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Cross Country Comparison of Efficiency in Investment Banking

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Abstract

This paper aims to identify the framework for comparing investment banks efficiencies across nations. In order to overcome traditional limitations two methods are adopted: first, where separate frontiers are estimated to check for the existence of structural differences between the countries; and second method which accounts for the influences of environmental factors on the industry, by including indicator of these factors in a definition of a common frontier. We use translog cost and profit function in order to measure X-efficiency. Data set consist from more than 900 investment banks from G7 countries (US, UK, Japan, Italy, Germany, France and Canada) and Switzerland over the period 2000-2007.

1. **Motivation and Introduction**

Investment banking industry on the world level has gone through incredible transformation due to cross border activities and consolidation. Today more and more banks are crossing international borders and providing services around world. Having in mind the business of investment banking and newest trends, we can say that efficiency of these types of banks is important for several reasons. First, investment bank engage in public and private market transaction for corporations, governments and investors, and by doing so is making benefits for all the participants. Second, efficiency of these institutions affect the financial markets and the ability of investment banks to minimize costs or maximizes profits is important both for them and for their clients. Third, by exercising their powers and by improving their efficiency, these institutions improve certain industry segments (this refers to boutique investment banks).

We can define investment banking as the intermediation between issuers and investors through the core function of advisory, M&A, debt capital markets and equity capital markets.

A number of environmental trends as well as the creativity and dynamism of their professional teams have shaped today's investment banks. Most of the researchers and analysts agree that the key drivers of the phenomenal secular growth of the business have been: GDP growth and stock market prices; globalization through cross border investment flows (cross border mergers and acquisitions in the developed world as well as direct and portfolio investment in emerging markets); the accumulation of assets managed by institutions (growing share of GNP wealth managed by institutions such as pension funds has created a well structured market for investment banks); securitization (has represented a direct economical transfer from commercial to investment banks); deregulation.[1]

Gardener and Molyneux (1995) have identified similar factors that affect and influence the evolution of investment banking, such as: real per capita income and wealth, economic forces that directly affect investment banking services through technological advances, the regulatory framework affects, distribution of property rights and the way that they are exercised.

Due to specific nature of this research and complexity of the investment banking business, we provide the literature definition of the same, where: ''Investment bank's business can be categorized into five main areas: broking (the broking of securities is commodity business in which firms appeal to customers mainly on

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[1] For further readings see Davis (2003)

price and integrity); trading (the trading of securities drives on market volatility); investment banking (represents the underwriting of new issues and advisory work also referred to as Mergers and Acquisitions); fund management (includes both retail and wholesale fund management); interest spread (income derivatives from borrowed funds).''[2]

There are two basic types of investment banks: full-service and boutique. Full service investment banks (also known as the Wall Street bulge bracket) offer clients a range of service including underwriting, merger and acquisition advice, trading, merchant banking and prime brokerage. For example, Goldman Sachs offers services in investment banking, trading and principal investments, asset management and securities service; Merrill Lynch in capital markets, investment banking and advisory, wealth management, investment management, insurance and banking. Boutique investment banks specialize in particular segments of the market. They do not offer a range of service and are not part of larger financial institution.[3] For example, Greenhill is specialized for Advisory services in M&A, Financial restructuring and Merchant banking, while Lazard offers Financial advisory and Asset management services.[4]

Beside these two basic types of investment banks it is important to mention financial holding companies, which operate full-service investment banking, and can besides that offer clients large sums of credit (for example Citigroup, HSBC, Credit Suisse, JP Morgan Chase and Bank of America).[5] For example, business segments for HSBC Group are personal financial services, commercial banking, corporate, investment banking and markets and private banking.

Investment banking represents a revenue motivated business. In order for management to maximize their share of that revenue, they have to improve some or all sectors of investment banking business. Investment banks diversify their business lines in order to have earnings more stable. For most investment banks today, investment banking represents only a portion of their overall income. By looking at the JP Morgan Chase annual report for 2006, we notice that income by line of business was 24% for retail financial services, 24% for card services, 27% for investment bank, 10% for asset management, 8% treasury and securities services and 7% for commercial banking. On the other hand Morgan Stanley income source for 2007 were 19% for asset management, 24% for global wealth management and 57% for institutional securities.[6]

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[2] For further readings see Gardener and Molyneux (1995)
[3] For further readings see Liaw (2006)
[4] Sources: Annual Reports for 2006 of the given banks.
[5] For further readings see Liaw (2006)
[6] Source was Morgan Stanley annual report for 2007.

Managing the cost base was always dominated by human capital, and influenced by investment in global infrastructure and product platforms. However, managing the cost bases raises also the issue of the relationship between cost and revenues, which means that banks can match its cost base to its revenue generating potential over time. Here the challenge is to either reduce cost base or to find other business to grow.[7]

The most valuable tangible assets are people and as such, the biggest expenses are compensation and benefits. Other operating expenses are generally less then compensation expenses, and are known as communication and technology, occupancy and depreciation, brokerage, clearing and exchanges fees, marketing and advertisements, office supplies, exc.[8]

Our focus in this article is on the efficiency frontier - how close investment banks are to a "best-practice" frontier. Since engineering information on the technology of financial institutions is not available, studies of frontier efficiency rely on accounting measures of costs, outputs, inputs, revenues, profits, etc. to impute efficiency relative to the best practice within the available sample.

