12. How Output Diversification Affects Bank Efficiency and Risk: An Intra-EU Comparison Study

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Abstract

This paper examines how banks have been diversifying away from traditional financial intermediation activity into noninterest income business and how this shift has affected their efficiency and risk-taking behaviour. To this end, we construct a global best-practice efficiency frontier following the Stochastic Frontier Approach and relying on the technique of Battese and Coelli (1995), which permits the estimation of the frontier and of the coefficients of efficiency variables in a single-stage. We opt for an application of this model to the EU-27 countries performing an intra-Union comparison between the old and the new EU members that provides us with substantial information concerning the level of harmonization of the European banking systems. Results indicate that the diversification of bank output enlarges efficiency margins in both cost and profit terms without altering the way banks treat risk. Also, environment identically affects the performance of European banks. By and large, both old and new EU member states follow similar behavioural patterns that are not influenced by product diversification, which reveals a rather harmonized European banking market.

12.1. Introduction

Over the past couple of decades or more, the extensive regulatory changes and the technological advances have transformed financial systems to a great extent. Banks have reacted to the challenges posed by the new operating environment by creating new products and services and expanding the already existing ones, which allowed them to diversify the product mix of their portfolio. The traditional business of taking deposits from households and making loans to agents that require capital has thus declined in favour of a considerable growth in activities that generate noninterest (fee) income and are not necessarily reported on

[1] The author would like to thank Angelos Antzoulatos for his support and guidance. Thanks are also due to Charles Calomiris and other participants at the 7th Conference on Research on Economic Theory & Econometrics (CRETE) for their valuable remarks as well as participants at the SUERF Conference on 'Productivity in the Financial Services Sector' for helpful comments and suggestions. The usual disclaimer remains.

banks' balance sheets[2]. In consequence, the sources of revenues and profits of banking institutions have been diversified as noninterest income relative to its interest counterpart from traditional financial activities has considerably increased[3].

In the present work we assess the effect of alterations in product mix on the performance of European banking markets. To clarify, we examine how banks in the EU have been diversifying away from traditional financial intermediation activity into noninterest income business and how this shift has affected their efficiency and risk-taking behaviour. Cost and profit efficiency frontiers are estimated with and without proxies of non-traditional activities in order the impact of diversified product offerings on banking performance to be explicitly measured. Regarding risk, it plays a central role in our analysis as non-traditional instruments are thought of as a basic tool for financial institutions to manage risk more efficiently. Recognizing this modern way of dealing with risk exposure and also taking into account that efficiency is likely to be miscalculated in case risk characteristics are not included in the cost and profit functions, we investigate the relationship that holds between product diversification and bank risk-taking behaviour focusing on the most important sources of bank risk.

Our data set encompasses the EU-27 countries thus allowing us to test whether the move towards the new financial intermediation business has affected the Union's banking systems uniformly. In other words, we examine whether European banking markets have *jointly* improved their performance by increasing their efficiency and lowering their risk after diversifying their portfolios. To this aim, we proceed in making an intra-EU comparison between the 15 long-term members and the group of the 12 states that lately ascended to the Union. Such comparative analysis can provide us with substantial information concerning the performance of banks within the Union, thus giving us a thorough picture of the level of harmonization in the European banking environment as a whole.

For the intra-EU efficiency comparisons to be meaningful, it is of importance not only to allow for variation in relative factor prices across countries, but also to control for country- and bank-level characteristics that lead to performance heterogeneities across banking systems or individual banks, respectively. In fact, efficiency literature has reached the agreement that operational environment is such an important component in cross-country efficiency comparisons that, if ignored,

[2] A number of studies have documented this upsurge in fee-generating activities of banks using data from different banking industries. See *e.g.* Rogers (1998), Rogers and Sinkey (1999), and Stiroh (2004) for US banking; also, Rime and Stiroh (2003) and Tortosa-Ausina (2003) for the Swiss and Spanish banking sectors, respectively.

[3] It has to be mentioned here that banks have long earned noninterest income by charging their customers' fees in exchange for a number of traditional services like checking and cash management, safe-keeping services (*e.g.* insured deposit accounts and safety deposit boxes), investment services (*e.g.* trust accounts and long-run certificates of deposits), and insurance services (*e.g.* annuity contracts). This sort of income, however, has only been a small fraction of banks' total income.

results will vary a lot (see *e.g.* Dietsch and Lozano-Vivas (2000); Cavallo and Rossi (2002)). We thus employ the stochastic efficiency frontier model of Battese and Coelli (1995), which enables efficiency comparisons as it pools the data defining a common frontier for all the countries under scrutiny also accounting for both environmental conditions – which are far beyond the control of bank managers – and bank-specific factors in a single stage[4].

To account for differences in the regulatory conditions among the EU banking sectors, we exploit the World Bank Regulation and Supervision Databases of Barth *et al.* (2001, 2008). Moreover, the Worldwide Governance Indicators developed by Kaufmann *et al.* (2002) are employed to capture the various levels of institutional development in our sample countries. The degree of banking market concentration that provenly affects efficiency (see *e.g.* Dietsch and Lozano-Vivas (2000)) is further considered in our empirical analysis. Finally, we control for variations in the macroeconomic environment, the level of technological progress, and the size of banks.

Our results indicate that product diversification increases cost and profit efficiencies without affecting the way banks treat risk. As for the environment, it has an identical role in the performance of European banks. On the whole, the banking sectors of both old and new EU member states are found to follow similar behavioural patterns, which are not significantly influenced by output diversification. This finding reveals a rather harmonized European banking industry.

To our knowledge, this is the first study that examines the effect of product diversification on the performance of the EU-27 banking sectors also conducting an intra-EU comparison analysis. Indeed, related studies focus exclusively on separate banking industries – mainly that of US – with only exception the study of Vennet (2002). Yet, Vennet, although using data from 17 European banking markets, does not proceed in making any cross-country efficiency comparisons[5]. Furthermore, the current work is differentiated from previous ones in that it investigates whether banks alter their risk-taking behaviour after they are entangled with diversified activities. In fact, the impact of output diversification on risk has been rather neglected from bank performance literature. Specifically, excepting

4 The Battese and Coelli (1995) methodology, though not so recently developed, has been very lately employed in several bank efficiency comparison studies (Cavallo and Rossi (2002); Williams and Nguyen (2005); Fries and Taci (2005); Kasman and Yildirim (2006); Barros *et al.* (2007); Lozano-Vivas and Pasiouras (2008); Lensink *et al.* (2008)). Nevertheless, with only exception the study of Lozano-Vivas and Pasiouras (2008) that shares some common features with the current one, none of the other studies that belong to this recent empirical literature strand shows any interest in the impact of output diversification on bank performance thus at best accounting for non-traditional activities only parenthetically. In fact, all the above studies are designed to address other issues, such as the efficiency differences among European banking sectors (Cavallo and Rossi (2002)), the effect of financial deregulation on bank performance in transition economies (Fries and Taci (2005); Kasman and Yildirim (2006)) or in South East Asian countries (Williams and Nguyen (2005)), the main factors that explain the probability of bank efficiency (Barros *et al.* (2007)), and the link between efficiency and bank ownership (Lensink *et al.* (2008)).

5 For a review of the existing literature, see Section 2 of the present study.

the studies of Rogers & Sinkey (1999) and Vennet (2002) that explicitly examine how non-traditional activities influence the level of bank risk, most of the relevant studies either simply control for risk preferences by incorporating capital ratio or total equity in their empirical models (see *e.g.* Lozano-Vivas and Pasiouras (2008)), or indirectly consider for risk by utilizing several risk-based measures of non-traditional activities (see *e.g.* Stiroh (2000); Clark and Siems (2002)). Last but not least, the study sketches the theoretical considerations that provide the rationale for the turning of banks into non-traditional services. Overall, the study offers the ground to empirically test the dilemma of focus versus diversification, which we think that has not been addressed thoroughly in the context of financial intermediation theory.

The rest of this paper proceeds as follows. Section 2 reviews the role of non-traditional activities in bank performance literature, whereas Section 3 illustrates the theoretical underpinnings of the paper. Section 4 provides a description of the data set and a justification of the variables used. Section 5 presents the cost and profit efficiency models and the estimation methodology followed. Section 6 discusses the empirical findings, and, finally, Section 7 concludes.

