

Charles University in Prague

Faculty of Social Sciences

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MASTER THESIS

The Impact of the Credit Crunch on the Cost and Profit Efficiency of the Banks: An International Comparison

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Declaration of Authorship

The author hereby declares that he compiled this thesis independently, using only the listed resources and literature.

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Prague, June __, 2011

Signature _____

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Any further omissions, flaws and mistakes are the sole responsibility of the author.

"The World is Flat"

Thomas Friedman

Abstract

This thesis documents, using an unbalanced panel of Top 1000 World banks with observations for 2005 – 2009, three main aspects related to cost and profit efficiency in banking. First, it established that there is no correlation between a bank's rank in the Top and its rank given by the efficiency scores. However, the size of the banks plays a positive role on the cost efficiency of the institution, big banks having higher cost efficiencies than small banks. Conversely, the profit efficiency is equal across different sizes. Second, it verified that for 2005 – 2009 there is no evidence that banks from the developed countries are more efficient than banks from emerging economies. This finding is further supported by the third aspect, which shows that banks originating in the developed economies, with large exposures to more sophisticated banking products, have been hit the hardest by the financial crisis. However the banks managed to shrink their cost inefficiency while losing efficiency on the revenue side. The post crisis, 2009, proved to be a year in which banks across countries and regions converged in terms of efficiency and plateaued at about 10% and 25% for cost and profit inefficiency respectively.

Keywords

Profit Inefficiency, Cost Inefficiency, Top 1000 World Banks 2010, Stochastic Frontier Analysis, Developed Economies, Emerging Economies, Crisis

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Acronyms

B

BRIC

Brazil, Russia, India, China - term defined by
Goldman Sachs iii, 36 - 51 -, - 52 -, - 53 -, - 54 -, -
60 -, - 65 -, - 68 -, - 76 -, - 77 -, - 78 -, - 80 -, - 83 -,
- 84 -, - 86 -, - 87 -, - 88 -, - 92 -, 94

C

CE

Cost Efficiency - 60 -, - 61 -, - 65 -, - 66 -, - 67 -, X

CI

Cost Inefficiency - 71 -, - 72 -, - 80 -, - 89 -, - 90 -, VII

CIR

Cost to Income Ratio - 56 -, - 57 -, - 63 -

D

DEA

Data Envelopment Analysis - 12 -, - 13 -, - 49 -

F

FDH

Free Disposal Hull - 12 -, - 13 -

G

GDP

Gross Domestic Product - 21 -, - 44 -, - 45 -, - 46 -, -
47 -, - 48 -, - 56 -, - 63 -

I

IMF

International Monetary Fund 2, - 41 -, 104

INF

Inflation - 44 -, - 45 -, - 46 -, - 47 -, - 56 -, - 63 -

L

LIQ

Liquidity - 49 -, - 56 -, - 57 -, - 63 -

N

NIM

Net Interest Margin - 48 -, - 56 -, - 57 -, - 63 -

O

OECD

Organization for Economic Co-operation and
Developmentiii, 36 -, - 51 -, - 52 -, - 53 -, - 54 -, - 60

-, - 61 -, - 66 -, - 68 -, - 76 -, - 77 -, - 78 -, - 80 -, -
83 -, - 86 -, - 87 -, - 92 -

P

PE

Profit Efficiency - 65 -, - 66 -, - 67 -, X

PI

Profit Inefficiency- 71 -, - 72 -, - 84 -, - 85 -, - 89 -, - 90
-, - 91 -, VII

POP

Population - 45 -, - 46 -, - 47 -, - 56 -, - 63 -

R

ROAA

Return on Average Assetsii, - 49 -, - 51 -, - 52 -, - 56 -,
- 57 -, - 63 -

RoW

Rest of the World *See*

S

SFA

- 13 -
Stochastic Frontier Analysis A, - 12 -, - 13 -, - 26 -, -
28 -, - 30 -, - 31 -, - 55 -

T

TFA

Thick Frontier Analysis - 12 -, - 13



Master Thesis Proposal

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Proposed Topic:

The impact of the 2007 crisis on the cost and profit efficiency of the banks: an international comparison

Topic Characteristics:

Bank managers, just as their counterparts from other industries, seek to maximize the shareholder's value. But unlike other industries, banks are highly leveraged and usually are high-risk entities. That is why the efficient use of the resources in the profit generation process has far reaching implications not only for the shareholders but also for the clients, depositors, regulatory and supervisory bodies, and the economy as a whole.

The literature on bank efficiency is richly represented by studies on the efficiency of US based banks and European banks, with somewhat scarce contributions in the field of international comparisons. The international studies are so far limited to G7 banking systems mostly. In this context this thesis follows the ambitious idea of filling this niche by undertaking an exercise of international bank efficiency analysis of the Top 1000 World banks, as published by the journal "The Banker". The list comprises representative banking institutions from different parts of the world, from developed countries to emerging economies.

The thesis also contributes to the existing research literature in this domain by analyzing the impact of the 2007 credit crunch on the efficiency of banks both at an individual and at a regional or country level. It also places itself among the first researches that employ cost and profit analysis in an attempt to compare internationally the banking industries from different regions.

Hypotheses:

- “The bigger means more efficient”- larger banks are more efficient than the small banks
- Banks from developed countries have a higher efficiency than banks from emerging economies
- The credit crunch had an adverse impact on both cost and profit efficiency of banks across the globe

Methodology:

Cost and profit efficiency will both be measured and compared. The most widely used methods of measuring efficiency lately have been the Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA). The first approach is based on regression analysis and it was developed by Aigner, Lovell and Schmidt in 1977 and Meeusen and Van den Broeck in the same year, independently. DEA on the other hand is a mathematical programming method used for the estimation of efficiency of units that employ in the production function multiple inputs and outputs. Both methods can be used for the estimation of the efficiency of the banks. But for the purpose of this thesis and for testing the above mentioned hypothesis the Stochastic Frontier Analysis will be used.

The method will be applied on a panel data of banks and the relevant indices obtained from the Bankscope database. The analyzed period will be 2005-2009 (or 2010 if the necessary data is available). The whole period is to be divided in distinct time frames comprising the following periods: pre-crisis (2005-2007), crisis (2007-2009) and post-crisis (2010 if available). The list of banks will comprise the latest Top 1000 world banks as presented by the “The Banker” and their performance will be measured for the given time period. Slight changes in the list of banks may occur due to availability of information issues for some of them, but this should not impair the results of the research.

The data will be obtained from the Bankscope database. If the Bankscope does not include the complete information on banks for all of the regions, the remaining data will be obtained from The Banker dataset (if available), World Bank datasets, International Monetary Fund data and/ or regional institutions’ statistics.

Outline:

1. Introduction
2. Literature review
3. Methodology
4. Data
5. The empirical results
6. Concluding remarks

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Author

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CHAPTER 1

Introduction

A retrospective glimpse on the importance of financial intermediation in the economy takes us back to the inception of the last century. Joseph Schumpeter, in his book “*Theorie der Wirtschaftlichen Entewicklung*”, first advocated the idea that financial intermediation is at the very heart of economic development.¹ Indeed, the main functions that banks perform make them an indispensable part of the free market economy. Risk management, information gathering, processing and monitoring of borrowers, liquidity offering and asset transformation are the main functions of banks as summarized by Freixas and Rochet (2008). Thus banks perform a crucial role in diminishing and controlling the moral hazard and adverse selection issues in an economy.

If for any reasons banks become themselves a source of moral hazard and adverse selection problems by distorting the processes of risk allocation and risk sharing, the whole banking system and the whole economy is at risk. The banks have for these reasons been at the center of almost all major financial turmoil of the last century. The last crisis, labeled “credit crunch” was not different from a classical banking crisis (see Brunnermeier (2009)). That is why, as any other banking crisis it had an adverse impact on the behavior and on the financial health of the financial institutions.

The crisis had an immediate impact on the bank’s balance sheets. According to the April 2009 IMF Global Financial Stability Report (2009) the estimated asset write-downs for the 2007-2010 period for banks alone could sum up to over 2.8 trillion USD. *Table 1-1* below depicts the estimated distribution of bank write-downs among different regions of the world. The biggest write-downs are attested for the European banks, as they amount to 1.109 trillion USD whereas the US banks have suffered slightly less - 1.049 trillion USD. The least affected by the crisis seem to be the Asian banks as they posed a write-down amount of only 337 billion USD. For the estimation of top loses of individual banks see *Appendix 1* which summarizes them. The list comprises mainly US and European banks, banks which have been constantly in the top performers for the past decade. This led to a sharp decline in confidence on the financial markets which marked a period of tight credit and liquidity, when all major players were avoiding risky undertakings and were just shunning away from unpredictable and toxic

¹ „*Theorie der Wirtschaftlichen Entewicklung*” was written in 1911, its first translation in English „*Theory of economic development*” dates with 1934

assets. The scrutiny undertaken by economist to shed light on the main causes and consequences of the 2007 credit crunch actually raised more questions than furnished answers.

Table 1-1: Bank Write-downs by Bank Domicile and Cumulative Loss Rates

(In percent)												
	U.S. Assets		U.K. Assets		Europe excluding UK Assets		Asian Assets		Emerging Markets		Total	
	(Billions of USD)	(Percent)	(Billions of USD)	(Percent)	(Billions of USD)	(Percent)	(Billions of USD)	(Percent)	(Billions of USD)	(Percent)	(Billions of USD)	(Percent)
Write-downs on Assets												
U.S. banks	966	9.3	22	5.9	24	4.6	3	1.3	35	6.9	1,049	8.8
U.K. banks	72	7.5	174	4.3	30	3.9	2	1.1	37	9.9	316	5.0
Europe excluding U.K. banks	198	7.0	111	4.4	622	3.9	6	1.0	172	8.5	1,109	4.6
Asian banks	116	12.0	33	6.8	29	4.6	141	2.0	16	6.8	337	3.5
Total	1,352	8.9	340	4.6	705	3.9	151	1.9	261	8.2	2,810	5.4

Source: (IMF Global Financial Stability Report 2009), with author's adjustments

As a result of the tremendous losses that most of the banks incurred during the current financial crisis the crediting activity halted and even the interbank lending was severely hampered. A grasp of the scale of the credit wind down in the United States is attempted in Ivashina and Scharfstein (2009). They documented a 47% drop in the issuance of new loans to large borrowers at the end of 2008 compared to 2007. An even larger drop, reaching an astounding 79%, was documented for the end of 2008 compared to the peak of the credit boom (mid 2007). While the halt in crediting speaks by itself about the depth and seriousness of the crisis, this was a conscious measure undertaken by bank management rather than a direct effect of the crisis.

In this context the activity of the largest and most active international banks has become a subject of daily scrutiny and debate, among regulators and government officials, in the media and in academia. The high salaries and bonuses of the top and middle management and the dismal results during the crisis raised questions regarding the quality of the decision-making processes in banks as well as about the corporate culture that drove those banks on the brink of collapse. It has also been argued that, to some extent, Basel II, its provisions and the models used by banks for risk assessment are to blame for the failure of the whole financial system during the 2007 credit crunch (see Stiglitz (2010)). Although this entire area deserves a more extensive discussion we will digress from it by focusing on a related subject which could also be of great interest from the perspective of credit crunch crisis analysis. Namely, we will analyze the impact of the crisis on the efficiency of banks, in an attempt to compare

the top world banks from different regions among them. This exercise appears to be promising at least from a few perspectives.

From a historical perspective the analysis of bank efficiency has always been an actual undertaking. According to Freixas and Rochet (2008) banks contribute to a Pareto-optimal allocation of resources in the economy by ameliorating the liquidity shortages through deposit attraction and credit diversification. The main conclusion in this context is that although a free-market economy without financial intermediation is still efficient, the financial intermediation makes it more efficient, at least in tranquil times. The question which still arises is whether the financial intermediaries themselves are efficient.

This question is even more pertinent today, when the financial world has recovered from the most severe crisis since The Great Depression, and when all the prevailing paradigms about the functioning of the financial markets have been irremediably invalidated. The banking industry and its business look odd from the perspective of the latest developments. The managers of the biggest banks around the world failed to deliver on their promise to maximize the profit and to safe keep the integrity of the entities they have been in charge of. It is thus of practical interest to determine whether the banks managed to preserve the before-crisis prevalent efficiency ratios and efficiency rankings in an international setting. This exercise would provide an insight about the quality of the management during the crisis.²

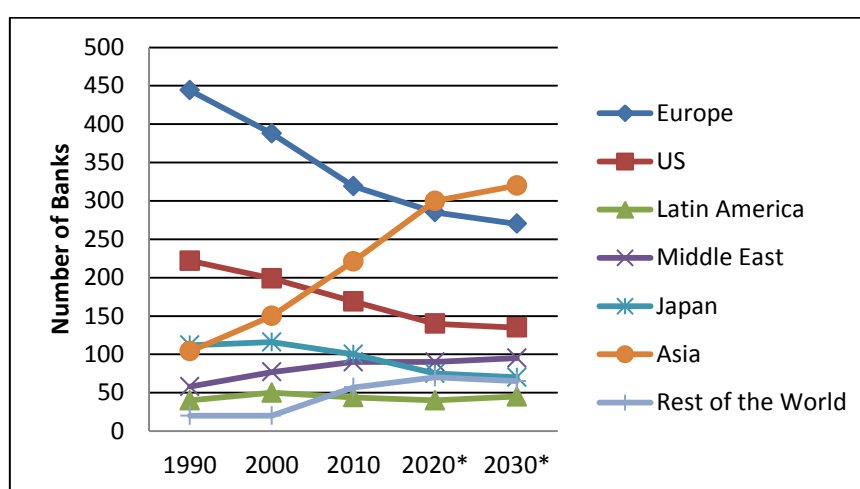
The international setting of the issue of bank performance has two fundamental arguments. The first one pertains to the global nature of the crisis, which provides some ground for this kind of undertakings. The financial distress affected the banks across the world and its impact seems measurable, albeit with some limitations as other factors might be quite noisy in the efficiency frontier estimation. The second argument stems from the very limited international comparisons in this area, which facilitates marginally higher value added of the entire analysis.

