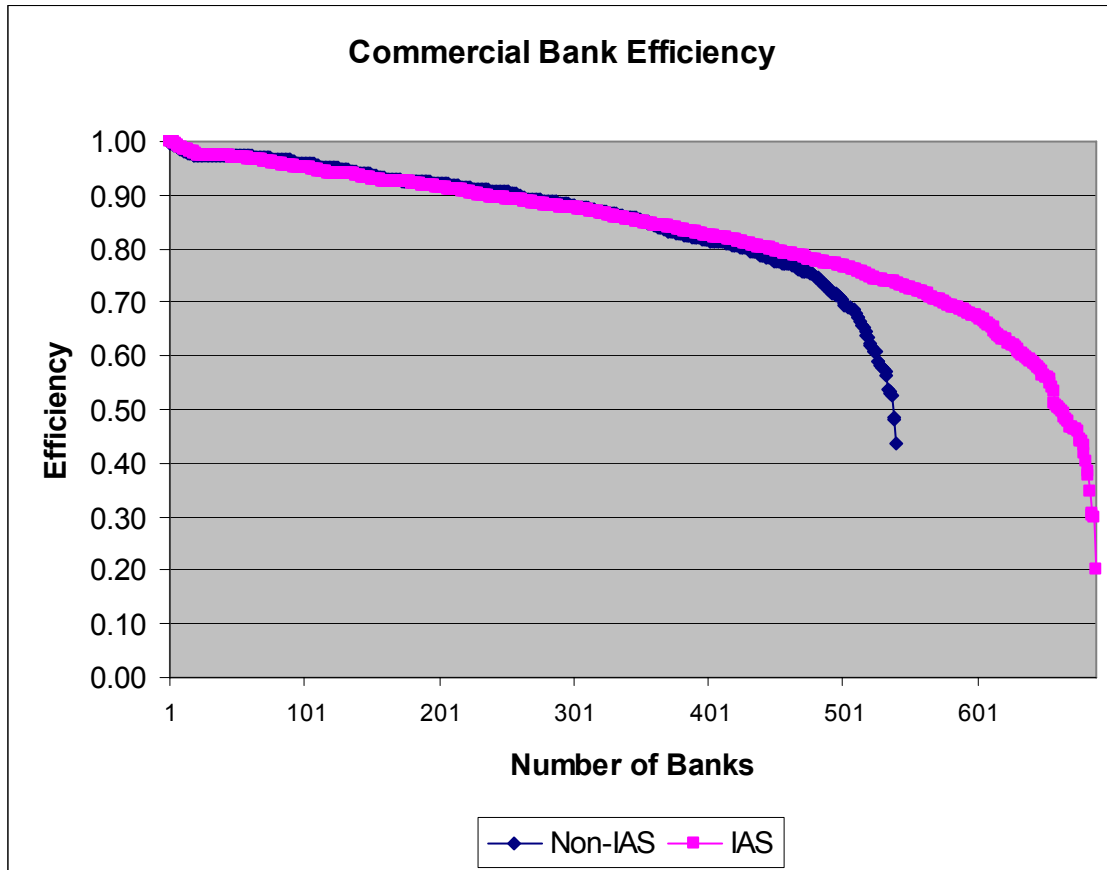
Although more Banks apply IAS, we observe lower extreme
levels of efficiency in countries with IAS.