12.2. The Role of Non-traditional Activities in Bank Performance Literature

As noted earlier, deregulation process and technological innovation have let banks to engage with non-traditional business. Although one part of bank performance literature does not consider the relevance of this sort of business at all (see Grifell-Tatjé and Lovell (1996); Wheelock and Wilson (1999); Maudos *et al.* (2002); Lensink *et al.* (2008)), some other has recently turned to utilize different proxies of non-traditional products as an additional bank output. In particular, Altunbas *et al.* (2000) examine the link between efficiency and risk in the Japanese commercial banking sector proxying non-traditional activities with the nominal value of Off Balance Sheet (OBS henceforth) items. The same proxy is also incorporated in the output vector of the models of Altunbas *et al.* (2001a, 2001b) and Casu *et al.* (2004) that study the efficiency and productivity of European banks.

To continue, Isik and Hassan (2003) evaluate the performance of Turkish banks including the risk-adjusted value of OBS activities according to the Basel Accord in their econometric model arguing that such an adjustment provides conformity with other bank outputs in terms of credit risk. Alternative proxies of nontraditional products are also included in the output vectors of other bank performance studies: Dietsch and Lozano-Vivas (2000) and Maudos *et al.* (2002) use *other earning assets*, Drake and Hall (2003) utilize *net fee and commission income*, while Tortosa-Ausina *et al.* (2008) employ the broader proxy of *noninterest income*.

Notwithstanding the incorporation of alternative proxies of non-traditional activities in the vector of outputs, none of the above studies estimates the clear effect that portfolio expansion has on bank performance. This gap is bridged by a recently developed thread of literature that compares performance measures derived by alternative models' specifications, that is, with and without the inclusion of non-traditional items. The origins of this literature can be traced back to 1994, when DeYoung explicitly addressed the impact of noninterest and fee income on the efficiency of US commercial banking sector. DeYoung (1994) estimated a cost efficiency frontier and found that the standard formulation, which disregards non-traditional income devalues efficiency for banks with a large share of this type of income.

Albeit several works followed that of DeYoung (1994), research has been almost exclusively focused on the US banking system. Indeed, Jagtiani *et al.* (1995) estimate the importance of OBS activities captured by guarantees, foreign currency transactions and interest rate products on the efficiency of US commercial banks, where efficiency is measured in terms of scale economies and cost complementarities[6]. Also using US commercial banking data, Rogers (1998) formulates cost, revenue, and profit frontiers to estimate efficiency with and without non-traditional services, which are proxied by net noninterest income. The same proxy measure is used by Rogers and Sinkey (1999), who empirically assess the level of involvement of US banks in nontraditional activities, and Stiroh (2000), who examines cost and profit efficiencies as well as productivity growth and scale economies for US bank holding companies. The latter study also uses a Basel-based credit equivalent measure (CEM) that converts all OBS activities to credit risk equivalents. Net noninterest income, CEM, and AEM (an asset equivalent measure that uses the rate of return on balance-sheet items to capitalize the non-interest income from OBS activities) are utilized in the empirical work of Clark and Siems (2002) that gauges the importance of nontraditional activities in the performance of US commercial banks.

As already mentioned, there is just a handful of works that use data other from US to estimate how nontraditional items affect bank performance. To start with, Vennet (2002) investigates the existence of efficiency differences between specialized and non-specialized financial institutions in Europe; the latter form of institutions consists of universal banks and conglomerates that offer both traditional and non-traditional services. Moreover, Rime and Stiroh (2003) measure cost and profit efficiencies as well as economies of scale and scope of large Swiss banks.

6 Using the same proxies for OBS activities, Jagtiani and Khanthavit (1996) study the effect of the introduction of risk-based capital requirements on the cost structure of large US banks.

Output is defined in such a way as to include two proxies for nontraditional services: the CEM of OBS derivative activities and the trading and portfolio management activities. Furthermore, Tortosa-Ausina (2003) examines the role of noninterest income on the efficiency of Spanish commercial and savings banks, where the recent study of Casu and Girardone (2005) tests whether the expansion of OBS activities has an effect on the productivity of five large European banking sectors.

Although proxies of non-traditional activities, bank performance measures and estimation techniques vary in the studies reviewed above, the empirical findings converge to the conclusion that ignoring nontraditional activities leads to a misspecification of bank output[7]. In particular, average performance is improved when these types of activities are taken into account. A possible explanation for this finding might be that whereas the resources that are used to produce nontraditional products are included in the input vector are not considered in the output vector. Or, according to some other explanation, banks are better producers of non-traditional rather than traditional items (Rogers (1998)). In either way, the finding that bank performance is underestimated in case non-traditional activities are ignored corroborates the growing importance of this kind of activities in the operation of banks.

12.3. THE FINANCIAL INTERMEDIATION THEORY: THE TRANSITION FROM THE TRADITIONAL TO MODERN APPROACH

The traditional financial intermediation theory relies mostly upon the vitiation of the Arrow-Debreu complete markets paradigm and of the Modigliani-Miller famous theorem. According to the former, firms and governments are financed by households via financial markets. As these markets are assumed to be perfect and complete (*i.e.* there are no transaction costs and no credit rationing, whilst there is a full set of contingent markets), the allocation of resources is Pareto optimal and hence there is no role for intermediaries. The Modigliani-Miller theorem, on the other hand, assumes that all households are involved and there is full participation in markets. This implies that financial structure is irrelevant as households can construct portfolios offsetting actions of intermediaries and thus intermediation cannot add value.

Still, in real life, imperfect information and transaction costs that exist in the economy restrict the scope for direct financing and vitiate the Arrow-Debreu

7 Exceptions are the study of Jagtiani *et al.* (1995) that finds no impact of non-traditional activities on bank performance, and that of Clark and Siems (2002), which concludes that cost efficiency estimates increase with the inclusion of OBS items, whereas profit efficiency estimates are largely unaffected.

model of resource allocation. Moreover, there is evidence that full participation does not hold in practice and thus the Modigliani-Miller theorem is not valid. Accordingly, financial institutions intervene between savers and borrowers taking advantage of market frictions[8]. Financial intermediaries allow transaction costs to be shared thus obtaining an advantage over individuals. In addition, they signal their informed status by investing their capital in assets about which they have special knowledge. By doing so, intermediaries manage to limit the problems that asymmetric information generates.

In recent decades, however, transaction costs have been reduced and information asymmetries have shrunk as information has become cheaper and more easily available due to technological advances. However, these changes have not coincided with a decline in financial intermediation; on the contrary, the volume of intermediation has been enhanced. In fact, where banks' total assets as a percentage of financial intermediation assets have fallen in all developed financial sectors and the total number of banking institutions has dropped, the intermediation role of banks has been amplified. Apparently, the traditional financial intermediation theory, which relies on the existence of transaction costs and asymmetric information, cannot satisfactorily explain the observed increase in intermediation activity.

The answer to this puzzle is provided by Allen and Santomero (1998, 2001) who revise the traditional intermediation theory. Claiming that its focus has been too narrow, they indicate risk management and reduction of participation costs as the primary factors that have led to the increase of the overall volume of intermediation. More specifically, Allen and Santomero argue that financial liberalization and technological progress have generated a large amount of novel financial products and thus the need for new markets where all these products could be traded in. Most individuals and firms, however, have neither the appropriate information nor the specialized knowledge to deal with this complex maze of modern financial tools. For them, the costs of learning how to use these tools and then participate in the new markets on a daily basis are especially high. Financial institutions, on the other hand, are both informed and skilled enough to intervene in the new financial markets and trade all this volume of non-traditional instruments in favour of their clients at significantly lower cost. Thereby, financial insti-

8 The two major aspects of financial intermediary activity are brokerage and qualitative asset transformation. Brokerage is usually referred to as 'soft' intermediation, while asset transformation as 'hard' intermediation activity. By brokerage, banks match transactors with complementary needs asking for a fee-based compensation. Banks take no particular position, although reputation risk is inherent in brokerage activity. Moreover, they have a basis of cost of gathering information; yet, information can be reused – either cross-sectionally or through time – at zero cost. Examples of banks' brokerage activity are transaction services, financial advice, screening, origination, issuance, and funding. As regards qualitative asset transformation, it refers to the transformation of the attributes of an asset (*e.g.* monitoring, management expertise, guaranteeing, liquidity creation etc.).

tutions facilitate participation, whereas at the same time can manage risk more effectively.