The analysis will focus on the group of the top banks as ranked by the magazine "The Banker". Every year the "Financial Times" magazine issues a special edition of "The Banker" in which they publish the list of world's top 1000 banks. The ranking tracks the world's largest bank holding companies by Tier 1 capital (the definition of Tier 1 capital as defined by Bank

² It would be hard to discuss this issue in absolute terms as the circumstances differ across banks and as such the management techniques might not be directly comparable, but it would at least respond to questions of relative performance

for International Settlements).³ Its publication commenced in 1970s and has now reached a number of forty yearly rankings. In the last forty years many things have changed in terms of banking, but the leaders of the first ranking are still there in the last edition and are represented, primarily, by the American and British giants like Bank of America, J.P. Morgan and Barclays. Notwithstanding this dominance over the years by the behemoths of the industry, in the middle and bottom, there were significant changes taking place. These changes, as the authors of the ranking put it, reflect the undergoing developments in world economy. As pointed out in the very beginning the financial sector in general and the banking industry in particular, are a benchmark of one's economic development at a certain point in time.

Figure 1-1 - The evolution of Top 1000 by Region⁴ 1990-2030⁵



Source: *The Banker* – compiled by the Author

The representation of different countries and regions in the Top 1000 ranking has changed throughout the decades. A once unthreatened European and American dominance is coming to dusk. The number of American banks has already shrunk below that of the Asian banks. According to the Financial Times experts the number of European banks will be surpassed by the Asian banks by the end of the next decade. The Japanese banks have lost and continue their gradual decline since the inception of the 9th decade of the last century. On the rise are the Chinese and Middle Eastern banks. At the moment they are poised to overtaking the world dominance in this realm as their buoyant economies show no signs of conceding to any of the

³ According to Basel Committee on Banking Supervision Tier 1 capital includes loss-absorbing capital, common stock, disclosed reserves, retained earnings and minority interests in the equity of the subsidiaries that are less than wholly owned.

⁴ The same conventional division of the banks by regions will be used throughout the entire thesis. Other grouping criteria may apply in certain situations

⁵ The number of banks in the Top 1000 for 2020 and 2030 are The Banker's forecasts

external shocks. These movements, captured in *Figure 1-1*, reflect the overall cycles of the economic development of these countries and their relative dominance in the world of finance *per se*. It also grasps a tentative new trend in banking that may strengthen in the near future.

The choice for this sample has been driven by five main reasons. The banks that are included in the rating are the biggest banks by the value of their Tier 1 capital, which by default makes them a benchmark of quality and high standards for the whole industry. Furthermore, these banks in virtue of their international dimension contributed to the spread of the crisis throughout the world. The third reason for the choice is that this is *a-priori* a sample of banks that have been selected by some well-established criteria which makes them more or less comparable. Fourth, the sample is relevant from the point of view of representativeness. It is composed of banks from the main financial centers of the world on one hand, but it also comprises banks from the most dynamic parts of the emerging markets⁶. It is also representative from the point of view of the specialization of banks. In this sense we have two large fully represented categories: investment banks and commercial banks. And at last, the chosen sample is flexible and large enough to allow a subsampling of banks in categories by size which will enable us to test whether the larger are more or less efficient than the smaller ones.

The bank efficiency is discussed in the context of the actual financial crisis given the following argumentation. The literature on bank efficiency which tackles the activity of banks and their performance during financial distress is, to our knowledge, rather scarce, and so the thesis comes to fill in this gap, at least partially. Next consideration relates to the dimension of the crisis, which has spread around the globe, although it emerged from a corner of the US economy. This aspect is of particular interest as it would be interesting to establish whether there is any relationship between the change in the efficiency of banks and their proximity to the epicenter of the crisis.

To explore the question of efficiency in producing units we arrive at the seminal paper of Farrell (1957) that was a crucial contribution for the development of efficiency measurement techniques and their application in empirical studies. The first econometric models which were readily applicable for empirical research purposes were proposed by two teams of researchers independently at the same time, Aigner, Lovell and Schmidt (1977) and Meeusen and van Den Broeck (1977). The literature on efficiency estimation then expanded rapidly

⁶ A thorough discussion of the composition of the sample will be undertaken in Chapter 4 when the dataset for the model will be analyzed

comprising works that covered both the private and the public sector companies, government agencies, hospitals and healthcare facilities, governments, universities and schools, farms and food producers, airline companies and, last but not the least financial institutions – namely banks. For a comprehensive list of areas of applicability of efficiency frontier techniques see Fried, Knox Lovell and Schmidt (2007).

The banks in virtue of their peculiar form of business were not that easy to tackle without a preliminary rigorous theoretical framework. The production function of a bank is not as easily definable as for a producing firm. The determination of inputs and outputs in financial intermediation is not an entirely straightforward exercise, as appropriately remarked in Sealey and Lindley (1977). The article represents a comprehensive and detailed analysis of the banking business, and the authors succeed in establishing a general production function for banks and in defining the main inputs and outputs of a bank in the framework of the neoclassical theory of firm.

The master thesis is organized as follows. The quest for the determination of the relative efficiency ranking of internationally important banks begins first with a thorough exploration of the relevant literature of this subject. The review will be undertaken in [Chapter 2](#) of the thesis and will comprise a short description of the evolution of thought, the main fields of applicability, the development of the framework of bank efficiency estimation, the main directions of research in this field from a historical perspective and the international comparison of bank efficiency studies will also be reviewed in the context of the main issues facing the researchers. The methodology will be discussed in [Chapter 3](#). The latest advances in the estimation methodology will be analyzed and a proper framework will be chosen. The Stochastic Frontier Analysis method of bank efficiency estimation will be discussed and its application on a panel of banks will be debated. Also the main hypothesis will be given a thorough consideration in the process of model estimation and certain adjustments might be undertaken for the elimination of any misspecifications of the model. [Chapter 4](#) introduces the dataset and defines the prime variables which will be employed in the formulation of the model. Some of the bank characteristics will be analyzed in a preliminary assessment of the dataset. [Chapter 5](#) will present the final results of the Stochastic Frontier Analysis applied on the panel and on five cross-sections of the top world banks. The results will be analyzed from the perspective of the formulated hypotheses. A thorough comparison will be attempted in order to establish any points of conversion and/or diversion in our analysis, which will also enable us to appreciate the overall validity of our model. The main conclusions will be

provided in [Chapter 6](#). It will also comprise some motivation for further research and will point out on some of the weaknesses of the actual analysis and ways for future researchers to address them in their undertakings.

CHAPTER 2

Literature Review

1.2. Introductory remarks

The following section would serve as a starting point in our discussion on the methodological aspects employed in this Master thesis by providing a relevant review of the already existing literature in the field of efficiency frontier estimation. It is, however, important to note that this literature is large and given the goals that we seek and the limited space, only a partial review will be attempted, focusing primarily on the objectives of the thesis. The attempt will be to grasp the main trend in the development of the relevant literature by focusing primarily on the bank frontier efficiency studies. For a detailed look on the evolution of the literature refer to the rather extensive surveys starting with Forsund, Lovell and Schimdt (1980), Bauer (1990) followed by a more specialized review in G. Battese (1992) and such studies as W. Greene (1993), Cornwell and Schmidt (1996), W. Greene (1997), Coelli, et al.(2005), Kalirajan and Shand (1999), A. N. Berger (2007), or finally the well acknowledged book of Kumbhakar and Lovell (2000).

2.2. Theoretical Evolution of the Models

According to the main purpose of the leading authors in this stream of literature two broad categories could be identified. The first one, deals primarily with methodological issues and concerns econometric aspects of the definition and estimation of an efficiency frontier given a certain production function, cost or profit function. The second stream is more empirically oriented and usually does not engage in the discussion of the modeling issues.

The methodological literature presents, in an extensive and detailed manner, issues pertaining to the estimation process in different settings. It would seem odd to start our discussion without referring to the seminal paper of Farrell (1957), who first defined and formalized the new concept of efficiency in a setting which allowed further research and rapid expansion of the literature in this field. By this token Farrell (1957) is *a priori* a steppingstone in the theoretical discussion about the measurement of efficiency in the decision making units. This paper is the direct precursor of the non-parametric models of frontier efficiency estimations, but it also serves as the point of departure in the development of the econometric modeling techniques of the stochastic frontiers, or the so called parametric models.

The first extension of the original model has been proposed in Farrell and Fieldhouse (1962) with a view to grasp the impact on efficiency of increasing returns to scale. Linear programming techniques are also employed in Aigner and Chu (1968), who estimate a production function and the efficiency frontier for a whole industry disregarding economies of scale and thoroughly discuss the implications of a linear programming technique and its main shortcomings. Later, in Seitz (1970) and Seitz (1971) the discussion is extended to comprise economies and diseconomies of scale as well as to account for neutral and non-neutral economies of scale. The model itself has suffered only very minor changes and thus no influential impact has been achieved until Timmer (1971), where an explicit assumption that some of the observations may lie above the frontier had been made. One of the last in this series of papers is represented by Afrait (1972) which develops a model that fits both to non-parametric models and parametric (more restrictive) models.

The influential and highly referenced papers of Aigner, Lovell and Schmidt (1977) and of Meeusen and van Den Broeck (1977) which were developed and published by two different teams of researchers at the same time, has marked the turning point in the development of the frontier efficiency measurement techniques literature and its empirical application. The models proposed by the above cited authors overcome several shortcomings inherent in all of the models that have been developed before them, and namely the composed error term is introduced. The production function thus takes the following form:

$$y_i = f(x_i; \beta) + \varepsilon_i \quad \text{Equation 2-1}$$

where $\varepsilon_i = u_i + v_i$ and $i = 1..N$ and u_i represents individual disturbances of each observation (or plainly speaking they represent the firm inefficiencies) and v_i represents disturbances that are generated by random external factors and do not relate to the individual observations. According to Aigner, Lovell and Schmidt (1977) the $v_i \sim N(0; \sigma_v^2)$ and the $u_i \sim N(0; \sigma_u^2)$ but only the negative part of the distribution is considered as relevant for the frontier estimation. The new paradigm was attractive but distinguishing between the two terms of the disturbances was necessary.

The original model was rather an exercise of average efficiency estimation which was not compelling and did not cater to the needs of the regulators, managers and other interested third parties. In 1980's the literature on efficiency measurement has had a qualitative as well as a quantitative leap forward. In W. Greene (1980) the problem of estimating jointly the allocative and technical inefficiency in a trans-log production function has been first

established. It has been dubbed the “Greene problem” latter on, and a series of papers have since then been devoted to solving this problem. At the same time the problem of estimating individual efficiencies has been given detailed consideration in Jondrow, et al. (1982) where two predictors for the firm effect are first introduced. The procedure was developed for half-normal and exponential distribution cases. The latter papers represented by Waldman (1984) and Schmidt and Sickles (1984) extend the model, the former proposing two alternative possible predictors and the later extending the model to panel-data. The panel data analysis is further given appropriate consideration in Battese and Coelli (1988).

In 1990’s the quest for a perfect model for efficiency estimation continued with a few very important findings in terms of empirical application. Except the original models that proposed half-normal and exponential distributions and the truncated distribution proposed in Stevenson (1980), a gamma distribution model is presented by W. Greene (1990) in which $ui \sim iidG(\lambda; m)$ (gamma distribution with mean λ and m degrees of freedom) and which acts as a more flexible setting. In the same time more attention is shifted to the panel data modeling. In S. C. Kumbhakar (1990) the author first introduces the time varying inefficiencies in the estimation of a production frontier using panel data, variations and extensions of the model are later accounted in Battese and Coelli (1992), Battese and Coelli (1995) and Atkinson and Cornwell (1994). The 90’s are also relevant in the context of introduction of Bayesian type estimation of stochastic frontiers and Gibbs sampling techniques which are extensively discussed and applied in van den Broeck, et al. (1994), Koop, Osiewalski and Steel (1995) and Koop, Osiewalski and Steel (1997).