For example, Berger and Humphrey (1997) stated, *''Frontier analysis provides an overall, objectively determined, numerical efficiency value and ranking of firms that is not otherwise available''* (Berger and Humphrey 1997, p. 2). Same authors concluded that in terms of applications role of efficiency analysis is: *''to inform government policy (e.g., by assessing the effects of deregulation, mergers, and market structure on industry efficiency); to address research issues (e.g., by determining how efficiency varies with different frontier approaches, output definitions, and time periods); and to improve managerial performance (e.g., by identifying best-practice and worst-practice branches within a single firm)''* (Berger and Humphrey 1997, p. 46).

Today more than ever investment banking business has changed due to globalization, deregulation and the accumulation of assets, innovations, aggressive expansion and rivalry amongst industry leaders. In the new conditions to stay competitive and successful investment bank needs to have a strong product line, the ability to provide clients with an integrated solution, a strong global presence, financial strength, integrity and teamwork.

Identification, analyses and measurement some of these factors could tell us whether current efficiency measurements are sufficient to meet new trends in investment banking and whether investment bank efficiency is determined by structural characteristics (such as environmental factors) or technological progress.

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[7] For further readings see Davis (2003)
[8] For further readings see Liaw (2006)

This paper contributes to the existing literature for the following reasons: First, with providing a focus on the investment banking, which is surprisingly inadequately explored (Berger and Humphrey 1997 cites no studies on investment banks, and the only paper analyzing this sector was from Beccalli 2004) we contribute to existing literature. Second, we perform cost and profit efficiency comparison of the investment banking industries in G7 countries (US, UK, Japan, Italy, Germany, France and Canada), through introduction of the appropriate environmental variables in the cost and profit frontier estimations. Our goal is to obtain a proper comparison of banking efficiency across countries by using a global best practice econometric frontier whereby the banks in each country can be compared against the same standard. Third, we conduct completely separate frontiers analysis to check for the existence of structural differences between the countries.

We choose to consider cost and profit efficiency comparison of the investment banking industries because markets are becoming more competitive and current differences in productive efficiency and costs among them, will determine each country banking structure and future competitiveness. Reason for consideration of alternative profit efficiency is in the case where assumptions underlying cost and profit efficiency are not met. Dietsch and Lozano-Vivas (2000) said *''To predict the effects of an expected increase in cross-border competition, knowledge of the differences or similarities in the current banking costs and productive efficiencies between countries is important''* (Dietsch and Lozano-Vivas 2000, p. 987).

Research regarding international comparisons of banking efficiency can be summarized into three groups (Berger 2007). First, comparisons of the efficiencies of banks in different nations, with all banks measured against a common frontier. Second, comparisons of the efficiencies of banks in different nations, with banks from each nation measured against their own nation-specific frontier. Third, comparisons of the efficiencies of foreign-owned versus domestically owned banks within the same nation, with both types of banks measured against the same nation-specific frontier. As it can be seen from same study all three types of comparisons have limitations, but only the third category addresses the key issues – why cross border consolidation among developed nations is so low and why foreign banks presence is much higher in developing nations.

As Berger and Humphrey (1997) said, cross-country comparisons are difficult to interpret because the regulatory and economic environments faced by financial institutions are likely to differ importantly across nations and because the level and quality of service associated with deposits and loans in different countries may differ in ways that are difficult to measure. On the other side, they can provide valuable information regarding the competitiveness of banks in different countries,

a concern of particular importance in the increasingly harmonized European market for banking services and the perhaps more globalized financial markets of the future.

2. Literature Review

This section reviews the existing literature on the influence of the environmental variables on the banking efficiency studies. It is organized as follows: section 2.1. examines the studies on the efficiency of investment banks, whereas section 2.2. analyses the issue of the influence of environmental variables on banking performance.

Section 2.1. The efficiency of the investment banks

Literature review by Berger and Humphrey (1997) quotes no studies on efficiency of investment banks. This is due to the difficulties of modeling successfully the peculiar nature of their production process (variables identification) and partially to the lack of good quality data. For example, the same authors mentioned only five studies that compare efficiency levels across countries where three of these studies took Nordic countries for comparison, and other two cross-country studies were applied for 11 OECD and 8 developed countries. As well, most financial institution efficiency studies have been applied to the U.S. banking industry.

Further motivation for our study comes from recent interest in comparison of banking efficiency.

International comparisons of bank efficiency, literature review from Berger (2007), investigate 100 studies that compare bank efficiencies across nations. These comparisons differ in terms of how efficiency is measured. Studies that have compared efficiency of different nations by using common frontier have mainly focused on several European nations, and U.S (they have examined mainly developed nations). Efficiency comparisons of different nations by using nation specific frontiers have been applied for depository financial institutions and insurance companies covering mainly U.S. and individual European nations (most of these single-nation efficiency studies do not focus on international comparisons). A number of recent studies have expanded the bank efficiency literature by comparing the efficiencies of foreign-owned versus domestically owned banks within the same nation using the same nation-specific frontier and they have been dealing with developed and developing nations. Generally, problems with these studies were that their results aren't distinguished by the nation of origin of the foreign owned banks, where only the most comprehensive developed nation studies have identified the nation of origin of the foreign owned banks.