Figure 2 Bank efficiency by accounting system: US GAAP vs. Non-US GAAP

Commercial Bank Efficiency
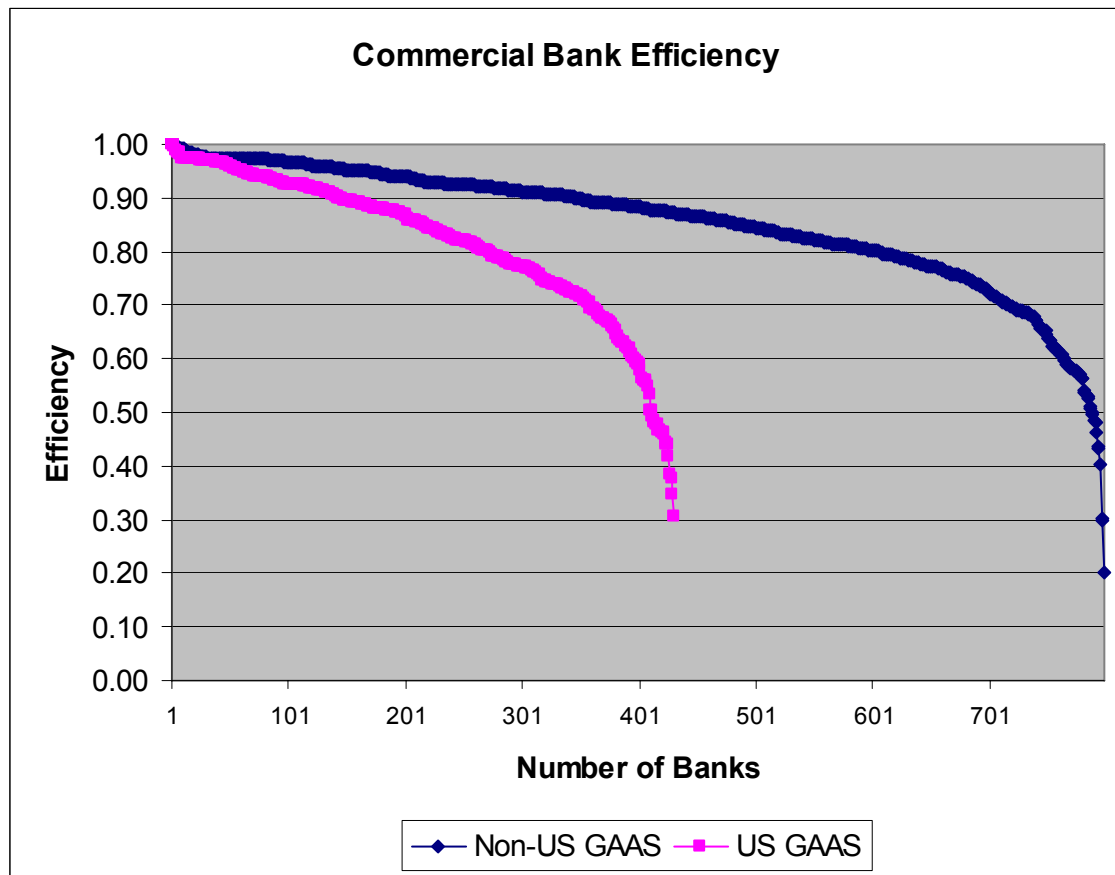
More banks apply Non-US GAAP. However, we find a concentration of lower extreme values in US GAAP.

Figure 3 Boxplot of IAS
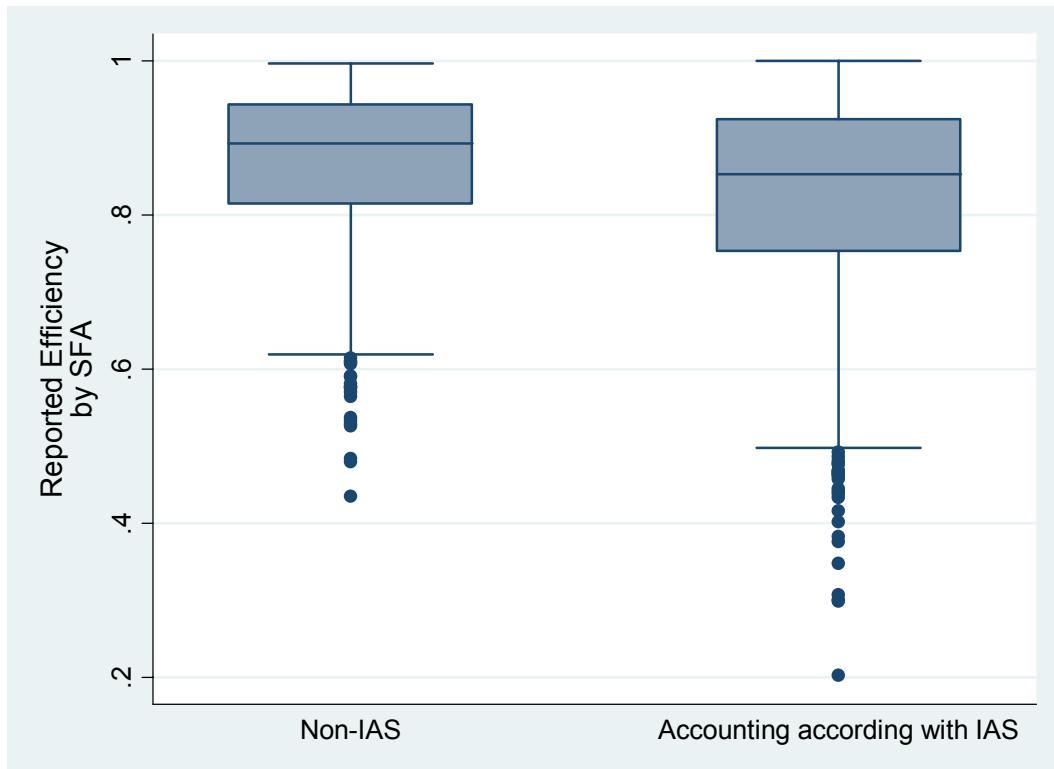
The median for each dataset is indicated by a centre line inside the box, and the first and third quartiles are the edges of the box area, which is known as the inter-quartile range (IQR). The extreme values (within 1.5 times the inter-quartile range from the upper or lower quartile) are the ends of the lines extending from the IQR. Points at a greater distance from the median than 1.5 times the IQR are plotted individually. These points represent potential outliers.