In the EU, which is the focus of the current study, limits on banking activities were substantially removed with the implementation of the Second Banking Directive in 1989 and the Directive on Investment Services in 1996. These two enactments allowed all banks to operate outside their home country and engage in all sorts of financial services. As a result, a number of bank consolidations within and across EU member states have taken place over the past years that led to the emergence of universal financial institutions, which provide a broad range of diversified activities that generate substantial amounts of noninterest income.

12.4. DATA AND VARIABLES

12.4.1. Data Description

All the bank-level data used in the study are obtained from the *BankScope* database produced by the Bureau van Dijk and Fitch-IBCA. In particular, our dataset is composed of commercial banks from the 27 EU member states and covers the period 2000-2007. We incorporate all those banks for which at least four years of data are available. This refinement allows us to reliably distinguish between the random and the inefficiency component in the Battese and Coelli composite error model that we use (see Fries and Taci (2005)). After checking the data for reporting errors and other inconsistencies (missing, negative or zero values), we obtain an unbalanced panel of 5928 observations corresponding to 741 banks[9]. The choice of using an unbalanced panel is mainly justified by the fact that we would like to account for mergers and acquisitions as well as for any bank failures and new entries that took place during the sample period in order to avoid selectivity bias. All data are reported in euros as the reference currency and are expressed in real 2000 prices.

The data for market concentration as well as those used in the construction of the regulatory variables were gathered from Versions II and III of the Bank Regulation and Supervision databases of Barth *et al.* (2001, 2008)[10]. Since regulatory policies do not vary a lot from year to year (see Barth *et al.* (2008)), we use the information contained in Version II and collected from 2000 to 2002 for the first four years of our data set (*i.e.* 2000-2003), and the Version III information that describes the situation in the 2005-2006 period for the rest four years (2004-

9 The Battese and Coelli (1995) model has the advantage that can be estimated for an unbalanced panel dataset. This augments the number of observations and thus the accuracy of the results.

10 An important point that has to be made here is that the Barth *et al.* databases refer only to commercial banks, which is the focus of our study.

2007) of our sample. Moreover, the degree of institutional development and the quality of governance are captured by an overall index based on the Worldwide Governance Indicators developed by Kaufmann *et al.* (2002). Lastly, real GDP growth rate and interbank rates are extracted from Eurostat.

12.4.2. Variables Definition

We now move to describe the variables employed in our empirical analysis. We justify why we decide to use these specific variables and how each is calculated. An analysis of summary statistics is offered in Table 1.

12.4.3. Output Quantities and Input Prices

An important concern in the empirical estimation of efficiency is the definition of bank inputs and outputs, which is strongly related to the specific role that deposits play in the operation of financial institutions. The banking literature addresses this issue by largely using two approaches: the intermediation or asset approach and the production or value-added approach[11]. Under the former one, financial firms are thought of as intermediaries that transform deposits and purchased funds into loans and other earning assets. This is to say, liabilities and physical factors are viewed as inputs, whereas assets are treated as outputs. The production approach, on the other hand, views financial institutions as producers of services for account holders measuring output with the number of transactions or documents processed over a given time period. Therefore, deposits are encompassed in the output and not in the input vector, which exclusively includes physical entities.

Berger and Humphrey (1991), however, propose a third approach that, contrary to the above two approaches, captures the dual role of banking operations. In fact, the so-called modified production approach can be viewed as a combination of intermediation and production approaches as it enables the consideration of both the input and output characteristics of deposits in the cost/profit functions. More specifically, the price of deposits is considered to be an input, whilst the volume of deposits is accounted as an output. In this specification, banks are assumed to provide intermediation and loan services as well as payment, liquidity, and safekeeping services at the same time.

In the current paper we adopt the modified production approach to define the inputs and outputs since it seems to go one step further describing the activities of banks in a more complete setting providing therefore a closer representation of

11 See Berger and Humphrey (1997) for a detailed analysis of the advantages and disadvantages of each of the two approaches.

reality. Five variable outputs are specified in total: traditional banking activities are captured by three outputs, namely total loans (y_1), total other earning assets (y_2), and total deposits (y_3), whereas non-traditional activities are proxied by non-interest income (y_4) – calculated as the sum of commission, fee, trading and other operating income – and the value of OBS items (y_5). As regards inputs, we consider three of them in our analysis, *i.e.* deposits, labour, and physical capital. The price of deposits (w_1) is defined as the ratio of interest expense scaled by total deposits, the price of labour is calculated by dividing personnel expense to total assets (w_2)[12], and the price of physical capital (w_3) is proxied by the ratio of noninterest expense other than personnel expense to fixed assets.

12.4.4. Risk Variables

We utilize four different metrics to capture the variation in the risk-taking strategies of banks. The first two concern individual bank risk-taking, whereas the other two measure risk at a country level. In particular, the ratio of loan loss provisions to total loans is used to proxy credit risk (*crdrisk*); the ratio of liquid to total assets measures liquidity risk (*lqdrisk*); the one-year standard deviation of the day-to-day interbank rate captures interest rate risk (*intrisk*); and, lastly, insolvency risk (*inslrisk*) is measured with the Z-score computed as follows:

$$Z_{jt} = \frac{(\overline{ROA}_{ijt} + \overline{TE_{ijt}/TA_{ijt}})}{\sigma(ROA_{ijt})}$$

where $\overline{ROA}$ stands for the average Return On Assets calculated by the mean ratio of variable profits (Pr_{ijt}) to total assets (TA_{ijt}), and TE_{ijt}/TA_{ijt}) is the mean ratio of equity to total assets[13]. Z-score combines three elements of bank risk and is inversely related to the probability of failure. By taking average values, we measure the z-score of the typical bank in each country at every sample year.

12.4.5. Environmental and Control Variables

With the purpose of enhancing the comparability of bank performance across the groups of old and new EU member states, we select a set of variables that capture a number of bank- and country-level differences. In specific, these variables account for the level of bank regulation and supervision, the quality of govern-

[12] We recognize that dividing personnel expense by the total number of employees instead of total assets would produce a rather more accurate measure of the unit price of labour. Nevertheless, due to a paucity of data on the number of employees in the Bankscope database, such an approach would result in the loss of a large number of observations.

[13] The definition of profits (Pr_{ijt}) differs between the restricted and the unrestricted model specifications (see Section 5.3 below). This produces two different Z-scores, one for each specification.

ance and the degree of institutional development, market structure, macroeconomic conditions, technological advances and bank size.

To start with, we construct five indices that describe the regulatory and supervisory environment of the banking sectors under examination[14]. The first is the activity restrictions index (*restr*) that measures the degree to which banks are free to engage in securities, insurance and real estate activities as well as the extent to which banks may own and control nonfinancial firms. This index takes values between 4 and 16, with higher scores indicating a less liberalized banking environment, where banks are prevented from diversifying their product offerings.

Moreover, we construct the capital regulatory index (*capreg*) that considers: a) the stringency of regulatory requirements concerning the amount of capital that banks must hold, b) the extent to which banks are allowed to include assets other than cash, government securities, or borrowed funds in their initial regulatory capital, and c) whether authorities confirm the sources of capital. This index ranges from 0 to 8, with larger values signifying greater capital stringency. Yet, the relationship that holds between capital and risk is rather vague. On the one hand, capital serves as a safety net for banks especially in periods of increased uncertainty. Under this scenario, better capitalized banks are expected to be less fragile. On the other hand, more stringent capital regulations are associated with reduced banks' rents, since banks are forced to supply fewer loans. To hedge losses, banks may engage in risky activities.

The third index is the private monitoring index (*prvmon*) that measures the degree to which supervisory authorities encourage private-sector oversight of banks and is calculated according to the following qualitative criteria: a) whether banks are required to obtain outside licensed audits and/or ratings by internationally credit-ratings agencies, b) whether an explicit deposit insurance scheme is imposed, c) whether banks are required to disclose accurate information to the public by producing consolidated accounts that cover the whole range of their activities and risk-management procedures, and, finally, d) whether bank directors are legally liable for erroneous/misleading information. This index varies from 0 to 9, where higher values implying more private monitoring. Again, there exist contradictory views in the literature regarding the role of private sector in bank monitoring. Some assert that private monitoring agencies operate more reliably and efficiently than official supervisory authorities mainly because they are not influenced by political or similar pressures, whereas others argue in support of the supervisory role of public authorities.