The last decade brought in some innovations in the frontier efficiency estimation. The most notable from a theoretical and practical perspective is the estimation of multiple output production functions with undesirable outputs. This became a relevant topic in the discussion of ecological and nature preservation issues. For a detailed discussion of the topic Fernandez, Koop and Steel (2002), Fernandez, Koop and Steel (2000) and Fernandez, Koop and Steel (2005) could be consulted. Apparently the discussion on Bayesian inference and Gibbs sampling remained in vogue and were discussed in the context of new, more flexible or more restrictive forms of the production function Griffin and Steel (2004), Griffiths, et al. (2000), Koop and Steel (2001), Kumbhakar and Tsionas (2005) and Kumbhakar and Tsionas (2005a) to name just a few. The issue of heterogeneity in panel data is given rigorous consideration after the publication of the much disputed World Health Organization Report (2000). The dataset on the healthcare systems from 191 countries has been analyzed in different settings

and treated for heterogeneity issues in a series of influential articles such as: W. Greene (2004), W. Greene (2005), Hollingsworth and Wildman (2002) and finally W. Greene (2010).

An overview of the main frontier efficiency models is depicted in the *Table 2-1* below. Of course the panel data models could be easily fitted under the parametric and non-parametric methods, but for the goals of this paper it is given a special treatment.

Table 2-1: Overview of the Efficiency Frontier Models

		Deterministic	Stochastic
Non-Parametric		Data Envelopment Analysis (DEA) ⁷ Free Disposal Hull (FDH)	-
Parametric	Cobb-Douglas	-	Stochastic Frontier Analysis (SFA) Thick Frontier Analysis (TFA)
	Trans-logarithmic	-	Stochastic Frontier Analysis (SFA) Thick Frontier Analysis (TFA)
Panel data models	Time variant	Data Envelopment Analysis (DEA) Free Disposal Hull (FDH)	SFA, DFA, TFA
	Time invariant	Data Envelopment Analysis (DEA) Free Disposal Hull (FDH)	SFA, DFA, TFA

Source: Compiled by author based on the reviewed literature

In conclusion to this section a few general remarks have to be made. First, the literature on frontier production functions has extended rapidly and is now a well-established area of its own. Second, the advance in computing technology and the wide applicability of the econometric framework made this area of research highly attractive, for both theoreticians and practitioners. And last, regardless of the vast majority of subjects already covered by the existing literature, there remains potential for further extensions and far more complex settings for frontier efficiency estimations

⁷ The theoretical underpinnings of the model can be found in Farrell (1957) but its readily applicable form has been defined in Charnes, Cooper and Rhodes (1978). The main purpose of the model, as the authors put it, was: „with special reference to possible use in evaluating public programs”, but it soon became a very popular tool in the evaluation of different types of programs and companies along with the Stochastic Frontier Analysis developed a year earlier.

3.2. The areas of applicability

The tremendous impact of the seminal paper of Farrell (1957) could be measured by the amazing expansion of the literature in this area in a relatively short period of time. But not only was the impact notorious for its rapid proliferation in terms of methodology development, it also captured wide acceptability due to its eclectic applicability. The prime goal of the classic paper was preserved, but the methods have been enhanced and adjusted to comprehend all areas of academic, but also practical, interest.

We find a rather extensive literature in efficiency estimation in agriculture. The field is represented by the works of Farrell (1957), Farrell and Fieldhouse (1962), Timmer (1971), Battese and Coelli (1992), Battese and Coelli (1995) all of them working primarily with the same datasets on American, British, Indian and Australian farms. For an extensive survey of the efficiency frontier literature pertaining to agriculture refer to G. Battese (1992). Another related area of applicability is the determination of efficiency of dairy farms with the most prominent contributions represented by Battese and Coelli (1988) and the more recent Fernandez, Koop and Steel (2000).

The airline business has also been given some detailed consideration in the studies of efficiency as this industry has some specific characteristics, which make it an interesting case in the efficiency estimation literature. The main stream of research is represented by Schmidt and Sickles (1984) and Atkinson and Cornwell (1994) both focusing on the US domestic Airline data.

In Meeusen and van Den Broeck (1977) and Aigner, Lovell and Schmidt (1977) authors compute the efficiency estimates for the French manufacturing industry and the primary metals industry in the USA, respectively. The electric generating utilities have also been under meticulous scrutiny. The main works are represented by Seitz (1971), Christensen and Greene (1976), Reifschneider and Stevenson (1991), van den Broeck, et al. (1994) and Hisnanick and Kymn (1999).

The methods employed in the efficiency estimation of for-profit companies soon penetrated in the field of public program assessment. It was the seminal paper of Charnes, Cooper and Rhodes (1978) who proposed the Data Envelopment Analysis for the efficiency estimation and pioneered the work in the field of public program assessment. It has even entered the field of government performance assessment Afonso, Schuknecht and Tanzi (2003). Later,

methods have been extended and modified to be applied in the field of healthcare and education provision assessment.

The healthcare studies are rather numerous, but since they are not a prime concern for this paper we will outline just the most recent and most debated papers in this field leaving the individual country-specific assessments out of discussion. One of the most prominent studies in this sense is the World Health Organization Report (2000), which puts a great emphasis on the estimation of differences in efficiency between the 191 countries that have been included in the dataset. Further discussions about the implications of this study can be found in Hollingsworth and Wildman (2002), W. Greene (2004), W. Greene (2005), W. Greene (2010). The discussion about this study is interesting in the context of the heterogeneity issues that a large panel-data comprising 191 countries inherently bears in it, and the solutions presented by different authors in tackling the issues and distinguishing between heterogeneity and inefficiency. These studies bear important implications for the current paper as well. The main issue is to formulate a model which could make an abrupt distinction between inefficiencies and heterogeneity.

The last aspect which deserves attention in the efficiency assessment methodology and empirical applications is the case of universities. This again is a rather representative branch of frontier efficiency estimation of its own. The main works here are represented by T. Coelli (1996), Avkiran (2001) and Carrington, Coelli and Rao (2005) for the Australian universities. The performance of German higher education has been discussed in Warning (2004) and of the Canadian universities in McMillan and Datta (1998). Of course the literature on university performance is not that narrowly represented but it is beyond the scope of the actual paper to give it more consideration.

To conclude the section a few important ideas have to be highlighted. First, the frontier models gained wide acceptance and penetrated all the fields of economic activity regardless whether they are profit oriented or not and went even further than their primary scope. Moreover, we can now distinguish important streams of literature in all of these areas of research, which points out a process of narrower specialization with implications on the quality and relevance of the researches. A last thought on the issues discussed above is that all of these areas have been extensively popularized in the industrialized countries such as the USA, Western Europe, Australia, Canada, Japan and other, but more research opportunities

are still available with the extension of these studies to the emerging and developing countries for which a shortage of empirical studies on such issues is attested.

4.2. The frontier efficiency of financial institutions

The last two section of this paper brought into discussion two important aspects. First we extensively discussed the evolution of the methodology in frontier efficiency estimation and second we devoted some space to the overview of the main areas of application of that methodology. We did not talk much about the bank efficiency estimation so far, but this section will entirely be devoted to this. The outline of the section is primarily derived from Berger and Humphrey (1997) and A. N. Berger (2007).

1.2.4. An introductory methodological survey

The definition of inputs and outputs of a bank is subject to different interpretations and formulations in the literature. The debate revolves around the classification of deposits, as either inputs or outputs. Three main approaches emerged as a consequence. The first one, called the intermediation approach, was formulated by Sealey and Lindley (1977). The authors treat deposits as inputs used by banks to issue loans and other financial services. The second approach is referred to as the user cost approach and was proposed by (Hancock 1985). The approach distinguishes between the outputs and inputs relying on the information regarding their capacity to generate revenue. Under this approach, deposits can be either inputs or outputs. The last approach, due to Berger, Hanweck and Humphrey (1987), treats deposits as output. The approach is called the value added approach, and its main foundation refers to the process of deposit accumulation – which is not only lengthy but also labor intensive and thus can be attributed to the outputs. The preference to any of these approaches is dictated primarily by the availability and quality of data.

The number of authors and papers written on bank efficiency has expanded rapidly since the development of frontier efficiency estimation techniques.⁸ The studies on bank efficiency tackle diverse issues related to bank activity, and the authors usually employ diverse techniques in achieving their goals⁹. The only constant in all of the papers is the general approach to efficiency estimation which according to Berger and Humphrey (1997) is a “sophisticated way of benchmarking the relative performance of production units”. The same authors undertake a detailed survey of the main methods, papers and results obtained in the

⁸ In Berger and Humphrey (1997) the authors survey 130 papers on bank efficiency and A. N. Berger (2007) surveys another 100 papers on cross-country bank efficiency comparisons

⁹ The impact of changes in regulation, capital requirement, mergers and acquisitions, the European Single Market Program assessment and competition issues are among the most disputed

field of bank efficiency. The results of Berger and Humphrey (1997) indicate that the whole relevant literature could be divided in two broad groups according to the methodology of efficiency frontier estimation. The first is the group of studies which relate to the non-parametric frontiers which comprises Data Envelopment Analysis and Free Disposal Hull, whereas the second group encompasses Stochastic Frontier Approach, Distribution-Free Approach and Thick Frontier Approach. There is no conclusive evidence on which of the two approaches, parametric or non-parametric, is better¹⁰.

2.2.4. A tentative survey of the leading works in bank efficiency analysis

A thorough and comprehensive survey of all bank efficiency literature is highly improbable by default that is why we attempt to highlight the leading studies, their outcomes and implications for future research. We distinguish a few areas of general interest in the bank efficiency estimation studies and they are represented by the following. First, the impact of regulatory reforms on the efficiency of financial institutions; then the corporate governance and the quality of management as factors of efficiency differentials among institutions; mergers, acquisitions, competition and concentration are other concerns in connection to the financial institution's efficiency; stability of the efficiency over time and the main determinants of its change; and finally, the most recent stream of literature which focuses on the impact of the Single Market Programme of the European Union and its impact on the convergence of bank efficiency between the banking sectors and/or banks from different member states is also highly representative. A special consideration will be devoted to the international comparison studies in the next section of the thesis.

The banking sector is the most regulated industry in the world due to its business peculiarity which involves an environment with asymmetric information, principal agent problems and of course high degrees of moral-hazard. All of these pieces of the financial intermediation puzzle make a strong case for a highly vigilant and restrictive supervisory process of the respective state authorities, on one hand, but there are still incentives to pursue liberal regulatory incentives if this is associated with higher efficiency ratios of the banking sector, on the other hand. The respective literature which tackles this issue finds, at best, mixed results. The US studies on 1980's deregulation in banking, Elyasiani and Mehdi (1995) and Bauer, Berger and Humphrey (1993) find little evidence in change of bank efficiency. On the other hand

¹⁰ Of course such results are at least confusing and don't help much when it comes to the choice of a method. According to A. Berger it is hard even for a seasoned researcher to choose from the plethora of models that have been designed so far

later studies on the impact of regulation in Australia, Sturm and Williams (2004), Singapore, Lee, Worthington and Leong (2009), Europe Casu, Girardone and Molyneux (2004), and UK, Leigh (2001) all find improvement in efficiency of banks associated with deregulation. Whereas in Kumbhakar, Lozano-Vivas, et al. (1999) the authors find for the Spanish savings banks a contrary, to the above mentioned studies, result. The impact assessment of Basel II framework on banks is carried out in Pasiouras (2008), who quantifies a great positive impact of the framework.

The corporate governance and the quality of the management team of a bank usually play a crucial role in the overall performance of a bank. To decipher this relationship we will take a closer look to studies related to the issue. In Mester (1996) a link between banks with low efficiency and the placement of a higher share of their assets in construction and land development had been established. A strong positive relationship between the quality of the management and corporate governance of a bank, proxied by the quality of loans and/or loan loss provisions, and its cost and profit efficiency are found in Cebenoyan, Cooperman and Register (1993), Berger and Mester (1997) and Valverde, Huphrey and del Paso (2007). The lower the quality of the management is usually consistent with lower ranking in the efficiency measures. Moreover, the authors also find evidence that lower efficiency of banks could serve as predictors of subsequent failures of the banks.

The literature on bank mergers, acquisitions, competition and concentration and their impact on the efficiency of the banking system is largely represented by a very wide set of papers. The literature could be divided in two distinct periods. The period before the 2000s when it was primarily dominated by studies on American banks which started to consolidate after the deregulation processes that took place in the USA in the 80's. The most notorious works in this area are represented by Berger and Humphrey (1992), Akhavein, Berger and Humphrey (1997), and DeYoung (1997) for the United States and S. A. Berg (1992) for the Norwegian banks. However the results of the implications of mergers on efficiency are rather mixed, with the exception that efficiency studies could be rather good predictors of the main outcomes of a merger or acquisition procedure, as there was established a relationship between the ex-ante and post event efficiencies of the participating banks. The second stream of literature is represented by the 2000s literature and it comprises over 150 papers which are extensively discussed in DeYoung, Evanoff and Molyneux (2009) who document a series of interesting results of the bank mergers, which however do not have any implications for our study, albeit

they represent an actual area of interest from the perspective of international crisis impact and its implications on the merger and acquisition processes.

3.2.4. International comparisons of bank efficiency

In a globalized environment investment opportunities are diverse and multiple, but also unequally dispersed geographically. The dawn of new financial centers in parts of the world that, not so long ago, were viewed as remote, made the banking technology and the bank business relatively uniform. However, there are still numerous barriers that translate into sensible differences from region to region. Policy makers and researchers alike strived to understand the main forces that underlie the slow process of convergence in terms of banking technology and bank efficiency among different regions of the world. Our quest in this part of the thesis is to highlight the main areas of concern in the international comparisons of bank efficiency literature and emphasize the main challenges that a researcher has to face.