Figure 4 Boxplot of US GAAS
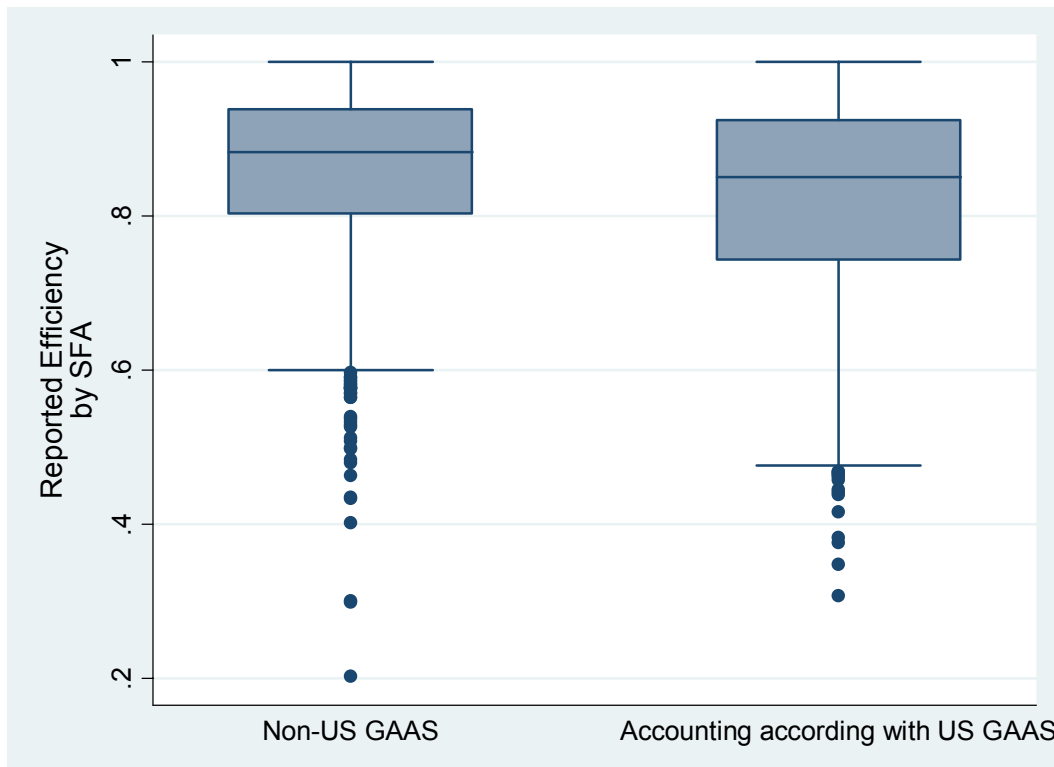
Figure 5 Histogram of Efficiency Grouped by Non-US GAAP (0) and US GAAP (1)
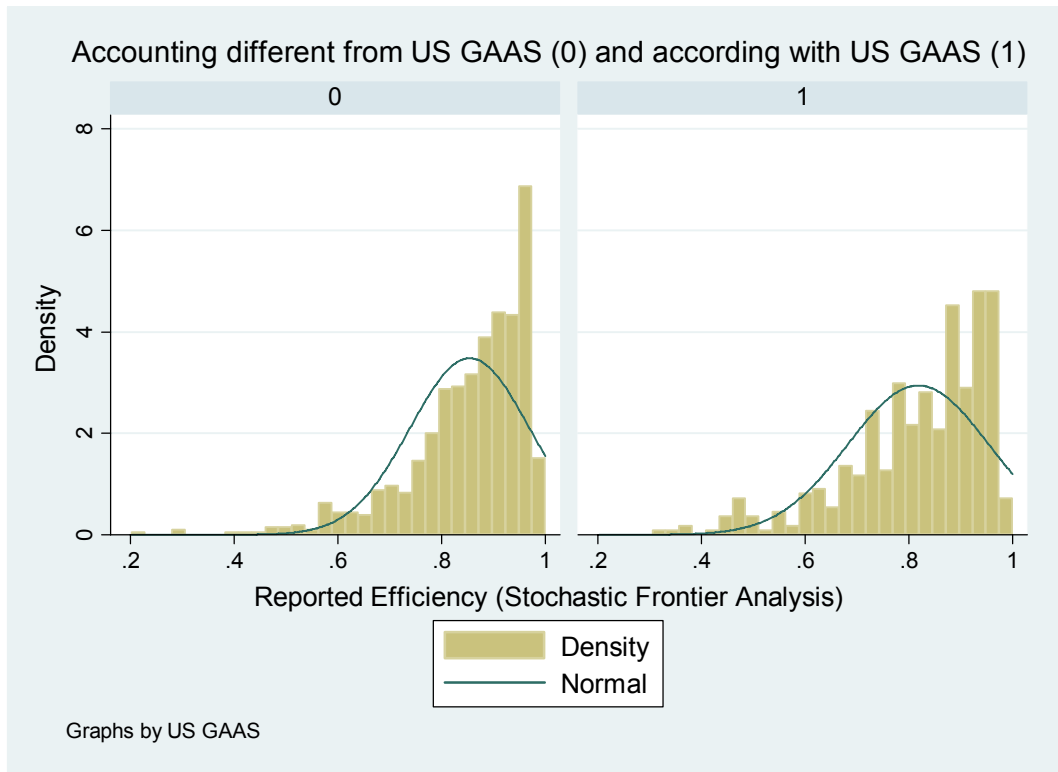