Finally, the quality characteristics of bank supervision are proxied by two different indices: the first is the official supervisory power index (*suprvpower*), which

[14] The exact survey questions used for the construction of each index as well as the scoring system followed are that of Barth *et al.* (2004).

measures the extent to which supervisory authorities have the power to intervene in the banking system. This index has a minimum value of 0 and a maximum value of 14, with 14 being the highest level of supervisory power. The second is the supervisory forbearance discretion index (*forbdiscr*) that shows the degree to which authorities is likely to engage in forbearance in cases banks behave imprudently. It takes values from 0 to 4, with higher values indicating greater discretion. Whereas strong supervisors can undertake specific actions against the vulnerabilities of the system (market failures, asymmetric information, excessive risk-taking) that will potentially improve bank performance, at the same time, it is easier for a powerful authority to benefit favoured constituents thus undermining competition and interrupting the development of the banking sector. Accordingly, the influence of supervisory power on the operation of banking system is rather contradictory.

To proxy the overall level of institutional development and the quality of governance we construct the KKZ index, which is the simple average of the following six indicators: voice-accountability, political stability, governance effectiveness, regulatory quality, rule of law, and control of corruption. Higher values of the KKZ index indicate a more developed institutional framework[15].

An important determinant of bank performance is market structure, which is strongly related to the degree of competition. We measure the degree of market concentration with the 5-bank concentration ratio (*c5*), *i.e.*, the sum of assets of the five largest banks divided by the value of total banking system assets[16].

It is widely accepted that the demand and supply of banking services are seriously affected by economic performance. More precisely, high levels of banking activity are generally related to favourable economic conditions. We thus include real GDP growth rate (*GDPgr*) to control for differences in the level of economic development and also proxy the degree of bank activity.

According to the conventional wisdom big banks are heavily involved in non-traditional activities. We thus employ the log of TA in the model to capture the non-linear effect of bank size on performance. The inclusion of a size variable (*size*) is also essential since a strong scale bias might be produced making large banks more efficient than small banks, if otherwise.

Finally, technological changes over time are captured by a linear time trend (t) as well as its squared root (t^2) since the model used follows a second order approximation (see Lensink *et al.* (2008)).

15 Since no values are reported for 2001 for any of these six indicators, we use the mean average of 2000 and 2002 to proxy KKZ for this particular year.

16 Concentration ratios for Austria and Ireland are not available in the Barth et al (2001, 2008) databases and are therefore computed using data from Bankscope.

12.5. EMPIRICAL ANALYSIS

12.5.1. Cost and Profit Efficiency Frontiers

The Battese and Coelli (1995) model that we use to estimate bank efficiency relies on the Stochastic Frontier Analysis (SFA) of Aigner *et al.* (1977). SFA is commonly represented by two-stage parametric models: in the first stage the stochastic frontier production function is specified and estimated together with technical efficiency; in the second stage efficiency estimates are regressed against a set of environmental variables to test whether these variables have an effect on efficiency levels. However, as Wang and Schmidt (2002) point out, parametric two-step approaches produce biased coefficients for the reason that the assumptions made in the first step concerning the distribution of the inefficiency term are violated in the second[17]. The Battese and Coelli model avoids the pitfalls present in the standard SFA by estimating bank efficiency and its determinants in a one-step process. To clarify, efficiency scores are drawn from an *ex ante* specified functional form and regressed on a vector of bank- and country-specific variables in a single step. An additional advantage of the model is that it can be estimated for an unbalanced panel data set, which enhances the number of observations and thus the reliability of the empirical outcome.

Both cost and profit specifications of the Battese and Coelli model are employed in our analysis. Regarding cost efficiency, it refers to technical and allocative efficiency and is defined on the basis of how close the actual cost of a sample bank is to the cost of the best-practice bank, according to which the cost efficiency frontier is determined. Using longitudinal data the model specifies a stochastic global cost frontier of the following general form:

$$\ln C_{ijt} = C(y_{ijt}, w_{ijt}, q_{ijt}; \beta) + v_{ijt} + u_{ijt} \quad (1)$$

where C_{ijt} is the observed variable cost that bank i ($i = 1, 2, \dots, N$) faces in country j ($j = 1, 2, \dots, K$) at time t ($t = 1, 2, \dots, T$); y_{ijt} denotes the vector of output quantities for bank i in country j at time t; w_{ijt} denotes the vector of input prices for bank i in country j at time t; q_{ijt} is the vector of risk variables that influence bank efficiency; β is a vector of all unknown parameters to be estimated; v_{ijt} stands for the random error term that is assumed to be *i.i.d.* $N(0, \sigma_v^2)$, and independent of the term $u_{ijt} \geq 0$ that accounts for technical and/or allocative inefficiency in production and is imposed to be non-negative (as higher level of inefficiency is associated with higher cost); moreover, u_{ijt} is independently but not identically distributed, such that it is obtained by truncation at zero of the normal

[17] In the first stage typical SFA assumes that the inefficiency component of the error term has a truncated-normal distribution. This assumption is vitiated in the second stage, where a normal distribution is assumed instead.

distribution with mean m_{ijt} equal to $z_{ijt}\delta$, and variance σ_u^2, *i.e.* $u_{ijt} \sim N(z_{ijt}\delta, \sigma_u^2)$ [18]. The term z_{ijt} represents the vector of explanatory variables that affect the inefficiency of bank i of country j at t and δ is the vector of the unknown coefficients to be estimated that also includes an intercept term[19]. The inefficiency term can therefore be written as follows:

$$u_{ijt} = z_{ijt}\delta + w_{ijt} \quad (2)$$

where w_{ijt} is defined by the truncation of the normal distribution with zero mean and variance σ^2, such that the point of truncation is $-z_{ijt}\delta$, and because $u_{ijt} \geq 0$, we obtain that $w_{ijt} \geq -z_{ijt}\delta$.

The stochastic cost frontier (1) and the model for the inefficiency term (2) are simultaneously estimated using the maximum likelihood method. The likelihood function is expressed in terms of the variance parameters, that is, $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and $\gamma = \sigma_u^2/(\sigma_v^2 + \sigma_u^2)$. The cost inefficiency score for an individual bank i in country j at the t-th observation is obtained as $Costineff_{ijt} = \exp(u_{ijt})$, and takes values between unity and infinity. To stay in line with bank performance literature that measures efficiency rather than inefficiency scores, we calculate $CEFF_{ijt} = (Costineff_{ijt})^{-1}$, which produces the cost efficiency score for bank I in country j at time t. Values closer to unity correspond to higher efficiency.

While cost efficiency has been almost monopolized the interest of bank performance evaluation literature, profit efficiency might be of equal or even greater importance if compared with its cost counterpart as it combines both the cost and revenue sides of banking operation[20]. Profit efficiency measures the extent to which the profits of a sample bank fall below the profits of the best practice bank. Literature (*e.g.* Rogers (1998); Stiroh (2000); Clark and Siems (2002)) estimates profit efficiency utilizing the so-called alternative profit function, which takes input and output quantities as given for banks letting output prices to vary. This non-standard approach is also preferred in the current study for a couple of reasons. First, in the standard profit function output prices are exogenously given implying that banks have no market power in the pricing of their output. However, empirical evidence shows that, notwithstanding the fact that deregulation has increased the degree of competition in the financial sector of the economy, banks still do not operate under perfectly competitive conditions[21]. This provides support to the use of the alternative profit function that allows banks to have

18 The truncation at zero safeguards that the costs of the best-practice bank are always lower than those of the best-practice bank.

19 As Battese and Coelli (1995) note, *"not including an intercept parameter may result in the estimators of δ-parameters associated with the z-variables being biased and the shape of the distribution of the inefficiency effects, u_{ijt}, being unnecessarily restricted"*.

20 Berger and Mester (1997) characteristically argue that *"profit efficiency is superior to the cost efficiency concept for evaluating the overall performance of the firm"*.

21 See *e.g.* the study of Bikker and Haaf (2002) that evaluates competitive conditions and market structure in the banking sectors of 23 industrialized countries including those of the EU-15.

control over the output prices. Second, literature reports a serious lack of output price data, which are necessary for the standard profit function approach to be implemented. This also holds true for the current study, since it is not possible to calculate the prices of nontraditional output for which only income information is available. Overall, the alternative profit specification seems to be much more attractive.