Only a few studies have been made on efficiency of investment firms like Anolli and Resti 1996, and Beccalli 2004. Study from Beccalli (2004) has introduced two

new methods for cross country comparisons of the cost efficiency of UK and Italian investment firms over the period 1995-1998. The first method shows differences between the efficiency of the two countries by incorporating environmental variables into the cross country common frontier. The second method shows differences in the efficiency of the domestic versus foreign investment firms in the two countries, by testing the ability to monitor and control on a cross-border basis. Methodology used is based on parametric stochastic frontier approach (SFA) in order to model cost efficiency. Data in the study are taken from financial statements from both countries. The author found important to control for environmental variables since they had significant influence on cost efficiency and profitability in her research. In terms of cross country operations, it was found that more efficient firms go abroad, exporting a more efficient model while less efficient firms attract foreign investment firms with higher efficiency.

Over the past decade, substantial research has been done for measuring the efficiency of financial institutions, mainly commercial banks. Different efficiency concepts (cost, profit and alternative profit), different efficiency measurement methods (parametric and non parametric) have been employed to improve current methodology. Next, we give overview some of these researches.

Looking at the study from Berger and Mester (1997) we can realize that there is still little information and no consensus on the sources of the substantial variation in measured efficiency, although there has been significant research regarding the efficiency of financial institutions.

There is a consensus in the literature that differences in frontier efficiency among financial institutions exceed inefficiencies attributable to incorrect scale or scope of output. However, there is really no consensus on the preferred method for determining the best-practice frontier against which relative efficiencies are measured (Berger, Hunter & Timme 1993).

Recent studies such as those from Hughes and Mester (1993), McAllister and McManus (1993), Mester (1996), Berger and DeYoung (1997), Altunbas, et. al. (2001), suggest that risk characteristics need to be incorporated in the underlying industry cost or profit functions because, `unless quality and risk are controlled for, one might easily miscalculate a bank's level of inefficiency'. What these studies have in common is their focus only on one country.

Earlier consideration leads us to investigate efficiency and synergies on both cost and revenue side. We can find many studies dealing with banking changes in cost and profit efficiency, but they are mainly limited to US and Europe, while no study has treated the investment banking cross-country cost and profit efficiency. Some of the studies that have analyzed universal banking (which includes investment

banking in their business) together with traditional banking are analyzed in next paragraphs.

Allen and Rai (1996) use distribution-free approach (DFA) and stochastic frontier approach (SFA) for a systematic comparison of X-inefficiency measures across 15 developed countries under different regulatory environments. The authors estimate a global cost function for international banks to test for both input and output inefficiencies. Results for 1988-1992 data (in the form of balance sheet and income statement) suggest the prevalence of input X-inefficiencies far outweighs that of output inefficiencies, and that the distribution-free model overestimates the magnitude of X-inefficiencies relative to the stochastic cost frontier approach.

Vander Vennet (2002) used a parametric methodology in order to measure cost and profit efficiency of European financial conglomerates and universal banks in 1995-1996. The sample consists of 2.375 EU banks from seventeen countries for which all the variables were available from their published annual statements. Results show that financial conglomerates are more revenue efficient than specialized banks and that universal banks are more efficient on both cost and revenue side. The author suggests, *''Further research should examine the sources of the efficiency differences between various types of banks'* (Vander Vennet 2002, p. 280)'.

Section 2.2. The importance of the environmental variables in the studies of banking efficiency and performance

Berger et al. (1993) and Berger and Humphrey (1997) confirm that efficiency scores differ markedly across studies. According to Mester (1993, 1997) and Berger and Mester (1997), the failure to account for heterogeneity is a likely candidate to cause this instability of efficiency results. Consequently, controlling for heterogeneity results in efficiency scores that more accurately reflect management's ability to minimize costs and maximize profits was also recognized by Bos et al. (2008).

Cross-border comparison of efficiency was somewhat of a paradox, since banks were compared to a common efficient frontier while assuming that different countries have access to the same technology. Some research papers were working on country specific environmental factors in order to avoid this technology problem (Lozano-Vivas et al. 2002, Dietsch and Lozano-Vivas 2000).

According to Dietsch and Lozano-Vivas (2000), considering environmental conditions while measuring banking efficiency differences across countries is important because these differences should take into account the way in which banking services are produced. In the research from Beccalli (2004), author also

proves the importance of environmental variables, for the cross-country comparisons of the cost efficiency of UK and Italian investment firms.