Figure 6 Histogram of Efficiency Grouped by Non-IAS (0) and IAS (1)
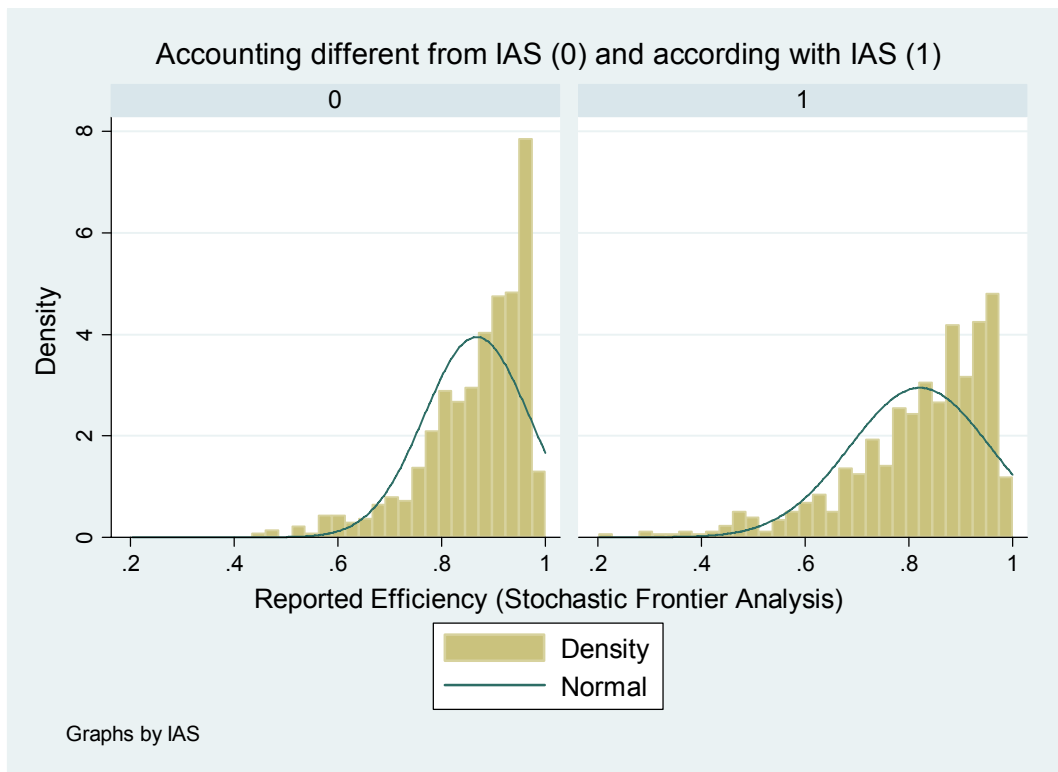
Table 7 Correlations between efficiency and accounting system variables