The empirical procedure that we follow in the estimation of profit efficiency is essentially the same with that discussed above for cost efficiency, except that we replace variable cost (C_{ijt}) with variable profit (Pr_{ijt}) in Eq. 1 and transform the dependent variable to $\ln[Pr_{ijt} + 1]$, where $|\min(Pr_{ijt})|$ represents the absolute minimum value of profit over all sample banks. This transformation safeguards that, in case there are banks in the sample that report losses, the natural logarithm is taken of a positive value. Moreover, the sign of the inefficiency term of the profit function now turns into negative thus obtaining the profit efficiency score for an individual bank *i* in country *j* at time *t* as $PREFF_{ijt} = \exp(-u_{ijt})$. $PREFF_{ijt}$ takes values from zero to one, with unity being the highest score achieved by the best-practice bank.

The cost (profit) function is specified as a standard translog specification. Therefore Eq. (1) can be written as follows[22]:

$$
\begin{aligned}
\ln\left(\frac{C_{ijt}}{w_{2,ijt}}\right) = {} & \\
& a_0 + \sum_{m=1}^{3} a_m \ln\left(\frac{w_{m,ijt}}{w_{2,ijt}}\right) + \sum_{m=1}^{3} \beta_s \ln y_{s,ijt} + \frac{1}{2}\sum_{m=1}^{3}\sum_{m=1}^{3} a_{mh} \ln\left(\frac{w_{m,ijt}}{w_{2,ijt}}\right)\ln\left(\frac{w_{h,ijt}}{w_{2,ijt}}\right) \\
& + \frac{1}{2}\sum_{s=1}^{3}\sum_{p=1}^{3} \beta_{sp} \ln y_{s,ijt} y_{p,ijt} + \sum_{m=1}^{3}\sum_{m=1}^{3} \gamma_{ms} \ln\left(\frac{w_{m,ijt}}{w_{2,ijt}}\right) \ln y_{s,ijt} \\
& + \phi_1 crdrisk_{ijt} + \phi_2 lqdrisk_{ijt} + \phi_3 inslrisk_{ijt} + \phi_4 intrisk_{ijt} + u_{ijt} + v_{ijt}
\end{aligned} \tag{3}
$$

where the inefficiency term u_{ijt} is defined by

$$
\begin{aligned}
u_{ijt} = {} & \delta_0 + \delta_1 restr + \delta_2 capreg + \delta_3 prvmon + \delta_4 \mathrm{sup} rvpower \\
& + \delta_5 forbdiscr + \delta_6 KKZ + \delta_7 c5 + \delta_8 GDPgr + \delta_9 size \\
& + \delta_{10} t + \delta_{11} t^2 + w_{ijt}
\end{aligned} \tag{4}
$$

22 This model refers to the restricted cost function that contains only traditional bank outputs (see Section 5.2 below). The extension to the unrestricted models is straightforward.

In Eq. (3), the restriction of symmetry of the second order parameters is imposed, *i.e.* $\alpha_{mh} = \alpha_{hm}$ and $\beta_{sp} = \beta_{ps}$. Moreover, the dependent variable and all input prices are scaled by one price (here we arbitrarily choose w_2) in order to guarantee linear homogeneity in prices. Thus, the sum of the coefficients of input prices equals to 1, *i.e.* $\sum_{m=1}^{3} a_m = 1$. The basic model that is estimated in a single-step by using maximum likelihood consists of Eqs. (3) and (4).

12.5.2. Restricted and Unrestricted Models

As already said, we use two different frontier specifications: one that relies on the cost function and one that relies on the alternative profit function. Across the two specifications, three separate models are estimated to test for the significance of output diversification on bank performance. The first model is the restricted model that includes only traditional banking products in its output vector. The second, which we call unrestricted model A, also considers modern banking activities by augmenting the output vector with noninterest income. The third model, labeled unrestricted model B, differs from A in that it proxies output diversification not with noninterest income, but with OBS items. A comparison of the findings of the three models is expected to lead to a robust view of the importance of diversified products on bank performance and risk.

12.5.3. Cost and Profit Definitions

The definition of variable cost (C_{ijt}) depends on the vector of inputs used that remains unaltered across the restricted and the unrestricted model specifications. Thus C_{ijt} is computed by adding interest with non-interest expense. On the other hand, the way variable profit (Pr_{ijt}) is defined differs between the two model specifications depending on the income-generating activities of banks. More specifically, in the case of the restricted model where the output vector consists solely of traditional bank products that create interest income, profit is equal to interest income less the variable cost defined above. In contrast, in the case of the unrestricted models (A and B), profit is calculated as the sum of interest income with noninterest income (which is mainly produced by nontraditional banking activities) less cost.

12.6. EMPIRICAL RESULTS

12.6.1. Efficiency Estimates

Tables 2 and 3 report the mean cost and profit efficiency scores for the traditional EU-15 countries and for the 12 New Member States (NMS). Apparently, the banking systems of the first group of countries operate more efficiently in both cost and profit terms (see restricted models). This superiority is further verified when noninterest income is included in the output vector (see unrestricted models A). In particular, cost efficiency is augmented by approximately 10% for EU-15 and by 7% for NMS. In similar vein, profit efficiency estimates increase by 15% in the case of EU-15 and by 13% in the case of NMS. On the contrary, almost no change is reported in the efficiency levels when OBS items are considered instead of noninterest income (see unrestricted models B). This might be evidence that the nominal value of OBS activities is a rather poor proxy of diversified banking products.

We test the statistical significance of the observed differences in efficiency scores between the restricted and the unrestricted model A of both cost and profit functions by conducting the non-parametric Wilcoxon signed-rank test. It turns out that the p-value of the Wilcoxon t-statistic is below.05 in all cases, which indicates that the mean scores obtained from the restricted models are statistically lower than the ones obtained from the unrestricted models A[23].

12.6.2. Output Diversification and Risk-taking

Let us now turn to analyze the performance of risk variables. Tables 4, 5, 6, and 7 document a negative and significant relationship between cost and profit efficiencies with all four measures of risk. In fact, this relationship remains unchanged across the restricted and the unrestricted model specifications. This finding suggests that output diversification does not affect the risk-taking behaviour of banks.

More analytically, the results reveal that more efficient banks perform a lower credit risk. This implies that banks should focus more on credit risk management, which has proved problematic in the recent past. Serious banking problems have arisen from the failure of banks to recognize impaired assets and create reserves for writing off these assets. A considerable help toward smoothing these anomalies would be provided by improving the transparency of the financial systems,

[23] Using the parametric t-statistic we reach the same conclusion.

which in turn would assist banks to evaluate credit risk more effectively and avoid problems associated with hazardous exposure.

Concerning liquidity risk, it has also a negative sign showing that increased liquidity leads to higher efficiency levels. This finding is rather expected as banks have been traditionally solving their liquidity problem by holding cash together with a considerable amount of short-term government securities that they could sell for cash. As regards interest rate risk and insolvency risk, they are also found to significantly reduce cost and profit efficiencies.

All in all, the estimation results suggest that higher levels of risk aversion are related to increased levels of efficiency. And, more importantly, this behavioral pattern is not influenced by the inclusion of nontraditional items in the model since the signs of all risk coefficients remain unaltered across the different model specifications.

12.6.3. How the Environment Affects Bank Efficiency

Results (see Tables 4, 5, 6, and 7) confirm the effectiveness of regulatory policies for increasing bank efficiency. Indeed, looser restrictions on bank activities combined with more stringent capital regulations, higher degree of private monitoring and powerful supervisory authorities boost the efficiency of the EU banking sectors. Furthermore, the KKZ index has a significantly positive effect on the dependent variable in all models showing that developed institutional environments are positively associated with cost and profit efficiencies. We interpret these results as suggesting that bank regulations and high-quality governance are both necessary and sufficient conditions for banking systems to operate in high efficiency levels.

To continue, the most efficient banking sectors are those with higher market concentration; moreover, economic development boosts efficiency since a statistically significant positive link between real GDP growth and efficiency is documented. This latter finding implies that an increase in GDP leads to lower total costs and higher profits. An explanation for this could be that the more prosperous countries become, the better access to new technologies their banks acquire and this renders them capable of producing more output using less input. This is corroborated to a great extent by the finding that technological advances (captured by t and t^2) have a positive impact on cost and profit efficiencies. Finally, we report a positive relationship between bank size and efficiency, which shows that larger banks -that are highly involved in nontraditional activities- operate more efficiently.