Looking at the cross-country differences in banking efficiency Valverde, et al. (2007) showed using data on large banks across 10 European countries for the period 1996-2002, that they are roughly equally efficient after controlling for differences in business environment, banking costs, and bank productivity. Parametric approach for measuring cost efficiency used in this study was the distribution free approach (DFA). Results suggest that the large banks in each of the 10 countries had almost identical average efficiency values and since no country have a strong efficiency advantage, it seems likely that state efforts to promote ''national champions'' through favorable mergers may determine the outcome.

In existing studies that estimate the efficiency of banks in a cross-national scenario, the standard approach is to construct a common efficient frontier for all firms, regardless of their home country. However, this standard approach is unable to compare the different banking systems on an equal footing, because it does not account for cross-country differences in regulation, economic and demographic conditions, which are beyond the control of bank managers.

Without a common benchmark it is difficult to compare efficiency levels and rankings (Coelli et al., 2005; Bos and Schmiedel, 2007). Most recent studies therefore estimate a common benchmark, but seek to control for systematic differences across banks that are not due to inefficiency.[9]

In this paper, we therefore have to account for potential differences arising from certain country-specific aspects of the banking technology on the one hand and from the environmental and regulatory conditions on the other. In particular, the economic environments are likely to differ significantly across countries. Three categories of environmental variables are taken into account: (1) those that describe the main macroeconomic conditions, which determine the banking product demand characteristics, (2) variables that describe the structure of the banking industry, and (3) those that characterize the accessibility of banking services. More explanation about given variable is provided in the data and sample section of the paper.

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[9] Deprins and Simar (1989), Kumbhakar and Lovell (2000) observe that it can be difficult to determine if an exogenous variable is a characteristic of production technology or a determinant of productive efficiency.

3. Methodology

Primary objective of our empirical analysis is to identify the framework for comparing investment banks efficiencies across nations.[10] Two methods are adopted: first, where separate frontiers are estimated to check for the existence of structural differences between the countries; and second method which accounts for the influences of environmental factors on the industry, by including indicator of these factors in a definition of a common frontier.[11]

We use stochastic frontier approach to model cost and profit efficiency.

Efficiency is estimated by using the parametric Stochastic Frontier analysis (originally independently proposed by Aigner, Lovell and Schmidt (1977) and Meeusen and Van den Broeck (1977)). This model can be expressed in the following form:

$$Y_i = x_i\beta + \varepsilon_i \qquad \varepsilon_i = v_i + u_i \qquad i=1,...,N \qquad (1)$$

Where:

- Y_i is the (logarithm of the) cost of production of the i-th firm;

- x_i is a k×1 vector of (transformations of the) input prices and output of the i-th firm;

- β is a vector of unknown parameters;

- ε_i is disentangled in two main components: The first is the random error term (v_i), accounting for measurement errors, bad luck and other factors unspecified in the cost function. The v_i are assumed to be iid normal random variables with mean zero and constant variance σV^2, $|N(0,\sigma_V^2)|$ and independent of the u_i; The second term is a non-negative cost inefficiency term (u_i), added to the cost frontier representing minimum cost. It is generally assumed to have a half normal or truncated normal distribution, with variance equal to σ_U^2, $|N(0,\sigma_U^2)|$[12].

Firm-specific estimates of technical inefficiency, u_i, can be calculated by using the distribution of the inefficiency term conditional on the estimate of the

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[10] According to Berger and Hannan (1994), efficiency measurements problems partially come from the fact that the measured efficiencies of the different industries may not be comparable to each other at all.

[11] Introduction of two methods is performed in order to overcome traditional limitations.

[12] Assuming a half-normal distribution with mean zero implies that most banks are closely located to the frontier and with small level of inefficiency. Another possibility is to relax this *a priori* assumption and estimate the mean of the truncated normal distribution from the data.

composed error term, ε_i (Jondrow et al., 1982). The mean of this conditional distribution for the half normal model is shown as:[13]

$$E(\mu_i / \varepsilon_i) = \frac{\sigma \lambda}{1 + \lambda^2} \left[\frac{\int (\varepsilon_i \lambda / \sigma)}{1 - F(\varepsilon_i \lambda / \sigma)} + \left(\frac{\varepsilon_i \lambda}{\sigma} \right) \right]$$

(2)

Where $F(.)$ and $f(.)$ are respectively the standard normal distribution and the standard normal density function. $E(u_i/\varepsilon_i)$ is an unbiased but inconsistent estimator of u_i. The ratio of variability (standard deviation,σ) for u and v can be used to measure the relative inefficiency of a firm, where $\lambda = \sigma_u/\sigma_v$ is a measure of the amount of variation stemming from inefficiency relative to noise for the sample.