	ef	ias	gaas	reqcon	dirisk
ef	1				
ias	-0.1851*	1			
gaas	-0.1389*	0.6435*	1		
reqcon	-0.017	0.1936*	0.1202*	1	
dirisk	-0.0739*	0.3516*	0.2505*	-0.0485	1

Table 8 Differences in Bank Efficiency (Two-sample t test with equal variances)

PANEL A
Are financial institutions required to produce consolidated accounts covering all bank and any non-bank financial subsidiaries?

Variable	Group	Banks	Mean	Std. Err.	Std. Dev.	[95% Conf.Interval]	
reqcon	0 [NO]	65	0.850	0.014	0.113	0.822	0.878
	1 [YES]	1163	0.841	0.004	0.124	0.834	0.848
	Total	1228	0.841	0.004	0.124	0.835	0.848
	Difference [0-1]		0.009	0.016		-0.022	0.040
	P value (diff≠0)	0.552			t =	0.59	

The two-sample t-test is used to determine if two population means are equal.

PANEL B
Must banks disclose their risk management procedures to the public?

Variable	Group	Banks	Mean	Std. Err.	Std. Dev.	[95% Conf.Interval]	
dirisk	0 [NO]	560	0.851	0.005	0.109	0.842	0.861
	1 [YES]	668	0.833	0.005	0.134	0.823	0.843
	Total	1228	0.841	0.004	0.124	0.835	0.848
	Difference [0-1]		0.018	0.007		0.004	0.032
	P value (diff≠0)	0.01			t =	2.60	

PANEL C
Are accounting practices for banks in accordance with International Accounting Standards (IAS)?

Variable	Group	Banks	Mean	Std. Err.	Std. Dev.	[95% Conf.Interval]	
ias	0 [NO]	540	0.867	0.004	0.101	0.859	0.876
	1 [YES]	688	0.821	0.005	0.135	0.811	0.831
	Total	1228	0.841	0.004	0.124	0.835	0.848
	Difference [0-1]		0.046	0.007		0.032	0.060
	P value (diff≠0)	0.00			t =	6.60	

PANEL D
Are accounting practices for banks in accordance with U.S. Generally Accepted Accounting Standards (GAAS)?

Variable	Group	Banks	Mean	Std. Err.	Std. Dev.	[95% Conf.Interval]	
gaas	0 [NO]	798	0.854	0.004	0.115	0.846	0.862
	1 [YES]	430	0.818	0.007	0.136	0.805	0.831
	Total	1228	0.841	0.004	0.124	0.835	0.848
	Difference [0-1]		0.036	0.007		0.022	0.050
	P value (diff≠0)	0.00			t =	4.91	

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