Although numerous, the studies on international comparison of bank efficiency cover primarily works oriented at identifying efficiency differences between the banking sectors of the developed countries. According to A. N. Berger (2007) the whole literature on international comparisons could be divided in three categories:

- Common frontier models
- Individual frontier (individual frontiers for every country) models
- Cross-country frontier models

The emergence of all these models stems from the main challenges inherent in any international study and from an unyielding need for a perfect model which would comprehensively explain the main differences in bank efficiency around the world. Which of the above mentioned models is the most feasible is not straight forward, and some further discussion is needed.

The international efficiency studies do inherently bear some drawbacks of data comparability which have to be alleviated using advanced econometric methods¹¹. A common efficiency frontier across banks from different countries might not explain well all the differences incurred by banks in terms of capital market development, the size of the banking market, the regulatory and supervisory frameworks, the cost of the resources and the quality of the human capital. It is by default impossible to take full account of all of these differences. On the other

¹¹ See A. N. Berger (2007) for a detailed discussion

hand, the second type of models might not be readily comparable due to obvious biases that pertain to the estimation of individual frontiers of countries. The third type of models is of course considered to be the most appropriate, but some studies might find it inconvenient in fitting the goals of the researcher.

There is no obvious reason to rely solely on the given classification above due, in big part, to the rather heterogeneous nature of the research in this field *per se*. Estimation of simple common efficiency frontiers in Berg, et al. (1993), Allen and Rai (1996) and Pastor, Perez and Quesada (1998) is contrasted by the estimations in Pastor and Serrano (2000), Bos and Schmiedel (2007), Dietsch and Lozano-Vivas (2000), Lozano-Vivas, Pastor and Hasan (2001) and Kwan (2003). The contrast, in the later class of papers, is primarily given by a more stringent specification of the frontiers, with detailed account for country and environment differences. In Bos and Schmiedel (2007) the authors propose and implement a meta-frontier for the European banks, which helps alleviate the problem of hidden heterogeneity in the data. This study also points out the fact that pooled estimates of cost and profit efficiency are underestimated.

Two important shortcomings of this kind of studies are highlighted in A. N. Berger (2007). First, it is highly improbable that any researcher could, in his cross-country banking efficiency comparison study, account for all environmental as well as economic differences. Although this might be true, it is still arguable whether such an exercise would be needed. From our point of view, a rough approximation would yield the necessary results, as the banking technology *per se* is under the auspices of rather harmonized banking regulations¹². Of course, the impact of cultural and behavioral differences between different countries makes it highly improbable that a bank from one country would yield the same efficiency ratios if it were to operate in another country. This represents the second consideration discussed in A. N. Berger (2007), and seems more credible in the light of bank efficiency comparisons between banks from different countries.

Comparing the bank efficiency of different countries by constructing individual frontiers for each country and then undertaking a comparative study of those, is another stream of literature which gained considerable attractiveness for the researchers in this area. Albeit the amalgam of papers using country specific frontiers is hard to decipher (see Berger and Humphrey (1997) for a detailed discussion), the papers that undertake a comparison of

¹² See for example the Basel Committee for Banking Supervision and its recommendations

country specific frontiers are rather limited in number. However in Berger, Hasan and Klapper (2004) an international comparison of community banks is undertaken and the results show that the regions with the most efficient banks do also have a higher GDP growth rate. Thus, the authors present compelling links between the financial sector development and the overall economic development of a country. The paper is also of relevance in the sense that it presents a technique of country frontier comparison. In Pastor and Serrano (2006) an international comparison of banking efficiency with regard to the impact of specialization is undertaken on a sample of European banks. The study reveals the existence in the European banking of high-cost inefficiencies and rather high inefficiencies associated with the retail banking. The discussion could be further extended on the country specific studies as represented in Berger and Humphrey (1997), but for the scope of this paper this would not yield much relevance and so we leave it for future discussions.

The last category of studies which are of keen interest in the light of their wide applicability are represented by the group, that we labeled “the cross-country frontier models”. This kind of models seems attractive mostly because they assuage the shortcoming of the first class of models that we discussed, and mainly it treats the issue of uncommon cultural and country specific environmental factors. The treatment is given by the computation of the efficiency of a foreign-owned bank and its comparison to the efficiency of domestically owned banks using the same efficiency frontier. This allows comparing directly the banks with differing ownership and managerial structure among them and inferring the necessary conclusions without facing additional econometric difficulties as posed in the earlier studies. The highly applicable framework ensured the proliferation of efficiency studies involving cross-country frontier estimation. As in the case of later models, the results displayed by this stream of literature are not definite and are open to further scrutiny.

Two distinct settings could be distinguished when discussing the cross-country frontiers. The first is represented by studies which focus on the developed countries, as in Berger, DeYoung, et al. (2000) and Miller and Parkhe (2002) who find that the US headquartered banks have higher efficiency compared to the domestic banks and compared to other foreign banks which operate in the same environment. The authors could not find empirically compelling explanations for these findings. One tentative explanation could be the fact that the USA is a competitive “playground” for the banks, A. N. Berger (2007), and this creates the necessary conjunctures which lead to a better filtering of the employed management team members as well as allow for innovative solutions for profit maximization and risk management. In the

light of the last developments on the international financial arena it is worthy to explore the question whether the US based bank competitiveness came at a preeminent cost of moral hazard and excessive risk taking and whether this could somehow be avoided. In the same realm, of developed countries bank efficiency analysis, such contributions as DeYoung and Nolle (1996) and Chang, Hasan and Hunter (1998) are also informative. The authors explore American data and reveal that the domestic US banks are usually more efficient than their foreign counterparts. But the studies lack further explanatory power because there were no country-origin distinction made and thus just general conclusions could be inferred.

The second setting deals with the research of the developing country banking systems and the entry of foreign banks on their market. Representative in this sense are Claessens, Demirguc-Kunt and Huizinga (2001) who using 7900 bank observation for 80 countries for the 1988-1995 period find that foreign banks are on average more efficient than the domestic banks and that the presence of foreign banks in developing nations usually leads to the margin squeezes and makes the competition fiercer. In Yildirim and Philippatos (2007) the authors focus on 12 European transition countries over the 1993-2000 periods. They investigate both cost and profit efficiency and find that profit efficiency is lower than cost efficiency and that larger banks have on average higher efficiencies than lower banks. The paper also highlights that foreign banks do have higher cost efficiencies than domestic banks but have lower profit efficiencies than the later. This could be explained through the fact that cost efficiency could be easily achieved by proper management techniques, which is most probably the case in this setting. The profit efficiency is higher for the domestic banks as they use extensively the knowledge about the particularities of doing business in their country of origin. Thus it should be clear that domestic ownership in the banking sector does not always preclude the attainment of successful outcomes.

No definite conclusion on the suitability of one or other kind of model can be easily drawn from all the information given above. Each of these three models does however elicit important results for the future research undertakings and they show no signs of saturation. The area is further being challenged by the new developments due to unprecedented implications of the credit crunch on the bank activity around the world. The resilience of the banking sectors around the world has been challenged. Now new questions arise to whether the banking sectors and mainly the dominating financial institutions managed to resist to the financial crisis without losing efficiency and whether the emerging market banks can catch-up with those from the developed markets.

A few general conclusions regarding the efficiency frontier literature will grant the closing of this section.

First, it is imperative to point out that frontier efficiency estimation pertains to a domain of chief interest for all, management teams of productive units, supervisors and regulators of different industries, merger and competitive control units, researchers and academicians. Notwithstanding their different interests, at times, the point of congruence in this literature resides in the rather utilitarian outcomes that it produces for policy and decision making. Second, the frontier efficiency analysis is a framework that can be easily and successfully extended on different areas of human activity, which makes it a very popular tool. Third, for researchers the frontier analysis is a proper framework for testing multiple hypotheses under different settings and rather complex assumptions which shows that this is a rather flexible framework and can be easily employed, given it was once mastered. Fourth, regardless of the numerous good parts of the framework, it remains still highly disputed whether certain already developed models are better than other or not, and so the author by himself has to decide on the appropriate model. And finally, in the context of the actual crisis and further developments in the field of banking, this framework might be successfully employed in deciphering the puzzle about the impact of the new regulation on the banking industry while at the same time it may furnish insights about the inner changes that took place in the global banking industry.

In the next section we engage in a thorough discussion of the methodology employed in this paper and define the ultimate model that we will employ in our analysis.

CHAPTER 3

Methodology

Albeit different from classical production units, banks still use certain amount of inputs to produce outputs. The main difference resides in the definition of the inputs used and outputs obtained¹³. In this instance the activity of a bank becomes prone to the efficiency analysis. The main reasons why inefficiencies may arise in the banking activity pertain mainly to the business model of banks which are financial intermediaries and thus inherently absorb the inefficiencies from the real economy into their activity. Secondly, although the classical microeconomics advocates perfect markets, the reality comes in with its own share of distortions – principal agent problems, asymmetric information, moral hazard, ill designed incentives and of course the regulatory and supervisory framework on its own. Finally, from a philosophical perspective it is hard to imagine a human activity which would guarantee lack of wastefulness and/ or misallocation of resources. Still, the methodology to be employed in this paper, assumes that a near perfect process of production exists and that certain units attain “perfection”, i.e. are situated on the production or cost frontier, while the others are benchmarked against this “efficiency frontier”. The method is known for its relative simplicity and popularity among academics and regulators alike and thus it will serve our research purposes for this thesis. In the following expositions we are going to address in detail the main aspects of the methodology and formulate our final model.

1.3. Stochastic Frontier Analysis – Theoretical Framework

The choice of the methodology for our research has been driven by a few crucial aspects of the underlying study. First, we opted for an efficiency frontier analysis rather than a classical ratio analysis in the pursuit of comparability between banks across different economic, political, geo-political and cultural settings. Among the choices given by the diversity of frontier methods, the preference for a parametric rather than a non-parametric one, has been driven by the need to explain as much of the heterogeneity in the dataset as possible. This would be close to impossible in a non-parametric setting. That is why the Data Envelopment Approach, albeit computationally less demanding, would not serve our purpose at grasping the differences in general economic conditions that different banks face. And the last, since in the first instance we chose to impose some form for our cost and profit functions, we are now

¹³ There is still a certain dose of uncertainty in defining the main outputs and inputs of a bank, and different researchers use different approaches when dealing with this issue

compelled to allow for as much flexibility as possible. The only functional form that grants it is the trans-logarithmic form of the cost and profit functions. Given all of the above arguments and considering the relatively high popularity of the Stochastic Frontier Approach in the banking efficiency estimation (see the surveys by Berger & Humphrey (1997) and Berger A. N. (2007) the choice for this method is natural. Moreover, according to the parsimony principle we adhere to, we will employ the model that assumes the Half-Normal distribution for the inefficiency term.

1.3.1. Half – Normal SFA Model for Cross – Section Data

The method has been proposed by Meeusen and van Den Broeck (1977) and Aigner, Lovell and Schmidt (1977) independently. The production function, as originally specified by these authors, is given by:

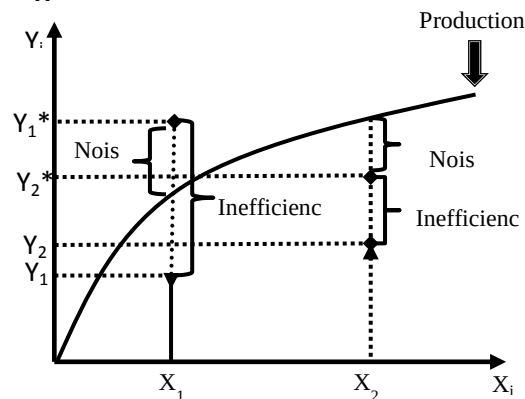
$$y_i = x_i' \beta + \epsilon_i \quad \text{Equation 3-1}$$

and

$$\epsilon_i = v_i - u_i \quad \text{Equation 3-2}$$

In this relationship y_i is the output vector and x_i is the vector of inputs ($x_1, x_2, \dots, x_i$) and β is a vector of parameters that have to be estimated, ϵ_i is the error term which can be decomposed in two distinct parts. The first one, v_i , is the disturbance (statistical noise) and the second term, u_i , is the inefficiency term. The task is to maximize the output y_i given the set of inputs x_i , the graphical representation is depicted in *Figure 3-1* below.

Figure 3-1: Production Frontier



Source: (Coelli, et al. 2005), graphics by author

The main assumption regarding these two terms is that they are independent of each other and of the explanatory variable x_i , and satisfy the following assumptions (as specified in Coelli, et al. (2005)):

1. $E[v_i] = 0 \rightarrow \text{zero mean}$
2. $E[v_i^2] = \sigma_v^2 \rightarrow \text{homoskedasticity}$
3. $E[v_i v_j] = 0$ for all $i \neq j \rightarrow \text{uncorrelated}$
4. $E[u_i] \neq 0$ and could take values in the range (0; 1]
5. $E[u_i^2] = \text{const} \rightarrow \text{homoskedasticity}^{14}$
6. $E[u_i u_j] = 0$ for all $i \neq j \rightarrow \text{uncorrelated}$

Thus, these properties imply that the error term has the classical properties and is $v_i \sim iidN(0, \sigma_v^2)$ distributed, whereas the inefficiency term $u_i \sim iidN^+(0, \sigma_u^2)$ distributed. The different distributional assumptions help us distinguish between the noise and the inefficiencies that we aim to estimate. The half – normal and exponential distributions are among the most popular due to the relative simplicity of assumptions and estimation, but such distributions as truncated normal proposed by Stevenson (1980) or gamma distribution developed by Greene (1990) are also employed, albeit they are more computationally demanding.