Estimates of bank specific cost efficiency are obtained by calculating:

$$CE_i = [\exp(-u_i)]^{-1}$$

(3)

This measure takes on a value between 0 and 1. Cost efficiency equals one for a fully efficient bank that operates on the efficient stochastic frontier.[14]

The method of maximum likelihood is proposed for simultaneous estimation of the parameters of the stochastic frontier and the model for the technical inefficiency effects. We utilize the parameterization of Battese and Corra (1977) who replace σ_V^2 and σ_U^2 with $\sigma^2 = \sigma_V^2 + \sigma_U^2$ and $\gamma = \sigma_U^2/(\sigma_V^2 + \sigma_U^2)$. The parameter γ must lie between 0 and 1, where a value of zero means that all the deviations from the frontier are due to random error and a value of one indicates that all deviations are due to inefficiency. The technical efficiency of production for the i-th firm is defined by equation:

$$TE_{i,} = \exp(-u_{i,})$$

(4)

The prediction of the technical efficiencies is based on its conditional expectation, given the model assumptions.[15]

We choose to consider also alternative profit efficiency. Reason for consideration of alternative profit efficiency is in the case where assumptions underlying cost and profit efficiency are not met and are violated by the data. According to Berger and Mester (1999, pg.3), ''*profit maximization is superior to cost minimization for most purposes because it is the more accepted economic goal*

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[13] For further readings see Beccalli (2004, pg. 1368)
[14] For further readings see Bos and Schiemdel (2007, pg.2086)
[15] For further readings see Battese and Coelli (1995, pg.328)

of firm's owners, who takes revenues as well as costs into account when making decisions''.[16]

The frontier definition is the same as in the cost case, except for the dependent variable: we replace total cost with total profit and the inefficiency term (u_i) is subtracted as in the production case, given that the frontier represents maximum profit. Efficiency is given by the ratio of observed profit to frontier maximum profit (the ideal best practice for which $u_i = 0$), equal to:[17]

$$PE_i = [\exp(-u_i)] \qquad (5)$$

In order to successfully perform first method of our research we specify both stochastic cost and profit function for each country to verify whether or not structural variables are the same in each country. Then we specify common stochastic frontier with two cases (case I with only endogenous structural variables, and case II with exogenous environmental variables).

To define a common frontier we use the following translog[18] specification[19]:

$$\ln TC_i = a_0 + \sum_i a_1 \ln y_i + \sum_j b_j \ln p_j + \frac{1}{2}(\sum_i \sum_j c_{ij} \ln y_i \ln y_j + \sum_i \sum_j d_{ij} \ln p_i \ln p_j) +$$

$$+ \sum_i \sum_j g_{ij} \ln y_i \ln p_j + f_E \ln E + \frac{1}{2} h_{EE} \ln E \ln E + \sum_j k_{Ej} \ln E \ln y_j + \sum_j m_{Ej} \ln E \ln p_j \qquad (6)$$

where

TC_i is total cost for the i-th firm;

y_i are the output quantities;

p_i are the input prices.

E is the firm level of equity capital.[20]

As usual, symmetry and linear homogeneity restrictions are imposed standardising total cost TC and input prices p_i by the last input price.

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[16] Some of the studies employ an alternative profit function in which the firm maximizes profits given output quantities, rather than taking output prices as exogenous (Berger, Cummins and Weiss, 1996; Humphrey and Pulley, 1997; Akhavein, Berger, and Humphrey, 1997; Berger and Mester, 1997).

[17] Fiordelisi and Ricci (2006, pg.11)

[18] Berger and Mester (1997) used the distribution free approach and stochastic frontier approach for both translog and the Fourier specification of the cost and profit function, and have concluded that difference between two methods are not relevant. Same was observed and stated also by Vander Vennet (2002).

[19] For further readings see Vander Vennet (2002, pg.264)

[20] Equity is included into equation (as suggested by some authors such as Altunbas et al. 2000, Vander Vennet 2002, Beccalli 2004, Bos and Schmiedel 2007) as a measure of financial capital. It is treated as a netput, specifying interaction terms with other output and input prices

In this model we don't account for possible strong heterogeneity in the sample (so efficiency estimates could be biased). Many authors have stressed the importance of accounting for heterogeneity in the frontier definition.

According to Dietsch and Lozano-Vivas (2000) the environmental conditions faced by financial institutions are likely to differ substantially and the specific environmental conditions of each country play an important role in the definition and specification of the common frontier of different countries.

In order to account for heterogeneity we follow Coelli et al. (1999) approach where there are two different ways for including environmental conditions or firms specific factors, that the authors specify as Case 1 and Case 2 Model.[21]

Case 1 - Environmental factors have a direct influence on the production structure

One possibility is to consider that environmental conditions/firm specific factors have a direct influence on the production structure. In this case we have to include some control variables in the deterministic portion of the stochastic frontier: it implies *"assuming that every firms face a different production function"* (Coelli et al. 1999, p. 254).

So we'll have:

$$\ln y_i = \beta_0 + \sum_{k=1}^{K} \beta_k \ln x_{ki} + \sum_{j=1}^{M} \theta_j \ln z_{ji} + v_i - u_i$$

(7)

where we account for M environmental/firm specific factors z_j assuming different values for each i-th firm.