12.7. CONCLUSION

In this study we examined the effect of output diversification on the performance of the European banking systems utilizing cost and profit efficiencies as well as the risk-taking behaviour of banks as alternative performance measures. To assess the degree of harmonization in the entire European banking market, we compared the performance of the 15 old EU member states with that of the 12 recently acceded EU countries. To make comparisons meaningful, we relied upon the technique of Battese and Coelli (1995), which allows the estimation of the frontier and of the determinants of efficiency in a single-stage. A number of sophisticated variables that account for environmental differences were also taken into account in our econometric analysis.

A rather uniform impact of output diversification on the performance of the EU banking sectors is documented: on average, cost and profit efficiency margins are enlarged, while the risk-taking behaviour of European banks is not critically altered. Concerning environment, it plays an essential role in bank efficiency: greater openness combined with strict capital regulations and strong supervision positively affect efficiency. Economic development and technological progress also lead to higher efficiency levels. Most notably, the involvement of banks in diversified product offerings has no serious impact on the aforementioned trends.

On the whole, the banking sectors of both old and new EU member states are found to follow very similar behavioural patterns, which are not significantly influenced by output diversification. This finding might suggest that the banking markets in the EU are highly harmonized, paving the way for further research.

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12.9. APPENDIX

Table 1: Descriptive Statistics

Variable Country	w1	w2	w3	y1 (th EUROS)	y2 (th EUROS)	y3 (th EUROS)	y4 (th EUROS)	y5 (th EUROS)	crdrisk	lqdrisk	intrisk	Z-score (restricted model)	Z-score (unrestricted models)	restr	capreg	prvmon	suprvpower	forbdiscr	c5	KKZ
Austria	0,049	0,022	5,524	3.703.931	3.011.302	4.645.903	80.098	1.285.564	0,046	0,161	0,313	1,85	5,55	7,00	6,50	5,00	11,50	2,50	0,91	1,62
	0,097	0,034	16,612	14.238.607	11.617.482	18.578.617	317.523	5.270.219	0,401	0,169	0,193	0,21	1,48	0,00	1,50	0,00	1,50	0,50	0,02	0,03
Belgium	0,034	0,018	3,031	1.038.242	1.492.207	2.167.644	27.174	1.756.660	-0,003	0,299	0,313	2,70	4,37	8,00	3,50	6,00	10,50	2,50	0,90	1,41
	0,032	0,025	5,030	1.439.891	1.564.794	2.019.505	22.392	1.791.785	0,085	0,272	0,193	0,58	1,22	1,00	0,50	0,00	0,50	0,50	0,02	0,06
Bulgaria	0,042	0,019	0,334	202.289	125.883	291.367	6.620	58.505	0,013	0,193	0,473	11,22	11,65	9,50	7,00	6,00	11,00	1,50	0,55	0,22
	0,067	0,013	0,355	318.676	175.768	405.891	8.142	114.138	0,022	0,124	0,263	3,53	2,66	0,50	0,00	0,00	0,00	0,50	0,01	0,03
Cyprus	0,063	0,016	0,634	2.931.669	1.561.228	4.079.230	58.932	664.183	0,021	0,208	0,378	6,51	6,48	11,0	6,00	7,00	10,00	2,00	0,78	0,94
	0,048	0,009	0,855	4.128.615	2.233.871	5.623.132	95.597	1.107.372	0,040	0,165	0,270	5,52	4,32	0,00	1,01	0,00	2,02	1,01	0,11	0,04
Czech Republic	0,056	0,009	1,273	1.993.646	2.804.895	3.959.701	82.390	1.217.049	0,005	0,183	0,302	6,47	9,53	12,0	6,50	6,50	8,99	1,50	0,67	0,78
	0,079	0,007	1,933	3.081.868	4.077.746	5.899.269	125.190	1.929.610	0,019	0,167	0,190	1,25	2,96	0,00	0,50	0,50	1,00	0,50	0,02	0,07
Denmark	0,078	0,020	3,959	4.044.638	2.079.921	3.251.139	27.384	987.824	0,006	0,201	0,351	8,70	11,79	9,50	5,00	6,50	9,50	1,50	0,86	1,81
	0,515	0,011	17,711	22.187.841	11.786.042	17.630.707	120.713	5.005.258	0,010	0,184	0,242	1,68	2,89	0,50	1,00	0,50	0,50	0,50	0,04	0,04
Estonia	0,029	0,016	1,038	2.199.664	472.609	1.995.328	47.360	255.028	0,007	0,166	0,373	12,58	18,06	6,50	4,00	6,50	13,50	2,50	0,98	0,99
	0,012	0,007	0,909	3.528.314	701.851	2.552.468	61.789	275.778	0,013	0,154	0,271	11,16	11,19	1,52	1,02	0,51	0,51	0,51	0,00	0,07
Finland	0,058	0,006	3,686	23.695.132	27.318.381	25.072.267	535.548	9.459.400	0,000	0,113	0,313	16,49	47,46	8,50	4,50	7,00	7,50	1,50	0,99	1,90
	0,049	0,002	1,995	17.518.430	30.753.117	22.692.731	346.642	7.482.499	0,001	0,116	0,197	9,35	12,28	0,51	0,51	1,02	1,53	0,51	0,00	0,04
France	0,109	0,019	4,397	2.986.370	5.013.420	4.287.181	122.578	2.973.744	0,006	0,166	0,312	3,43	4,64	7,50	5,49	5,50	7,50	2,00	0,62	1,21
	0,615	0,018	28,341	18.914.109	38.654.142	25.732.348	708.116	17.740.407	0,059	0,184	0,193	0,58	0,94	1,50	2,50	0,50	0,50	1,00	0,02	0,03
Germany	0,038	0,018	4,847	6.917.108	7.225.941	8.808.582	134.782	38.382.512	0,587	0,321	0,313	2,82	3,82	7,00	5,50	5,50	8,50	3,50	0,46	1,54
	0,036	0,019	21,735	35.343.645	37.132.941	40.530.828	570.153	341.240.689	4,039	0,252	0,193	0,54	1,15	0,00	0,50	0,50	0,50	0,50	0,26	0,06
Greece	0,024	0,017	0,873	7.985.242	2.429.355	8.575.930	118.966	3.786.583	0,012	0,074	0,306	8,97	11,23	9,04	4,56	6,48	11,04	2,52	0,70	0,74
	0,008	0,005	0,615	9.152.725	3.032.894	9.141.745	133.859	5.765.811	0,009	0,051	0,191	6,25	7,40	1,01	1,51	0,50	1,01	0,50	0,04	0,07
Hungary	0,051	0,023	1,288	2.720.031	1.109.920	3.270.210	106.670	1.344.984	0,006	0,065	0,891	6,02	12,31	11,0	6,00	6,00	14,00	2,00	0,63	0,89
	0,018	0,022	1,336	2.784.696	1.263.395	3.150.040	140.684	832.344	0,006	0,058	0,584	2,87	4,34	0,00	2,01	1,01	0,00	1,01	0,00	0,05
Ireland	0,053	0,003	2,925	11.536.263	8.729.858	11.009.977	185.612	3.048.782	0,002	0,182	0,313	8,65	15,96	7,00	2,50	6,50	11,50	3,50	0,88	1,54
	0,048	0,003	5,640	26.051.178	13.293.232	21.064.691	349.440	8.168.498	0,010	0,139	0,194	5,89	6,47	0,00	0,50	0,50	0,50	0,50	0,06	0,04