The next step in the estimation is to maximize the log-likelihood function and obtain the estimates. This is done according to Aigner, Lovell and Schmidt (1977) by maximizing the following formula.

$$\ln L(y | \beta, \lambda, \sigma^2) = N * \ln \frac{\sqrt{2}}{\sqrt{\pi}} + N * \ln \sigma^{-1} + \sum_{i=1}^N \ln [1 - \Phi * (\epsilon_i \lambda \sigma^{-1})] - \frac{1}{2\sigma^2} \sum_{i=1}^N \epsilon_i^2$$

Equation 3-3

The vector of outputs y is maximized with respect to the vector β , $\lambda = \sqrt{\frac{\sigma_u^2}{\sigma_v^2}}$ and $\sigma = \sqrt{\sigma_v^2 + \sigma_u^2}$. The Φ in the formula stands for the cumulative distribution function of the standard normal variable evaluated at $(y_i - \beta^T x_i) * \lambda \sigma^{-1}$. The authors derive the function for both, half-normal distribution and for the exponential distribution. Since the relationship is

¹⁴ This assumption is not always necessary to hold, a discussion of Frontier Models with Heteroskedastic inefficiency and/ or disturbances can be found in Greene(2004).

highly non linear the estimation is done using a Maximum Likelihood¹⁵ iteration. Having the results of the maximization procedure we now have to predict the inefficiencies.

The prediction of the individual production units inefficiency for the cross – sectional half-normal model, for the above given production function, is represented by the following relationship:

$$\mathbf{TE}_i = \frac{y_i}{\exp(\mathbf{x}_i^T \boldsymbol{\beta} + \mathbf{v}_i)} = \frac{\exp(\mathbf{x}_i^T \boldsymbol{\beta} + \mathbf{v}_i - \mathbf{u}_i)}{\exp(\mathbf{x}_i^T \boldsymbol{\beta} + \mathbf{v}_i)} = \exp(-\mathbf{u}_i) \quad \text{Equation 3-4}$$

Of course arriving at this relationship is not a straightforward exercise. It is imperative that we have some information about the u_i s before we want to get their respective values from the truncated normal pdf which is obtained after observing the values of y_i s. The pdf is given by:

$$\mathbf{p}(\mathbf{y}_i | \mathbf{q}_i) = \frac{\frac{1}{\sqrt{2\pi \frac{\sigma_v^2 \sigma_u^2}{\sigma^2}}} \exp \left\{ -\frac{1}{2 \frac{\sigma_v^2 \sigma_u^2}{\sigma^2}} \left[\mathbf{u}_i + \frac{(\ln \mathbf{q}_i - \mathbf{x}_i^T \boldsymbol{\beta})(\sigma_v^2 \sigma_u^2)}{\sigma^2} \right]^2 \right\}}{\Phi \left(\frac{(\ln \mathbf{q}_i - \mathbf{x}_i^T \boldsymbol{\beta})(\sigma_v^2 \sigma_u^2)}{\sigma^2} \right)} \quad \text{Equation 3-5}$$

The prediction of individual inefficiencies of firms was derived from the above pdf specification in Jondrow, et al. (1982) and is given by:

$$\mathbf{u}_i \equiv E\{\mathbf{u}_i | \mathbf{y}_i\} = \mathbf{u}_i^* + \sigma_* \left[\frac{\phi\left(\frac{\mathbf{u}_i^*}{\sigma_*}\right)}{\Phi\left(\frac{\mathbf{u}_i^*}{\sigma_*}\right)} \right] \quad \text{Equation 3-6}$$

where we denoted $\mathbf{u}_i^* = -\ln(\mathbf{q}_i - \mathbf{x}_i^T \boldsymbol{\beta})$, $\sigma_* = \frac{\sigma_v^2 \sigma_u^2}{\sigma^2}$, $\phi(x)$ – the standard normal density evaluated at $\mathbf{x}_i$ and $\Phi(x)$ – the standard normal cumulative distribution function evaluated at $\mathbf{x}_i$, as in Coelli, et al. (2005).

2.3.1. Half – Normal SFA Model for Panel Data

The extension of the above model to panel data is a rather laborious exercise first undertaken in Pitt and Lee (1981) and Schmidt and Sickles (1984). Later the model has been extended in Battese and Coelli (1988), Battese and Coelli (1992) and Battese and Coelli (1995). We will analyze the main features of the model following the line proposed in G. Battese (1992) where the production function for a panel dataset is defined as:

¹⁵ According to (Coelli, et al. 2005) the MLE estimates are the most popular in empirical work due to their asymptotic properties, i.e. they are asymptotically efficient

$$y_{it} = \beta^T x_{it} + v_{it} - u_{it} \quad \text{Equation 3-7}$$

The only remarkable difference from the cross-section, at this stage, is the t subscript which indicates the "time" dimension of the dataset. The authors proposed as a predictor for the inefficiencies:

$$u_i = \exp(-\eta(t - T_i)) \quad \text{Equation 3-8}$$

where T_i stands for the total number of periods in the panel and η is an unknown scalar parameter. The log-likelihood function for the parameterization of the model is given by:

$$\log L_i = -\frac{T_i}{2}(\log 2\pi + \log \sigma^2) - \frac{(T_i-1)\log(1-\gamma)}{2} - \frac{1}{2} \sum_{t=1}^{T_i} \frac{\varepsilon_{it}^2}{(1-\gamma)\sigma^2} - \frac{1}{2} \log \left[1 + \gamma \left(\left(\sum_{t=1}^{T_i} u_{it}^2 \right) - 1 \right) \right] - \frac{1}{2} \left(\frac{\mu_i}{\sigma\sqrt{\gamma}} \right)^2 - \log \Phi \left(\frac{\mu_i}{\sigma\sqrt{\gamma}} \right) + \frac{A_i^2}{2} + \log \Phi(A_i) \quad \text{Equation 3-9}$$

We preserve the notation from the cross-section model and define the new terms as:

$$\gamma = \frac{\sigma_u^2}{\sigma^2}, \quad \varepsilon_{it} = y_{it} - \beta^T x_{it}; \quad \mu_i = 0 \text{ or } \mu \text{ or } \sigma^T w_i; \quad A_i = \frac{(1-\gamma)\mu_i - \gamma d \sum_{t=1}^{T_i} u_{it} \varepsilon_{it}}{\sqrt{\gamma(1-\gamma)[1+\gamma((\sum_{t=1}^{T_i} u_{it}^2)-1)]}} \quad \text{and} \quad d =$$

1 if we estimate a production function and -1 if we estimate a cost function.

The derivations and the maximization of the function in this case are not as straightforward as in the case of cross-section analysis. Important parts of the derivations can be consulted in (Battese and Coelli 1992). The authors arrive in the end at the predictions in Equation 3-8.

This prediction of u_i s is used in most applications related to inefficiency estimation and we will abide by it when estimating the inefficiencies using the panel of banks for the 5 year period that we investigate.

The introduction of the cross-section and panel data models has a dual motivation which stems from the properties embedded in them. The panels are usually more information intensive than the cross-sections, and thus they enable us to investigate the inefficiency effects in a less rigid theoretical environment. Moreover, the panels are also more reliable in generating more efficient predictions of firm inefficiencies. The time dimension of the panels is a crucial element which allows for the investigation of changes in inefficiencies. This last aspect is true mainly for balanced panels, in which each firm is observed over an equal number of time periods. Unfortunately our dataset does not possess this feature, and thus a straightforward analysis of the time effect on the predicted inefficiencies is impossible. This serves as a motivation to use the cross-section model, at the risk of more inefficient estimates.

We employ it for every single year in the dataset and obtain the inefficiencies of individual banks which are then compared in a dynamic setting.

The choice of the model and its further application is not a straight forward exercise. The Bayesian inference models, Gibbs sampling, sample selection, latent class models, heteroskedasticity embedded models, gamma distribution models and a plethora of so many other types of models makes the selection exercise a rather complex and laborious procedure. Our choice has been driven primarily by the parsimony principle, albeit we acknowledge that given the nature of the dataset this might be not an entirely satisfactory choice. On the other hand, using the same sample of banks, there is room for future research and assessment of the asymptotic properties of different models. At this stage and for our purposes the above described models seem to grasp all the necessary information that we envisaged.

2.3. Cost function

Except the production context that we used to introduce the SFA models, input – output relationship, their immediate applicability extends over the remaining aspects of the firm activity. Namely we can also estimate the cost and the profit functions.

The cost function is primarily a depiction of the use of the input mix that a firm uses in the production process. The main decision, which the management faces in this instance, is how to combine the inputs in such a manner that the total output remains the same while the costs are minimized. This minimization problem is given by the simple representation as in Coelli, et al. (2005):

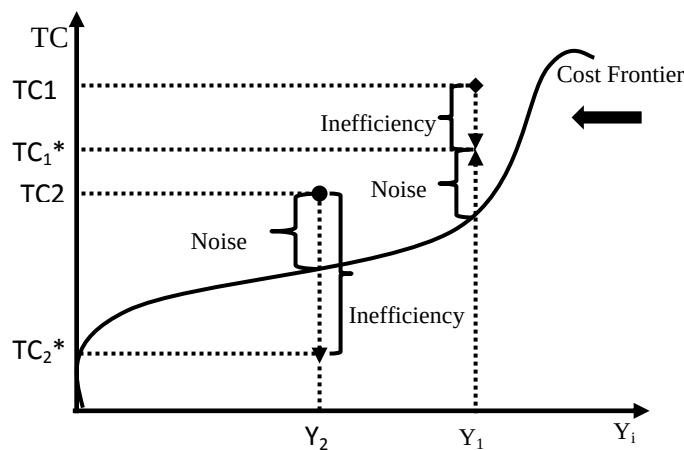
$$c(p, q) = \min(p'x) \text{ such that } T(q, x) = 0 \quad \text{Equation 3-10}$$

where $p = (p_1, p_2, \dots, p_N)$ is the vector of input prices and $q = (q_1, q_2, \dots, q_M)$ is the vector of outputs. The whole problem is then, to determine the best combination of inputs such that the cost of producing the outputs is minimal. The representation of the problem is depicted in *Figure 3-2* below.

The SFA model enables us construct the cost frontier from the readily available observation. The curve represents the best observed performing units from the sample. Thus, having different samples we might have different representations of the cost frontier. All the other observations are benchmarked relative to this frontier. As can be inferred from the *Figure 3-2* there are two components of the estimation. The noise, also called the "good" or "bad" luck, and the inefficiency term.

Any deviation from the curve is treated as inefficiency, and thus the firms that deviate from it, could be able, by altering the mix of inputs, to minimize the costs until they reach full efficiency. Of course the full efficiency is an arbitrary and rather abstract notion in this context, because due to factors, other than those manageable there might be environmental factors which would never allow further proximity to the frontier.

Figure 3-2: Cost Frontier



Source: Author's graphics and representation

Although the process of estimation is nothing further than a simple regression, before proceeding with it we have to take full account of the main properties of such a function as well as empirical forms of representation. According to the production theory, and as summarized in Coelli, et al. (2005), the main properties of the cost function are:

1. Non – negativity → the costs of producing an output cannot be negative;
2. Non – decreasing in p → an increase in the prices of inputs cannot decrease costs;
3. Non – decreasing in q → more costs are incurred by producing more outputs;
4. Homogeneity → a 50% increase in input prices implies a 50% increase in total costs;
5. Concave in p → input demand function cannot slope upward.

Of course the reality alters these properties in multiple ways and the main outcome of such a distortion is the suboptimal activity of production and the presence of cost inefficiencies, which economists deem measurable. Moreover, the cost inefficiency could also be expressed as a product of technical and allocative inefficiencies and further inferences could be drawn from the investigation of these two components.

The next challenging task is to determine a functional form for the cost frontier so that it fulfills at least theoretically all of the properties described above. The most convenient forms for this purpose are the Cobb – Douglas function and the trans-logarithmic function.

The Cobb – Douglas cost function with M input prices and N outputs is represented as:

$$lnc_i = \beta_0 + \sum_{m=1}^M \beta_m \ln p_{mi} + \sum_{n=1}^N \theta \ln q_{ni} + v_i + u_i \quad \text{Equation 3-11}$$

The Trans – logarithmic cost function with M input prices and N outputs is:

$$lnc_i = \beta_0 + \sum_m^M \beta_m \ln p_{ij,m} + \sum_n^N \gamma_n \ln q_{ij,n} + 0.5 \sum_m^M \sum_M^N \theta_{mn} \ln p_{ij,m} \ln p_{ij,M} + 0.5 \sum_n^N \sum_N^n \varphi_{mn} \ln q_{ij,n} \ln q_{ij,N} + \sum_m^M \sum_n^N \omega_{mn} \ln p_{ij,m} \ln q_{ij,n} + v_{ij} + u_{ij} \quad \text{Equation 3-12}$$

The preference for either of these two functions is dictated primarily by the structure and size of the dataset as well as the goals sought by the researcher. It is obvious that the Trans – logarithmic function entails loss of degrees of freedom but yields a more flexible form of the cost function. On the other hand the Cobb – Douglas function is easier to apply on smaller samples and comes without loss of degrees of freedom but this all is achieved at the expense of flexibility.