This specification can be straightforwardly adjusted for the cost case by assuming the natural log of total cost as dependent variable and changing the sign of the inefficiency component (u_i). Using the translog specification, the deterministic portion of the cost frontier is the following:[22]

$$\ln TC_i = a_0 + \sum_i a_1 \ln y_i + \sum_j b_j \ln p_j + \frac{1}{2}(\sum_i \sum_j c_{ij} \ln y_i \ln y_j + \sum_i \sum_j d_{ij} \ln p_i \ln p_j) +$$

$$+ \sum_i \sum_j g_{ij} \ln y_i \ln p_j + f_E \ln E + \frac{1}{2} h_{EE} \ln E \ln E + \sum_j k_{Ej} \ln E \ln y_j + \sum_j m_{Ej} \ln E \ln p_j + \sum_{j=1}^{M} \theta_j \ln z_j \quad (8)$$

Case 2 - Environmental factors influence the inefficiency distribution

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[21] Same approach was used by Fiordelisi and Ricci (2006) for Banc assurance in Europe.
[22] For further readings see Fiordelisi and Ricci (2006, pg.13)

A second possibility is to include the environmental/firm specific variables not directly in the production frontier, but to use them for modelling the inefficiency distribution.

As noted by Battese and Coelli (1995), the stochastic frontier production function is estimated in the first stage under the assumption that the inefficiency effects (error term) are identically distributed, while in the second stage the predicted technical efficiencies are regressed upon a number of factors, hence suggesting the inefficiency effects are *not* identically distributed. A more appropriate approach involves the specification of a model in which both relations are estimated in a single stage. This accounts for a stochastic frontier production function in which the technical inefficiency effects are a function of firm characteristics.[23]

The inefficiency components u_i are assumed to be distributed independently, but not identically. For each i-th firm the technical inefficiency effect is obtained as truncation at zero of a normal distribution $N(\mu_i, \sigma^2)$ where the mean μ_i is a function of M factors representing the firm specific environment (Fiordelisi and Ricci 2006):

$$\mu_i = \delta_0 + \sum_{j=1}^{M} \delta_j z_{ji} \tag{9}$$

The deterministic portion of the frontier remains the same as in equation 6 .

In this case we are supposing that all firms share the same technology, and environmental/firm specific factors have an influence only on the distance between each firm and the best practice.

The resulting efficiency estimates are incorporating the effect of environmental factors and can be viewed as gross measure of efficiency.[24]

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[23] For further readings see Coelli, et al.(1999, pg.255)
[24] For further readings see Bos, et al.(2005, pg.11)

Data and variables

This study comprises bank's balance sheet and annual reports data of G7 countries (US, UK, Japan, Italy, Germany, France and Canada) and Switzerland over the 2000-2007 period. The data were compiled from the International bank Credit Analysis Bankscope Database.

In order to estimate separate regional and common frontiers, the sample selection requires us to consider only those countries, for which a sufficient large number of observation is available. Number of observation is 992.

Table 1. reports the number of banks, by distinguishing for countries.

Table 1. Overview of the selected sample

Country/Year	2001	2002	2003	2004	2005	2006	2007	Total
Canada	4	4	4	5	4	4	4	**29**
France	5	3	4	6	12	12	9	**51**
Germany	12	12	13	13	11	15	16	**92**
Italy	3	3	2	5	8	11	9	**41**
Japan	21	19	21	24	25	24	24	**158**
UK	17	18	18	31	40	42	35	**201**
USA	9	11	11	12	10	11	11	**75**
Switzerland	55	47	48	50	49	48	48	**345**
Total	**126**	**117**	**121**	**146**	**159**	**167**	**156**	**992**

NOTE: We select banks with available balance sheets statements in Bankscope for the years 2000-2007.

In the literature, the definition of the bank inputs and outputs varies across studies and mainly depends on what a researcher pictures a bank to be.

Following Hughes and Mester (2008), **outputs** are typically measured by the dollar volume of the bank's assets in various categories. **Inputs** are typically specified as labor, physical capital, deposits and other borrowed funds, and sometimes equity capital. However, there is reasonable agreement about the specification of most of the important inputs and outputs for financial institutions. All agree that loans and other major assets of financial institutions should count as outputs (Berger & Humphrey 1997).

Accordingly, investment banks inputs are defined as price of labor (P_1), price of physical capital (P_2) and price of funds (P_3). More precisely, the price of labor

equals the personnel expenses over total assets. The price of physical capital is measured as operating expenses less labor and interest expenses over total fixed assets. Price of funds equals total interest expenses over total funds.

Having in mind specific characteristics of investment banking business and outputs that they produce, we consider added value approach where outputs are defined based on their share of value added. Outputs are defined as loans (Y_1) and other earning assets (Y_2). The variable equity controls for the differences in equity capital risks across banks. In order to estimate cost and profit efficiency scores, we use the total cost (TC) as the sum of interest, commission, fee, trading, and total operating expenses and total profit (TP) as pre-tax profit, as our depended variables.

In the table 2. we gives overview of the variables and their estimation:

INSERT TABLE 2.

Table 3. displays the description, mean, standard deviation, as well as minimum and maximum values of all the input prices, outputs and depended variable.

INSERT TABLE 3.

In order to account for heterogeneity we follow Coelli et al. (1999) approach where there are two different ways for including environmental conditions or firms specific factors: Case I, environmental factors have a direct influence on the production structure; Case II, environmental factors influence the inefficiency distribution.