Variable Country	w1	w2	w3	y1 (th EUROS)	y2 (th EUROS)	y3 (th EUROS)	y4 (th EUROS)	y5 (th EUROS)	crdrisk	lqdrisk	intrisk	Z-score (restricted model)	*Z-score* (unrestricted models)	restr	capreg	prvmon	suprvpower	forbdiscr	c5	KKZ
Italy	0,035	0,017	8,309	4.326.072	1.572.623	3.994.180	146.238	829.270	0,007	0,110	0,313	2,87	10,09	11,0	4,00	5,50	7,00	2,00	0,54	0,75
	0,039	0,011	31,433	6.919.236	2.472.527	6.989.780	222.629	1.837.452	0,011	0,203	0,193	0,63	1,54	1,00	0,00	0,50	0,00	0,00	0,03	0,12
Latvia	0,023	0,014	0,896	450.807	204.970	550.406	13.614	79.414	-0,011	0,147	0,618	11,22	12,14	7,50	5,50	7,00	11,51	3,50	0,67	0,65
	0,019	0,007	0,896	729.327	237.822	667.580	17.080	128.094	0,176	0,158	0,781	1,12	4,49	0,50	0,50	0,00	1,51	0,50	0,01	0,09
Lithuania	0,027	0,018	0,704	818.786	245.656	836.781	19.134	201.757	0,008	0,150	0,682	8,88	14,04	9,50	3,50	6,00	12,50	1,50	0,85	0,71
	0,012	0,010	0,545	1.201.393	296.538	953.985	22.648	376.262	0,014	0,107	0,622	1,75	1,91	1,51	0,50	1,01	1,51	0,50	0,03	0,10
Luxemb.	0,053	0,006	4,232	1.483.681	4.661.632	5.313.658	56.964	1.012.207	-0,016	0,436	0,313	3,42	5,54	7,50	6,00	6,50	11,50	3,00	0,29	1,82
	0,058	0,007	12,639	2.854.768	7.009.354	8.175.933	100.141	2.433.807	0,363	0,263	0,193	1,27	1,06	1,50	0,00	0,50	1,50	1,00	0,02	0,05
Malta	0,031	0,011	0,494	931.292	816.086	1.654.912	15.741	417.804	0,005	0,203	0,156	24,84	28,09	10,5	6,00	7,00	14,00	2,50	0,63	1,24
	0,009	0,005	0,455	947.253	815.012	1.592.971	16.474	402.047	0,008	0,172	0,090	28,69	8,62	0,51	0,00	0,00	0,00	0,51	0,21	0,05
Netherl.	0,062	0,010	2,774	18.635.144	18.073.921	25.017.601	355.715	8.244.625	-0,005	0,346	0,312	8,45	10,81	6,00	5,50	6,50	5,99	1,50	0,89	1,72
	0,071	0,008	5,911	67.849.837	75.969.274	97.466.569	1.332.398	32.147.393	0,076	0,215	0,194	4,84	4,41	0,00	0,50	0,50	1,00	0,50	0,01	0,07
Poland	0,054	0,017	7,532	678.350	630.036	1.071.462	40.253	1.489.296	0,013	0,092	0,840	5,32	5,30	7,50	4,50	6,00	8,50	2,00	0,53	0,57
	0,036	0,017	14,609	1.075.103	992.506	1.571.892	79.978	3.970.820	0,029	0,115	0,562	2,63	2,31	0,50	1,50	0,00	0,50	1,00	0,04	0,08
Portugal	0,053	0,010	1,472	19.881.245	7.648.750	17.551.821	445.088	10.215.965	0,003	0,087	0,313	14,90	19,49	11,0	6,50	5,50	14,00	4,00	0,83	1,16
	0,024	0,004	1,177	20.966.003	6.226.680	17.539.112	401.294	9.226.300	0,002	0,099	0,196	3,27	6,65	1,02	0,51	0,51	0,00	0,00	0,04	0,10
Romania	0,062	0,030	1,232	310.241	161.665	493.517	16.322	97.371	0,016	0,141	3,826	6,11	6,96	11,5	4,99	5,00	9,00	1,50	0,62	0,01
	0,044	0,018	1,804	622.491	370.424	921.528	29.666	170.978	0,035	0,143	3,507	3,21	3,06	0,50	1,00	0,00	0,00	0,50	0,03	0,07
Slovakia	0,037	0,012	0,780	682.228	804.806	1.333.866	21.469	309.976	0,006	0,173	0,478	10,15	10,57	10,5	5,00	5,00	13,50	1,00	0,67	0,66
	0,019	0,003	0,574	737.051	1.058.216	1.490.456	25.596	415.452	0,019	0,131	0,309	5,02	4,28	0,50	2,01	0,00	0,50	0,00	0,00	0,11
Slovenia	0,045	0,013	0,786	1.150.416	693.494	1.333.733	31.394	414.054	0,012	0,063	0,522	7,61	9,67	10,5	6,50	7,00	12,50	1,00	0,66	0,95
	0,015	0,003	0,734	1.543.644	862.459	1.634.236	38.197	441.536	0,014	0,065	0,285	2,42	3,59	0,50	1,51	0,00	0,50	0,00	0,03	0,04
Spain	0,039	0,016	0,679	30.096.968	13.626.555	29.122.657	624.731	11.714.345	0,042	0,070	0,313	8,31	8,15	6,50	8,00	6,50	10,00	1,38	0,53	1,15
	0,048	0,018	0,861	84.836.369	43.618.477	83.167.259	1.753.025	31.654.500	0,390	0,090	0,193	5,15	2,59	0,50	0,00	0,50	1,00	0,49	0,00	0,15
Sweden	0,024	0,013	5,450	10.795.688	6.181.605	10.452.125	167.453	14.014.274	0,002	0,092	0,283	19,69	15,32	9,00	2,50	6,00	6,50	4,00	0,79	1,76
	0,017	0,005	17,735	28.217.887	18.615.563	27.812.216	469.611	51.087.978	0,007	0,071	0,119	4,51	4,34	1,00	0,50	0,00	1,51	0,00	0,17	0,04
UK	0,048	0,012	7,079	22.752.626	21.272.241	27.032.567	514.425	12.072.014	0,007	0,289	0,262	8,49	6,95	4,50	5,50	6,50	9,51	4,00	0,45	1,56
	0,062	0,010	43,120	87.285.340	101.097.547	108.085.544	2.027.677	51.140.839	0,021	0,264	0,164	1,16	0,66	0,50	0,50	0,50	1,50	0,00	0,22	0,06

Note: For each country, the first number is the mean and the second is the standard deviation of the variable.

Table 2: Cost Efficiency Estimates

Model specification	Restricted		Unrestricted A (incl. noninterest income)		Unrestricted B (incl. OBS activities)	
	EU-15	12 NMS	EU-15	12 NMS	EU-15	12 NMS
Mean efficiency scores	0.69	0.64	0.79	0.71	0.70	0.63

Table 3: Profit Efficiency Estimates

Model specification	Restricted		Unrestricted A (incl. noninterest income)		Unrestricted B (incl. OBS activities)	
	EU-15	12 NMS	EU-15	12 NMS	EU-15	12 NMS
Mean efficiency scores	0.72	0.66	0.87	0.79	0.73	0.66

Table 4: Regression Results, Cost Function, EU-15

Model specification	Restricted	Unrestricted A (incl. noninterest income)	Unrestricted B (incl. OBS activities)
constant	1.593***	1.944***	1.622***
	(.0059)	(.066)	(.064)
ln(w_1/w_2)	.617***	.679***	.611***
	(.0088)	(.0095)	(.0077)
ln(w_3/w_2)	.345**	.399**	.331**
	(.164)	(.201)	(.158)
ln(y_1)	.475***	.424***	.471***
	(.0077)	(.0081)	(.0081)
ln(y_2)	.503**	.444**	.504**
	(.248)	(.223)	(.251)
ln(y_3)	.654***	.728***	.643***
	(.0087)	(.0090)	(.0064)
ln(y_4)		.109***	
		(.0096)	
ln(y_5)			.0017
			(.0051)
crdrisk	-1.186***	-1.075***	-1.162**
	(.0297)	(.0176)	(.574)
lqdrisk	-3.696***	-2.774***	-3.189**
	(.5467)	(.4832)	(1.513)
inslrisk	-2.437***	-1.873***	-2.264***
	(.4358)	(.3295)	(.4133)
intrisk	-8.176***	-7.700***	-9.112*
	(.377)	(.514)	(4.982)
restr	-2.785***	-2.999***	-3.205***
	(.3569)	(.3457)	(.4358)
capreg	.768**	.987**	1.086**
	(.350)	(.460)	(.5086)

Model specification	Restricted	Unrestricted A *(incl. noninterest income)*	Unrestricted B *(incl. OBS activities)*
prvmon	.335***	.247***	.294***
	(.0178)	(.0112)	(.0143)
superpower	1.765**	2.893**	2.341**
	(.824)	(1.390)	(1.183)
forbdiscr	.435	.789	.276*
	(.3210)	(.5542)	(.1409)
KKZ index	.180***	.132***	.239***
	(.0893)	(.0631)	(.0254)
C5	.607***	.523***	.584***
	(.0488)	(.0299)	(.0377)
real GDP growth rate	.896***	.818***	.716***
	(.060)	(.061)	(.067)
size	.189***	.193**	.276***
	(.086)	(.081)	(.0943)
t	.131**	.090**	.110**
	(.0592)	(.0431)	(.0530)
t^2	.285**	.201***	.145**
	(.1427)	(.0257)	(.068)