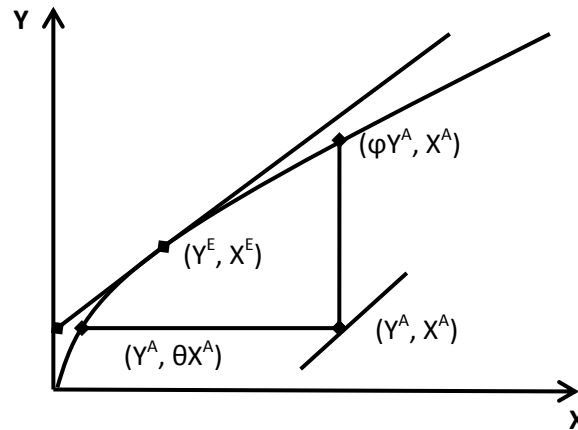
3.3. Profit function

Estimating a profit function implies both minimizing the costs and maximizing the output such that the difference between the revenues and the costs yields a maximum. Doing this entails having information both about the prices of inputs and prices of outputs. The function can be represented by the following relationship:

$$\pi(w, p) = \max_{q,x} (w^T q - p^T x) \text{ such that } T(q,x)=0 \quad \text{Equation 3-13}$$

where w represents the price of outputs, the remaining notation is similar with the one used in expressing the cost function. The graph depicting the relationship is presented below in Figure 3-3.

Figure 3-3: Profit Function



Source: (Fried, Knox Lovell and Schmidt 2007), graphics by author

The properties of the profit function are a derivation of the properties of the production and cost function. Thus the profit function should, from a theoretical stand point resemble the following – it should be non-negative, non-decreasing in output prices, non-increasing in input prices, homogeneous and convex in both input and output prices. As in the case of the cost-function, any violation of these properties purports inefficiency. The definition of the profit function has some obvious practical implications. Its dichotomous nature, production maximization and cost minimization, makes us expect higher levels of inefficiencies whenever we estimate it. Moreover, it seems to be more susceptible to different adverse shocks and thus a firm could easier deviate from the efficiency frontier. It thus becomes the perfect investigative platform for analyzing the impact of shocks and distressed production environments. It also has implications regarding the decomposition of the inefficiency in three distinct components: input-allocative inefficiency, output-allocative inefficiency and input-orientated technical inefficiency. In Kumbhakar and Tsionas (2005), one of the existing approaches of inefficiency decomposition is exemplified¹⁶.

The functional forms of the profit functions are also represented by the Cobb-Douglas and the Trans-logarithmic forms. The preference for any of the two is again dictated primarily by the properties of the dataset and by the goals of the researcher. Both are equally represented in the literature and yield rather similar results. The discussion on profit functions can then be extended to some more specific cases. One of these cases is when the researcher has limited information on the price of the outputs of the firms and the standard profit function cannot be estimated. The situation is encountered with high frequency. There are industries for which average output prices are unavailable. For this case an alternative profit function can be estimated. The modification resides in the fact that we substitute output prices with output

¹⁶ At this stage we refer to the inefficiency decomposition in a very tangible manner as our immediate interest is of a different nature (for further discussion see (Coelli, et al. 2005))

quantities. And in this case we get the classical cost function specification with the sole exception that on the left – hand side the profit of the firm replaces the total costs.

The attainment of the profit frontier by a firm is contingent on a number of important factors, which might be both under the immediate control of the management or exogenous and impossible to control for. In any instance the estimation of a profit function enables us determine the "best practice" frontier in the industry and then benchmark the rest of the production units relative to this frontier and to each other. The plethora of factors influencing the activity of a firm range from banal inadequate motivation and information asymmetries to such issues as attendant monitoring difficulties, agency problems, incomplete contracts, moral hazard and other psychological and behavioral biases inherent to human activity. The environmental settings add up to all of the above and distort the activity of the firms in ways that are usually beyond the coverage of any econometric model. Purposefully we leave unattended many of the issues listed above, and focus on a rather simplistic model, trying to assess certain aspects of the banking activity during a period which bears characteristics with far reaching implications for regulatory design and policy making.

4.3. The Final Formulation and Hypothesis Testing

Having discussed the most relevant technical aspects related to frontier efficiency analysis we will now turn to the explicit formulation of the model for our purposes. The underlying form of our cost and profit functions is given by (3.12). For the cost function we define the *Total cost* as the sum of *Total interest* and *Non-interest expenses* as in Fries and Taci (2005), the input prices are the *Price of labor* and *Price of funds*; the outputs are defined as *Total Earning Assets* and *Total Non-interest Income* as in Orea and Kumbhakar (2004). We follow the methodology in Berger and Mester (1997b) and add as net-puts in the cost function *The Total Business Volume* from the off-balance sheet and the *Equity capital*. We also apply the same normalization procedure as in Berger and Mester (1997b), by dividing the *Total Cost* by *Equity capital* and by dividing the prices by the last input price in order to control for heteroskedasticity and to comply with the homogeneity condition. The only difference for the profit function is that we use the profit as a dependent variable instead of the Total cost, all the rest remaining the same. Further explanation regarding the choice of variables will be given in the description of the data in the next chapter.

Using this setting, we intend to investigate and test three main hypotheses. Their formulation and testing is scrutinized in what follows.

1.3.4. Hypothesis 1:

"Bigger means more efficient" – we want to investigate whether the biggest banks from our sample have higher efficiency scores than the smaller ones.

To investigate this we will employ the panel data half-normal distribution frontier model on an unbalanced panel of banks, maximum observations per bank – 5 years and minimum observations one year, estimating a Trans-logarithmic cost and profit functions.¹⁷

To be more specific, we adhere to the model proposed by W. Greene (2002) given two crucial considerations. First, the model proposed in W. Greene (2002) allows us to include efficiency covariates in the first step of the regression and this simplifies the whole estimation process by enabling us to separate firm heterogeneity from the inefficiency effects. Moreover, this model treats some of the ills of the previous models by addressing the incidental parameter problem which yields biased and inconsistent estimates.

After defining the functions and running the model, the obtained inefficiency estimates will be compared with the actual rankings of the banks in the "Top 1000 World Banks" rating produced by "The Banker" magazine. Thus, we will be able to assess, using Spearman rank technique, the correlation between the rankings given by our model and the rankings of the banks from the magazine. This procedure suffices for our goal, because the magazine rankings are based on the value of Tier 1 capital and thus, the ranking of a bank is a representation of its size rather than of the quality of its assets or services provided. We will replicate the procedure for both functions. In order to compare our results with similar studies in the literature we will divide our sample of banks in two categories. The first category will comprise big banks and the second category will cover small banks. The division will be done according to a simple procedure. The average Equity capital and Total assets the sample will be determined and then all the banks will be compared to the average and divided in the two subgroups. Apart from presenting the relative efficiency scores, their correlations with the ranking and among the two estimations, we will also discuss the results of the regressions by analyzing the signs and significance of the coefficients and their impact on the inefficiencies.

2.3.4. Hypothesis 2:

The developed countries have more efficient banks than the developing countries

¹⁷ The final specification of the function, the variables that we use as outputs and inputs as well as the covariates included in the function will be discussed in the next chapter when we will introduce the data and analyze its properties

To test this hypothesis we will use the results obtained in the first part. The task now being to estimate the aggregate efficiencies for all the countries represented in the sample. We will estimate country level efficiencies by computing the weighted average efficiency scores based on the volume of assets a bank has in the total amount of bank assets from a given country. We will constrain our analysis only to those countries that are represented by at least five banks. Thus, all of the countries with fewer banks than five will be excluded from the analysis.

We intend to build a rating of the best and worst faring banking systems, both from the perspective of the cost inefficiency and profit inefficiency. Moreover the analysis will digress from a simple inter-country comparison to a regional and group of country comparison. It should include analyses regarding the BRIC¹⁸ countries, OECD¹⁹ countries, European countries, emerging economies and other more or less conventional groups. This kind of analysis should enable us uncover the most recent patterns in term of banking development and presumably help us in identifying any already set trend or any shift in the trend of banking development.

3.3.4. Hypothesis 3:

The 2007 credit crunch had a strong negative impact on both cost and profit efficiency of banks

The second part of the hypothesis, referring to the profit efficiency, is straight forward and is motivated by the tremendous losses that banks incurred during the crisis. The first part of the statement is, on the contrary, is rather debatable. However, we adhere to the view that banks' reaction to an abrupt change in business environment cannot be offset by immediate adjustment of the business model or of the costs. Thus, in the short term, at the moment the crisis is unleashed, the banks will have to deal with bigger cost inefficiencies which would then shrink as the management adjusts its business model to the new environment or the environment itself turns to the pre-crisis condition.

To determine the impact of the crisis on the sample of banks under analysis we would have to adjust our estimation techniques. This is, unfortunately, the case for our sample, since the data-panel we analyze is not balanced and so, the efficiency scores that we estimate using a

¹⁸ An acronym first used by Jim O' Neil in his paper "Building Better Global Economic BRICs" dated 30th November 2001 and stands for Brazil, Russia, India and China

¹⁹ Organization for Economic Co-operation and Development which was established in 1961

panel setting are averages for the period and no time effect or technological change effect is grasped by it. This shortcoming can be overcome by running a frontier model on a cross-section of banks for each year observed in the sample, and then compare the results across all the cross-sections.

The approach is debatable but has wide acceptance in the literature, mostly because, as W. Greene (2010) shows, the exclusion from the sample of a random number of observations has no statistically significant impact on the inefficiency estimates. Thus, even if the cross-section composition might slightly differ from year to year, (as not all the banks are equally represented) the results by running a regression on separate cross-sections should resemble the ones of the complete cross-section.

We take advantage of the simplicity and intuitiveness of the original model for cross-section stochastic efficiency frontier presented in Aigner, Lovell and Schmidt (1977) and Meeusen and van Den Broeck (1977) with Jondrow, et al. (1982) estimator as presented in this section above and apply it to our dataset.

The results that we obtain for individual banks will be aggregated then and the average inefficiency scores will be obtained for the entire sample for each year. After that a dynamic comparison of the inefficiency scores will be undertaken. Moreover we also intend to document any convergence or divergence of the inefficiency scores during the period between the countries and the regions that are represented in the sample. Finally, we will create a map of the countries with the hardest hit banking systems during the financial crises and will also try to determine any linkages between these regions or countries.

The methodology that we discussed is of course subject to further scrutiny and debate. The interpretation of the results has to be carried out in a very cautious fashion taking in consideration all of the assumptions and properties of the models we employ. To date, there is no such model that would grasp the complexity of the real world in its entirety, and for this reason approximations are regularly deployed to offer as close a description of the reality as possible. We are fully aware of the limitations and flaws of the models and perceive them as a rough approximation of the reality rather than the reality itself. For this reason, although ambitious, we aim at presenting a rough approximation of the world banking system efficiency, both from a cost and from a profit perspective. We also try to depict, as closely as possible, the impact of the credit crunch on the banks and on the countries represented by those banks in general.

CHAPTER 4

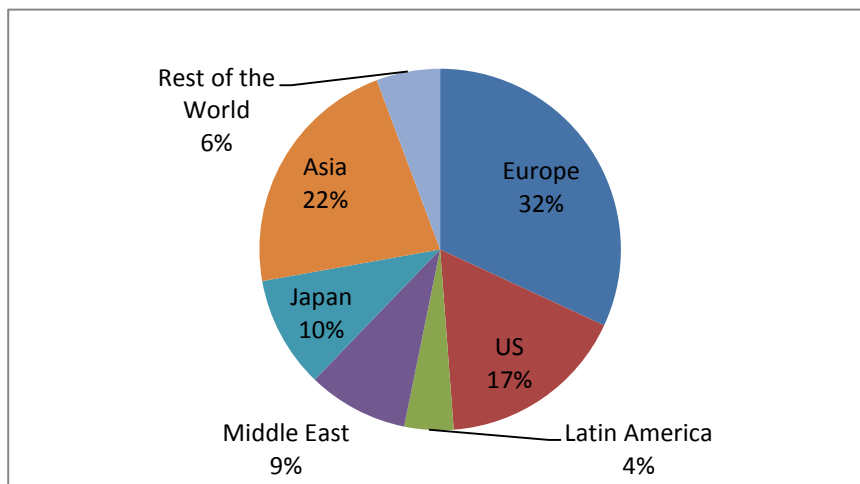
Dataset

This chapter covers the main issues related to the dataset and its preliminary analysis. The main variables are defined and their properties are presented.