To decide on which firm specific factors to account for heterogeneity in our research we choose on the basis of empirical literature evidence in this area. Therefore we have to account for potential differences arising from certain country-specific aspects of the banking technology on the one hand and from the environmental and regulatory conditions on the other. In particular, the economic environments are likely to differ significantly across countries. Three categories of environmental variables are taken into account: (1) those that describe the main macroeconomic conditions, which determine the banking product demand characteristics, (2) variables that describe the structure of the banking industry[25], and (3) those that account for profitability.

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[25] According to Liaw (2006) major types of risk investment banks face include market risk, credit risk, operating risk, reputation risk, legal risk and founding risk. The ability to properly and effectively identify, asses, monitor and manage each type of risk is critical to an investment bank's financial soundness and profitability.

Davis (2003) describes investment banking risk similar to Liaw, where according to him investment banks face credit, market and operational as main risks, and unexpected and product risk as additional risks.

The Table 4. And 5. explains environmental variables (for Case I and Case II) selected for our research, together with the studies that have used them previously.

INSERT TABLE 4.

INSERT TABLE 5.

Preliminary results

In our beginning we have been looking to make both separate frontiers and common frontier for all countries. Due to a small number of bunks for some countries we have excluded separate frontiers from our analysis.

For common frontier we have:

In the base model with only structural variables, where we have obtained next results:

Base Model Cost Efficiency Results for Common Frontier

COST EFFICIENCY				
Country	Mean	Std. Dev.	Min.	Max.
G7 countries & Switzerland (n=992)	0.70377	0.10965	0.17337	0.94976
Canada (n=29)	0.73448	0.04812	0.64020	0.81969
France (n=51)	0.62904	0.12983	0.33409	0.88071
Germany (n=92)	0.67939	0.12122	0.37095	0.91237
Italy (n=41)	0.62869	0.13480	0.19082	0.85540
Japan (n=158)	0.69358	0.09933	0.42994	0.92084
UK (n=201)	0.69940	0.14349	0.17337	0.94976
USA (n=75)	0.73091	0.04780	0.59030	0.83738
Switzerland (n=345)	0.72897	0.08022	0.26725	0.86095

Base Model Profit Efficiency Results for Common Frontier

PROFIT EFFICIENCY				
Country	Mean	Std. Dev.	Min.	Max.
G7 countries & Switzerland (n=992)	0.86930	0.08043	0.00000	0.99992
Canada (n=29)	0.86708	0.05786	0.75589	0.95603
France (n=51)	0.88475	0.05572	0.72805	0.97988
Germany (n=92)	0.86041	0.08344	0.58211	0.99233
Italy (n=41)	0.90522	0.05161	0.77428	0.99159
Japan (n=158)	0.86249	0.04985	0.54403	0.99982
UK (n=201)	0.86295	0.07341	0.62283	0.99992
USA (n=75)	0.81241	0.15018	0.00000	0.99887
Switzerland (n=345)	0.88450	0.07380	0.51010	0.99685

The Case I, where environmental factors have a direct influence on the production structure, we find not suitable for our data set (nevertheless we have run the model and found evidence that support previous claim).

The Case II, where environmental factors influence the inefficiency distribution, we find suitable for our data set. For the case II for profit efficiency results we have some problems for the negative values, but we are working on solving those problems.

In the table below, we give overview of the exogenous firm specific factors determining the inefficiency distribution in the cost case.

Cost Efficiency		
Variable	Coefficient	Significance
Z1 (PD)	0.72941	0.00007
Z2 (GDP)	-1.33577	0.00063
Z3 (FDII)	0.05758	0.41440
Z4 (FDIO)	0.62856	0.00001
Z5 (BAS)	-0.31863	0.00006
Z6 (CAR)	-1.09319	0.00000
Z7 (CONC)	-0.17582	0.05987
Z8 (NII)	0.48573	0.00000
Z9 (NNII)	-0.17349	0.00328
Z10 (IR)	0.37217	0.00050
Z11 (LIQ)	0.76525	0.00042
Z12 (OBSE)	0.50467	0.00000
Z13 (LB)	0.27581	0.07367
Z14 (SR)	0.26006	0.00583
Z15 (ROA)	13.70692	0.00177
Z16 (ROE)	-0.55655	0.15688
NOTES: A coefficient >0 means a positive effect on the inefficiency component u_i, and then a negative relationship with efficiency; the opposite for a coefficient <0. For the p value<0.01***, p value<0.05**, p value<0.1* and p value>0.1 not significative.		