*Note: The first number in each cell is the mean and the second is the standard deviation of the variable. Also: ***, **, * correspond to 1%, 5% and 10% level of significance, respectively.*

Table 5: Regression Results, Cost Function, 12 NMS

Model specification	Restricted	Unrestricted A *(incl. noninterest income)*	Unrestricted B *(incl. OBS activities)*
constant	1.789**	2.378***	2.098***
	(.8024)	(.0247)	(.0186)
$ln(w_1/w_2)$	.430***	.499***	.436***
	(.0022)	(.0108)	(.0029)
$ln(w_3/w_2)$	.286**	.345**	.334**
	(.141)	(.139)	(.159)
$ln(y_1)$	.321***	.397***	.654***
	(.0054)	(.0678)	(.1209)
$ln(y_2)$	1.204**	1.498**	1.352**
	(.568)	(.659)	(.661)
$ln(y_3)$	.876***	1.069***	.989***
	(.1986)	(.3429)	(.2361)
$ln(y_4)$		.578***	
		(.201)	
$ln(y_5)$			.0197
			(.0138)
crdrisk	-2.897**	-4.920***	-3.925**
	(1.365)	(.9830)	(1.792)
lqdrisk	-2.734***	-4.528***	-3.852***
	(.4990)	(.8726)	(.6403)
inslrisk	-3.461**	-6.302**	-5.983**
	(1.563)	(3.038)	(2.409)

Model specification	Restricted	Unrestricted A (incl. noninterest income)	Unrestricted B (incl. OBS activities)
intrisk	-2.960*** (.6701)	-3.946*** (.8402)	-4.720* (2.510)
restr	-3.897*** (1.432)	-4.238*** (1.910)	-3.970*** (1.678)
capreg	.654** (.3186)	.765** (.3764)	.704** (.3548)
prvmon	.782*** (.2001)	1.099*** (.3561)	.986*** (.2409)
superpower	1.854** (.8563)	2.630** (1.327)	2.132** (1.008)
forbdiscr	.997 (.685)	1.004 (.7024)	1.208 (.8730)
KKZ index	.199*** (.0460)	.231*** (.0504)	.268*** (.0614)
C5	.753*** (.1405)	.985*** (.2540)	.783*** (.1976)
real GDP growth rate	.9520*** (.2585)	1.278*** (.4127)	1.097*** (.3018)
Size	.743*** (.1979)	.859** (.2090)	.821*** (.2034)
T	.396** (.1708)	.679** (.3231)	.530** (.2368)
t^2	1.864** (.898)	2.288** (1.087)	.2063** (.915)

*Note: The first number in each cell is the mean and the second is the standard deviation of the variable. Also: ***, **, * correspond to 1%, 5% and 10% level of significance, respectively.*

Table 6: Regression Results, Profit Function, EU-15

Model specification	Restricted	Unrestricted A (incl. noninterest income)	Unrestricted B (incl. OBS activities)
constant	1.678*** (.1260)	2.893*** (.3492)	2.320** (1.510)
$ln(w_1/w_2)$	.530*** (.0196)	.674*** (.0285)	.655*** (.0233)
$ln(w_3/w_2)$	.201** (.1003)	.297** (.138)	.254** (.119)
$ln(y_1)$	.329*** (.0069)	.401*** (.0097)	.348*** (.0090)
$ln(y_2)$	.870** (.432)	.999** (.439)	.876** (.434)
$ln(y_3)$	.762*** (.0333)	.870*** (.0431)	.797*** (.0390)
$ln(y_4)$		.604*** (.0756)	
$ln(y_5)$			.0805 (.0673)

Model specification	Restricted	Unrestricted A *(incl. noninterest income)*	Unrestricted B *(incl. OBS activities)*
crdrisk	-1.452**	-1.987***	-1.760*
	(.674)	(.1974)	(.973)
lqdrisk	-3.673***	-3.980***	-3.791***
	(.7602)	(.8310)	(.7999)
inslrisk	-2.528**	-2.896**	-2.730**
	(1.243)	(1.350)	(1.338)
intrisk	-4.672***	-6.520***	-5.672***
	(.2407)	(.3510)	(.2890)
restr	-2.845***	-3.563***	-3.133**
	(.4320)	(.5620)	(1.570)
capreg	.873***	1.093***	1.001***
	(.1208)	(.2204)	(.2096)
prvmon	.540***	.762***	.657***
	(.0139)	(.0247)	(.0207)
superpower	1.650**	1.906**	1.784**
	(.8304)	(.8504)	(.7969)
forbdiscr	.230*	.320	.290*
	(.1401)	(.2541)	(.1598)
KKZ index	.260***	.341***	.328***
	(.0452)	(.0650)	(.0586)
C5	.974***	1.891***	1.673***
	(.1208)	(.3096)	(.2874)
real GDP growth rate	.769***	.980***	.853***
	(.102)	(.276)	(.236)
Size	.340***	.783**	.645***
	(.0410)	(.0894)	(.0761)
T	.450**	.873**	.652*
	(.2243)	(.4382)	(.3631)
t^2	1.320**	1.894**	1.520**
	(.5859)	(.8575)	(.7109)

*Note: The first number in each cell is the mean and the second is the standard deviation of the variable. Also: ***, **, * correspond to 1%, 5% and 10% level of significance, respectively.*

Table 7: Regression Results, Profit Function, 12 NMS

Model specification	Restricted	Unrestricted A *(incl. noninterest income)*	Unrestricted B *(incl. OBS activities)*
constant	1.532**	2.730***	2.329**
	(.7301)	(.4308)	(1.1851)
$ln(w_1/w_2)$	.634***	.762***	.719***
	(.0356)	(.0560)	(.0521)
$ln(w_3/w_2)$	.263**	.355**	.298**
	(.1291)	(.1329)	(.1384)
$ln(y_1)$	.245***	.640***	.903***
	(.0054)	(.0231)	(.0563)
$ln(y_2)$	1.250**	1.984**	1.512**
	(.5940)	(.8623)	(.7480)

Model specification	Restricted	Unrestricted A *(incl. noninterest income)*	Unrestricted B *(incl. OBS activities)*
ln(y$_3$)	.659***	.983***	.620***
	(.0320)	(.0536)	(.0382)
ln(y$_4$)		1.562***	
		(.3901)	
ln(y$_5$)			1.673
			(.9932)
crdrisk	-1.734**	-2.341***	-1.905**
	(.8404)	(.1620)	(.9199)
lqdrisk	-3.782**	-4.871**	-4.494**
	(1.840)	(2.399)	(2.104)
inslrisk	-2.780***	-3.783***	-2.945***
	(.3401)	(.4567)	(.3767)
intrisk	-4.840**	-9.056***	-6.904**
	(2.356)	(2.316)	(3.473)
restr	-3.103***	-3.999***	-3.867***
	(.5632)	(.6745)	(.6520)
capreg	1.783**	1.984**	1.876**
	(.8212)	(.8309)	(.8278)
prvmon	.578***	.767***	.634***
	(.0145)	(.0290)	(.0198)
superpower	1.235**	1.784**	1.520**
	(.6095)	(.8049)	(.7123)
forbdiscr	1.756	1.983	2.008*
	(1.253)	(1.421)	(1.867)
KKZ index	.278***	.345***	.299***
	(.0490)	(.0734)	(.0600)
C5	1.563***	2.777***	1.967***
	(.2710)	(.4045)	(.3028)
real GDP growth rate	.631***	1.389***	.956***
	(.0890)	(.1113)	(.0988)
Size	.389***	.831**	.774***
	(.0478)	(.1002)	(.0853)
T	1.563**	1.890**	1.783**
	(.7301)	(.8510)	(.8459)
t^2	.903**	1.064**	1.004*
	(.4436)	(.4599)	(.5849)

*Note: The first number in each cell is the mean and the second is the standard deviation of the variable. Also: ***, **, * correspond to 1%, 5% and 10% level of significance, respectively.*