1.4. Top 1000 World Banks 2010

An analysis of a panel of 1000 banks for the 2005-2009 period is attempted in this paper. The composition of the dataset is very peculiar. It is based on the annual publication of the "The Banker" magazine, namely, as a reference the July 2009 special issue is taken. This issue covers the so called "Top 1000 World Banks 2010" ranking (hereinafter – Top 1000). The ranking comprises 1000 biggest banks according to the reported Tier 1 capital, representing a total of 90 countries. The countries are not equally represented; merely only the biggest banks are listed. Figure 4-1 below depicts the share of the highest represented regions by the total number of banks in the Top 1000.

Figure 4-1: Share of Regions in the Top - 2010



Source: The Banker – compiled by the Author

United States and Japan are clearly two dominating banking nations. The two biggest economies have a staggering 27% representation in the Top 1000. Europe, which includes all European nations regardless of their EU membership status, accounts for another third of the sample. Asia, which comprises China but leaves out Japan, accounts for another 22% of the banks in the list. The banks in the list managed \$95.232bn in total assets by the end of 2009. Of this amount 13.34% is held by US based banks, 58.6% is under the control of EU-27 banks, a share of 8.9% and 10.3% of the assets is managed by Chinese and Japanese based

banks respectively. Brazil is far behind in the list, holding a mere 1.4% of the total slice of banking assets. It is thus clear that European banks dominate vigorously the ranking, both by the number of banks and value of assets.

In terms of Tier 1 capital the situation is quite similar, with the sole exception that Chinese banks hold more Tier 1 capital than their Japanese counterparts, 8.9% as compared to 8.2%. The US based banks retain a share of 19.8% of total Tier 1, while their European counterparts have 48.3% at their disposal. A quick look reveals that American banks seem better capitalized than the European banks, as for a lower share of total assets they hold a bigger share of Tier 1. The same can be said about the Chinese and Japanese banks, when compared.

All 1000 banks have earned approximately \$400bn in pre-tax profits. A third of all profits were accounted by the European banks, and another fourth was claimed by the Chinese banks. The US based banks claimed 9.4% of the total profits while Brazilian banks had an impressive 7.2% of the total pre-tax profits. The worst performing banks were the Japanese ones. On aggregate they recorded a total of \$11bn in losses in 2009²⁰. This proves that the Japanese banks have not yet recovered from the crisis and the outlook is grim.

Although at first look the dataset seemed rather heterogeneous, when delving resolutely points of comparability can be established. Moreover, even if most of the regions display significant differences among themselves, the banking sectors do exhibit rather similar patterns in terms of business models and banking products that they offer. This is of course violated in certain cases, in countries with more specific political and social regimes. Some of the differences would be addressed by employing environmental variables; others will still remain unexplained and probably transfer in higher inefficiency results for the banks. Regardless of the main shortcomings and challenges we might face while dealing with the data, a thorough analysis of this dataset is worthwhile and in the next section a final data-sample and its main properties will be introduced.

2.4. The Dataset

The dataset compiling process was done using two primary sources of information. First, the Fitch IBCA's Bankscope Database was used to retrieve individual level, yearly data for each bank listed in the Top 1000 for 2005 – 2009. Institutions with commercial bank type reports were selected, and consolidated, audited data was retrieved. Preference was given to data

²⁰ The data regarding the total assets, Tier 1 capital and profits for 2009 has been taken from the magazine "The Banker" – July 2010 edition

which met the International Financial Reporting Standards. Abatements were allowed for banks originating in such countries as Syria, Cuba, Libya, Vietnam, Myanmar, Venezuela and some Chinese and US based banks which reported under national standards. Second, IMF's World Economic Outlook was used for macro-level data for the same period for each of the countries represented in the sample, which was used as environment controls and for inflation adjustment of the primary bank level data.

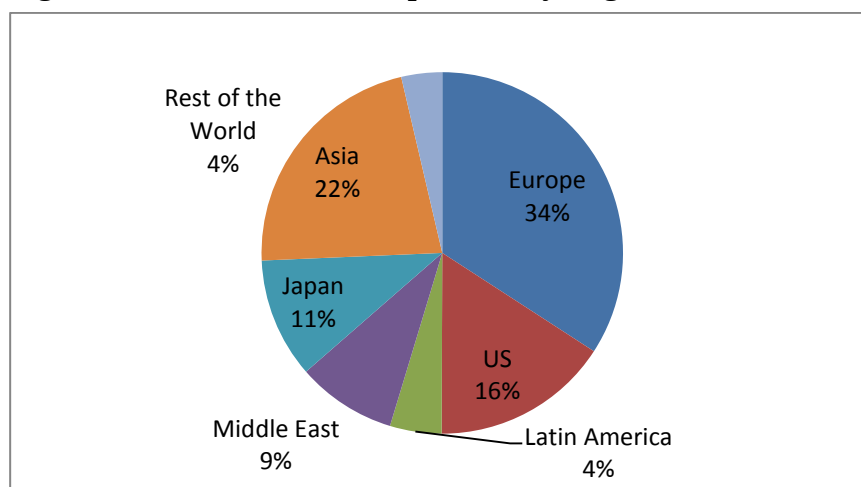
Each bank listed in the Top 1000 was searched for in the Bankscope database and included in the list. In the process three banks could not be identified in the database and many others had missing or incomplete data. Moreover, disaggregated data was problematic to retrieve as many banks lacked it. In order to preserve the entirety of the dataset and of the banks observed in it, a more aggregated level of data was retrieved. Nevertheless due to the fact that not all the banks report its data to Bankscope some of the banks were excluded from the database as there was no data recorded for them in the database. Up to 20 US based banks were lost from the dataset in the process. Some banks from other countries were also excluded from the dataset due to lack of information and in the end the bank representation by year is as reported in the *Table 4-1* below.

Table 4-1: Number of Banks by Year

Year	2005	2006	2007	2008	2009
# of Banks	856	910	936	955	931

Source: Compiled by Author

Figure 4-2: The Dataset Composition by Regions -2009



Source: Author's computations

The initial weight of the US based banks as well as that of the other groups has changed in the process. Nevertheless the figures are very proximate to each other and thus the initial nature of the dataset was preserved and no significant deviations should occur in the results. Use Figure 4-1 and *Figure 4-2* for comparison of the structure of the initial and final dataset

The use of Bankscope database is convenient from at least two perspectives. It is a very comprehensive database, comprising according to Mathieson and Roldos (2001) about 90% of the information for an individual country banking system. Another attractive feature of the database is its global format. The data is adjusted for any differences in the national legislation of the reporting countries, and thus all of the definitions used in the database are consistent across countries and legislations, making it uniform.

3.4. The Input and Output variables for the Cost and Profit functions

In this thesis the Sealey and Lindley (1977) approach is applied. A cost function is specified using the following variables. The dependent variable, defined as Total Costs (TC), is the sum of total interest and non-interest expenses of a bank as in (Fries and Taci 2005). The bank outputs are given according to the intermediation approach by Total Earning Assets (Q1) and by Total Non-interest income (Q2). The prices of the inputs are given by the price of Labor proxied by the ratio of Total Non-Interest Expenses to Total Assets (P1) and the price of funding (P2). Additionally, as in Berger and Mester (1997b), two net-puts (quasi-outputs) are defined – Total Off Balance Sheet Business Volume (Z1) and Common Equity (Z2).

The off – balance sheet items are included primarily to account for the new dimension in international banking. Lately, banks run off-balance sheets larger or equal to their balance sheets. All of the operations, albeit off the balance, are bearing considerable costs and are run at certain risks. That is why accounting for these items seems reasonable and advisable in these instances. Moreover, as in Berger and Mester (1997b) the off-balance sheet items are treated as fixed inputs.

The common equity is included to account for alternative sources of funding. Theoretically the capital is an alternative source of funding, albeit is a very expensive source. It was interesting to include it, primarily to see the impact of the crisis on the banks and determine their shock absorption capacity. However, the common equity does not enter the function directly. It is used as a normalizer. Total costs and all the outputs and net-puts are divided by Common Equity. In this way, scale bias is controlled for and the problem of heteroskedasticity is alleviated to a certain degree.

Although the price of funds was included in the regression, it also does not enter it directly. Rather, it serves as a normalizer too. The price of labor and Total Costs are divided by the price of funds in order to impose homogeneity on the cost function and obey the theoretical assumptions (the approach follows the mainstream in literature and resembles Berger and Mester (1997b))

The alternative profit function uses all of the variables discussed above, the only difference is the dependent variable which is defined as profit and is adjusted to include negative values. The adjustment is done as in Berger and Mester(1997b), i.e. the lowest value of profit for one year is found and then the following formula is applied: $PRO = \ln(\pi + \text{abs}(\min(\pi)) + 1)$. Thus the minimum value for a year for the whole sample of banks is (0) zero. This allows to account for all the negative values in the sample and to discriminate among them.

The standard profit function is a bit more difficult to define in this setting. It includes the prices of outputs rather than the output values. The construction of this function can be viewed in Berger and Mester (1997b). Unfortunately, the lack of some of the necessary information to build this function hampered our initial intention to apply the standard profit function for our sample. We considered a simpler procedure for computing the prices of outputs, but it turned out that such an undertaking does not resemble the necessary theoretical underpinnings. Thus we confine to estimating the cost and alternative profit functions, the summary and the descriptive statistics of all the necessary variables used in the analysis are presented in *Appendix 2-A*. For a detailed descriptive statistics by region inspect *Appendix 3-A*.

4.4. Country level and bank control variables

To let the inefficiencies vary across countries, country level variables are included in the regression. These variables have the task of explaining and alleviating the heterogeneity problem. The choice of variables was primarily determined by the availability of macro data. In order to model the macro-environment in which banks operate the following variables were used.

1.4.4. Country Level Variables

GDP per capita (USD) is used to account primarily for the general economic development of a country (see Fries and Taci (2005)). The variable could also be viewed as a proxy for the general country institutional quality and not the least for the purchasing power and activity of both the physical persons and industrial and commercial entities. The higher GDP per capita

could be associated with lower overall inefficiency levels due to, generally, higher skills and productivity of labor Claessens, Demirguc-Kunt and Huizinga (2001). On the other hand such a conclusion could be hampered by taking into consideration the Balassa-Samuelson effect, and the fact that labor force might be more expensive in high-income countries than in low or medium-income countries.

Inflation level (INF) is another macro-variable included in the regression. It accounts for the general stability of the economy and is a natural choice for such type of analysis. Inflation enables us to distinguish between stressed environments and normal ones. Moreover, the expectation is that inflation might have a negative impact on the level of efficiency of individual banks in particular and on the banking system as a whole. Higher interest expenses of the banks and higher net interest margins could be associated with higher inflation, and further with lower efficiency ratios Grigorian and Manole (2002).

Population (POP) is the number of people from a given country, and the variable is used as a proxy for the business environment in which banks operate. It should approximate the relative density of demand in the countries under scrutiny. It is however a very raw proxy, the more so as many of the banks in the data-sample are internationally active banks, that run operations across countries and regions. Keeping the variable in regression is dictated by the fact that most of the banks in the sample run the biggest share of their businesses in their country of origin. The main descriptive statistics of the country level variables are presented in *Table 4-2*. The statistics shows us that the lowest income state represented in the data-sample has a GDP per capita of only \$216.4 per capita while the highest is \$81163 per capita in 2005.

Table 4-2: Country Level Variables Summary Statistics

Variables	Units	Statistics	2005	2006	2007	2008	2009
GDP	USD per capita	MEAN	18032.98	19645.46	22242.01	24117.52	20374.01
		min	216.404	256.66	350.142	479.716	466.337
		max	81163.03	90198.74	107099.3	119521.3	106550.8
		std. dv.	18986.02	20656.45	23506.45	25598.78	20677.53
INF	Per. change	MEAN	4.926667	5.080679	6.602024	7.180089	3.635652
		min	-0.399	-0.112	0.699	0.393	-6.161
		max	18.53	38.723	28.824	30.9	25.057
		std. dv.	3.893718	5.195646	5.265039	5.9579	4.635811
POP	million people	MEAN	67.58391	68.24602	68.18636	65.85839	67.25987
		min	0.273	0.274	0.275	0.275	0.276

		max	1307.56	1314.48	1321.29	1328.02	1334.74
		std. dv.	191.0132	192.843	193.6469	190.3178	193.0344
Total no. of Observations			84	84	85	90	89

Source: World Economic Outlook Databases, computed by Author

The discrepancy widens from year to year. It is also easy to see that the contraction in mean output was recorded in 2009 as compared to 2008. This happens both for the minimum and maximum values. Another variable, inflation, has an increasing trend for the entire sample up to 2009, when it shrinks from a mean of 7.2% to 3.6%. The minimum value for inflation is attested for 2009 and is -6.2% while the maximum is attested for 2006 and hits 38.7%. These figures indicate rather heterogeneous environments in which banks operate. In order to disentangle the whole complexity of the dataset a closer look will be given to the same statistic disaggregated on different regions that are represented in the sample. *Table 4-3* depicts these statistics.