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Table 2. Variable definition

Type of Variable	Symbol	Variable Name	Calculation
Dependent variable	TC	Total Cost	TC is obtained as the sum of interest expense, commission expense, fee expense, trading expense and total operating expenses
Dependent variable	TP	Total Profit	TP is obtained as pre-tax profit
Input Price	P_1	Price of Labor	P_1 is calculated as personnel expenses over total assets
Input Price	P_2	Price of Physical Capital	P_2 is calculated as other administrative expenses and other operating expenses over total fixed assets
Input Price	P_3	Price of Funds	P_3 is calculated as total interest expenses over total funds
Output	Y_1	Loans	Y_1 represents loans
Output	Y_2	Other Earning Assets	Y_1 represents other earning assets
Control variable	E	Total Equity	E represents equity capital

Table 3. Descriptive statistics of outputs, inputs and control variables

Variable	Description	Mean	Median	Std. Dev.	Min.	Max.
TC	Total Cost	1418986.326	202828.997	5356962.056	3090.235	75506000.000
TP	Pre-Tax Profits	156199.286	25009.733	919083.984	-12831000.000	10426000.000
Y_1	Loans	5328236.750	543002.175	17842688.739	88.129	248222594.000
Y_2	Other Earning Assets	23635462.258	1089135.883	72202139.572	104.866	796332000.000
P_1	Price of Labour	0.045	0.018	0.068	0.000	0.558
P_2	Price of Physical Capital	683809.602	121872.506	2279613.974	1961.157	24233012.268
P_3	Price of Funds	0.056	0.024	0.264	0.000	4.571
E	Total Equity	1405882.276	304844.799	3922136.233	1089.681	39038000.000

Table 4. Environmental variables definition for Case I

Variable type	Variable name	Symbol	Studies
Investment banking risk exposure	Capital risk exposure	CAR	Dietsch and Lozano-Vivas 2000, Lozano-Vivas et al. 2002 as control variable, Altunbas et al. 2000, Athanasoglou et al. 2006, Brissimis et al. 2008, Lapetite et al. 2008
	Insolvency risk exposure	IR	Lapetite et al. 2008
	Liquidity risk exposure	LIQ	Altunbas et al. 2000 as proxy, Demirguc-Kunt and Huizinga 2004, Brissimis et al. 2008, Fiordelisi and Molyneux 2009
	Securities risk exposure	SR	????
CAR=equity/assets IR=(100+average ROE)/SDROE LIQ=Liquid assets/assets SR=Total securities/total assets			

Table 5. Environmental variables definition for Case II

Variable type	Variable name	Symbol	Studies
Social and macroeconomic conditions	Population density	PD	Dietsch and Lozano-Vivas 2000, Lozano-Vivas et al. 2002, Bos et al. 2005, Valverde et al. 2007, Fiordelisi and Molyneux 2009
	GDP per capita	GDP	Salas and Saurina 2003, Athanasoglou et al. 2006, Valverde et al. 2007, Fitzpatrick and McQuinn 2007, Brissimis et al. 2008, Fiordelisi and Molyneux 2009
	FDI Inflows	FDII	Beccalli 2004
	FDI Outflow	FDIO	Beccalli 2004
Banking structure (industry specific, determinants and risk)	Bank asset size [a]	BAS	Altunbas et al. 2000 as proxy, Lozano-Vivas, et al. 2002 asset quality as control variable, Valverde, et al. 2007 use total asset per bank, Athanasoglou et al. 2006, Lapetite et al. 2008, Fiordelisi and Molyneux 2009
	Capital risk exposure [b]	CAR	Dietsch and Lozano-Vivas 2000, Lozano-Vivas et al. 2002 as control variable, Altunbas et al. 2000, Athanasoglou et al. 2006, Brissimis et al. 2008, Lapetite et al. 2008
	Herfindhal index of concentration [c]	CONC	Dietsch and Lozano-Vivas 2000, Vander Vennet 2002, Athanasoglou et al. 2006, Fiordelisi and Molyneux 2009
	Income diversification [d]	NII	Lapetite et al. 2008, Fiordelisi and Molyneux 2009
	Income diversification [e]	NNII	Lapetite et al. 2008, Fiordelisi and Molyneux 2009
	Insolvency risk exposure [f]	IR	Lapetite et al. 2008
	Liquidity risk exposure [g]	LIQ	Altunbas et al. 2000, Demirguc-Kunt and Huizinga 2004, Brissimis et al. 2008, Fiordelisi and Molyneux 2009
	Off-Balance Sheet Exposure [h]	OBSE	Casu and Girardone 2007
	Publicly listed bank [i]	LB	Beccalli 2004, Fiordelisi and Molyneux 2009
	Securities risk exposure [j]	SR	????
Profitability	ROA [k]	ROA	Athanasoglou et al. 2006, Lapetite et al. 2008
	ROE [l]	ROE	Berger et al. 1993, Allen and Rai 1996, Lozano-Vivas et al. 2002, Vander Vennet 2002, Beccalli 2004, Athanasoglou et al. 2006, Lapetite et al. 2008

[a] BAS= total assets
[b] CAR is calculated as equity over assets
[c] Obtained as the sum of the squares of market shares for all banks operating in the industry
[d] NII = net interest income/net profits
[e] NNII = net non-interest income/net profits
[f] IR=(1+average ROE)/SDROE
[g] LIQ is calculated as liquid assets over assets
[h] OBSE is measured as off-balance sheet items over total assets
i The bank is publicly listed or otherwise, where 1 = listed; 0= non-listed
[j] SR is calculated as total securities over total assets
[k] ROA=Net profits/total assets
[l] ROE=Net profits/Shareholders equity (total assets - total liabilities)