Table 4-3: Summary Statistics for Country Level Variables by Regions

	Variable	Obs	Mean	Std. Dev.	Min	Max
US	GDP	5	45434.12	1765.974	42680.64	47155.32
	INF	5	2.5168	1.376483	0.701	4.086
	POP	5	301.808	4.476344	296.115	307.374
Japan	GDP	5	36345.09	2389.179	34150.33	39458.72
	INF	5	-0.1364	0.950957	-1.678	0.699
	POP	5	127.6996	0.087082	127.551	127.757
Europe	GDP	158	34665.82	24893.8	1843.51	119521.3
	INF	158	3.800057	3.860164	-2.581	22.337
	POP	158	23.92457	31.44938	0.316	142.8
Middle East	GDP	62	18784.13	20135.55	1282.766	76435.37
	INF	62	7.812984	5.205658	-4.865	22.5
	POP	62	23.0514	28.38825	0.734	76.8
Asia	GDP	82	8962.547	10530.36	216.404	37970.95
	INF	82	6.601378	6.794028	-6.161	38.723
	POP	82	196.7354	397.7826	0.404	1334.74
Latin America	GDP	65	6082.532	2238.891	2142.557	11382.96
	INF	65	6.914631	5.549431	-1.38	30.9
	POP	65	35.75865	52.05177	0.292	191.481
RoW	GDP	55	15607.63	17398.84	344.581	48827.5
	INF	55	5.165273	3.45882	-2.431	15.148
	POP	55	60.10033	88.2097	0.273	307.374

Source: World Economic Outlook Databases, computed by the author

When analyzing the dataset by regions a few interesting things could be pointed out. First, if comparing the GDP per capita except, US and Japan, all the other regions represented in the sample have considerable differences between the lowest and the highest value. The discrepancies are not that high in Europe, Middle East and Latin America, but they are staggering for Asia and for the Rest of the World. In terms of inflation, both the highest and the lowest rates are recorded for Asia – namely the highest rate was in Myanmar in 2006 (38.72%) and the lowest rate (deflation of 6.16%) was in Taiwan in 2009. The USA has a rather stable macro environment with inflation shrinking in the analyzed period from a high of 4.1% to 0.7%. Japan has also an environment of low inflation and periods of deflation. In Latin America, Chile is at one extreme with deflation of -1.38% in 2009 and Venezuela with inflation of 30.8% in 2008 and 25.1% in 2009. Europe resembles the same story with Ireland having a deflation of 2.6% in 2009 and Ukraine posting a 22.3% inflation rate in 2008. Middle East is no exception with a low extreme of -4.9% inflation rates for Qatar in 2009 and a high extreme of 22.5% for Iran in 2007.

2.4.4. Bank Control Variables

To let the inefficiencies vary across banks, with different liquidity and risk profiles as well as different cost profiles, from different competitive environments and forms of ownership, bank level control variables are introduced. The following six variables are used.

The net interest margin (NIM), is primarily used as a proxy for determining the market power of the banks. Institutions that can operate on high net interest margins usually face a less competitive and less risky environment, where they can impose their prices both for the resources they procure and for the services they provide. The intuition is that such banks, although might have rather high profits and stable market shares, might in the same time use all the resources under their control in an inefficient manner and thus have systematically higher levels of cost and profit inefficiencies.

The Cost to Income ratio is the second covariate used in the regression. As such this ratio was used in analyzing the determinants of inefficiency in banking and in comparing savings banks, conglomerates and universal banks in Europe in Vennet (2002). The author and banking experts treat the variable as a main indicator of efficiency in banking. Whether it resembles in any way the ranking of efficiency of banks from a frontier remains to be investigated. The main reason for its inclusion remains the differentiation between banks with

different cost profiles. Another proximate measure of this ratio was used in Berger and Mester (1997) where the authors find that banks with higher costs have lower cost inefficiencies.

The liquidity ratio (LIQ) defined as the ratio between total liquid assets and total debt and borrowing, is used as a control for the allocative efficiency of a bank. It also proxies the risk profile of a bank. The higher the liquidity ratio of a bank, the lower its cost and profit efficiency ratios have to be. It is well acknowledged in the literature that high liquidity of a bank is assured at a high opportunity cost. Many profitable and high yielding projects might be foregone for the safety of a high level of inflation. This ratio has not been used in the literature as a covariate for the inefficiency terms.

The return on average capital and average assets (ROAE and ROAA, respectively) are another two covariates included in the analysis. Both ROAE and ROAA are measures of bank performance and thus higher ratios should mean lower inefficiency rates (see Berger and Mester (1997b), Fries and Taci (2005) and Pastor, Perez and Quesada (1998)).

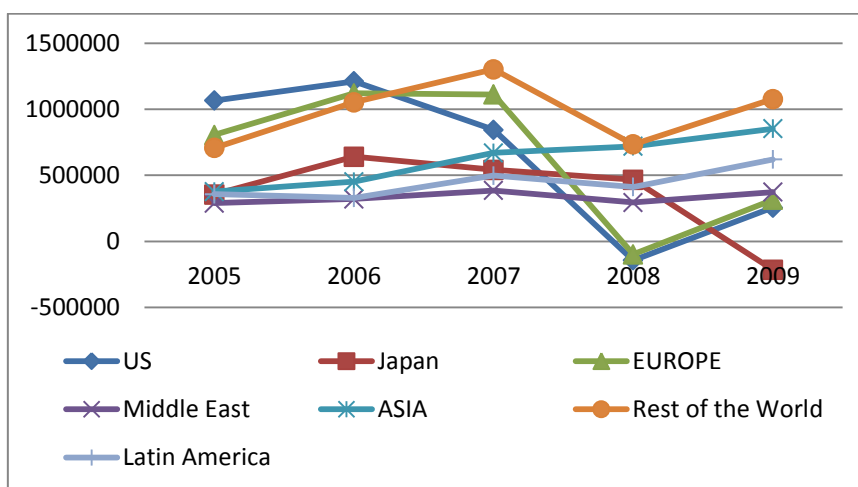
To control for the effect of the ownership on the performance of a bank, a dummy variable is defined. It takes a value of 1 if the government owns more than 50% of the bank and is 0 if the bank is privately owned. In this way we distinguish between two large groups of banks. The first group, owned by the government is believed to have lower costs as the publically owned companies do usually have lower salaries than the private sector. At the same time this does not necessarily mean that these banks have higher inefficiency ratios. The findings in the literature are mixed, Bonin, Hasan and Wachtel (2005) find no significant impact of the ownership type, private or government owned, on the efficiency of banks from a sample of transition economies. On the other hand Pasiouras (2008), on a sample of 715 representing 95 countries in a two-stage DEA framework, finds that government ownership is associated with higher inefficiencies.

5.4. Preliminary analysis of the banking data

To grasp the main dynamic changes in the banking data from 2005 to 2009 for the whole sample of banks and for the separate regions, a preliminary analysis will be performed. It also should indicate on the possible problems one might encounter while estimating the model. The evolution of total costs, profits and earning assets as well as performance and liquidity indicators will be analyzed and discussed.

When analyzing the evolution of the banks for the past five years the first conclusion one can infer is that the 2007 credit crunch had a sizeable impact on most of the banks around the world. While deciphering the individual stories of each bank is out of the scope of the thesis, the regional developments are interesting to inspect. Thus inspecting for the evolution of profits, *Figure 4-3*, a few trends can be distinguished. While Europe and the US experienced a drastic shrinkage in banking profits in 2008 compared to 2007, Asia and Latin America had steady or even increasing profits.

Figure 4-3: Profit Evolution by Regions 2005-2009

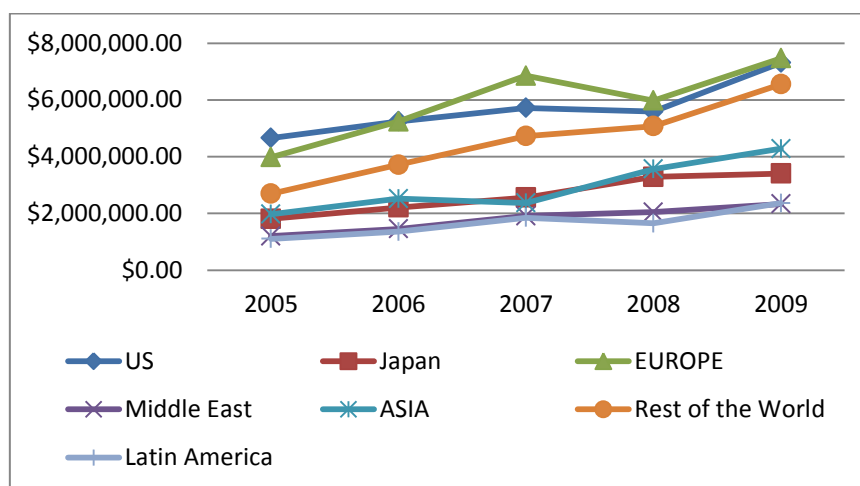


Source: Compiled by Author using Bankscope data

The only exception from these two general trends is the Japanese story. The average profits for the Japanese banks have been falling steadily starting in 2006 and throughout the whole period accelerating in 2009.

Another important development during and after the crisis was the tremendous amount of capitalization of the banking systems around the globe. The story is mainly valid for the US and for the European banks (see *Figure 4-4*).

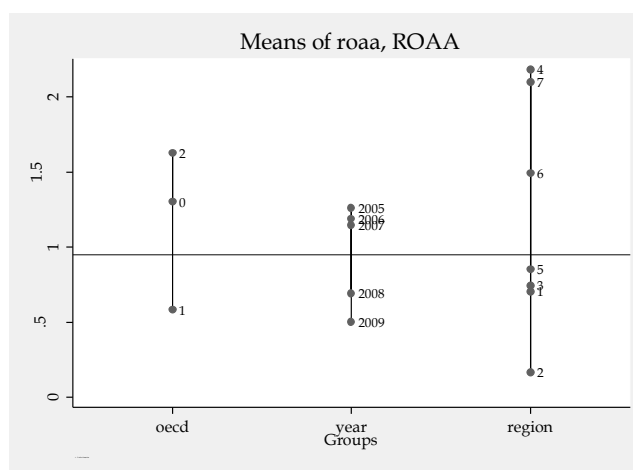
Figure 4-4: Mean Equity Evolution 2005-2009



Source: Compiled by Author using Bankscope data

Banks in other regions of the world mainly preserved the average capital figures at the pre-crisis levels. The only noticeable region which steadily increased the average banking capital was Asia. The lowest averages for the capital held by banks before and after the crisis remain in Middle East and Latin America. This figure is actually an indication of the regional placements of the behemoths of the industry. The US, European and fast growing Asian (mainly Chinese) banks are the leading companies in terms of capital.

Figure 4-5: Means of ROAA by Groups



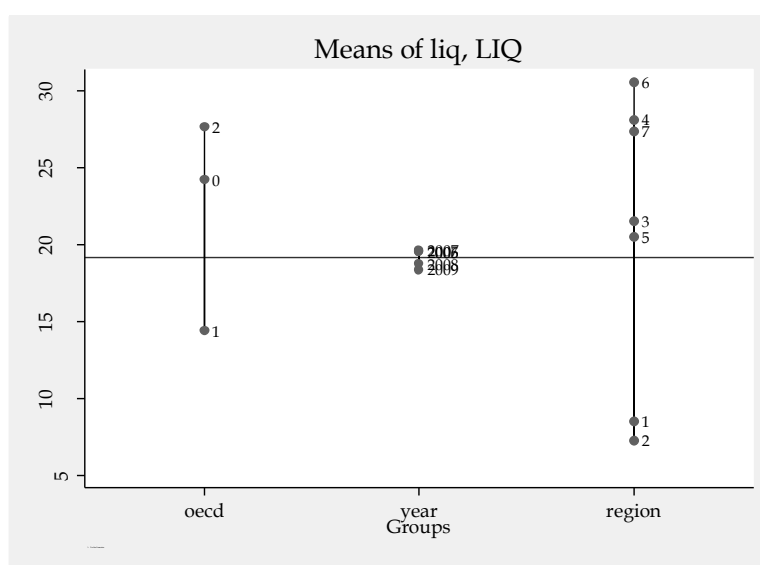
Source: Author's representation using Bankscope data

In terms of performance as measured by the ROAA the following general tendencies can be attested. *Figure 4-5* depicts the means of the ROAA for three distinct groups. The first is a division of the countries in OECD members, BRIC countries and the rest of the world. Thus for OECD group, 1-are the OECD countries represented in the sample, 0- BRIC countries and 2- The Rest of the World countries. For the group year, yeach year, 2005 to 2009 represents

the cross-section sample for the entire dataset. Finally the group "region" is defined as follows: 1-US; 2-Japan, 3- Europe, 4- Middle East, 5- Asia, 6- Latin America and 7- Rest of the World.

Thus, when analyzing the first group, it is obvious that banks from the OECD countries have lower average performance for the 2005 – 2009 period compared to their counterparts from BRIC and the rest of the world. When inspecting the yearly performance of the whole sample, an obvious conclusion surfaces. The worst years in terms of banking performance are the crisis years of 2008 and 2009 while the best was 2005. By regions emerges another interesting picture. Apparently the best performing banks in the analyzed periods were in Latin America and Middle East while the worst were in Japan with the US and European banks being relatively equal in terms of returns on average assets. Asian banks fare a bit better than the US, European and Japanese counterparts but still have an average ROAA for the 2005-2009 period below 1%.

Figure 4-6: Means of Liquidity by Groups



Source: Compiled by Author using Bankscope data

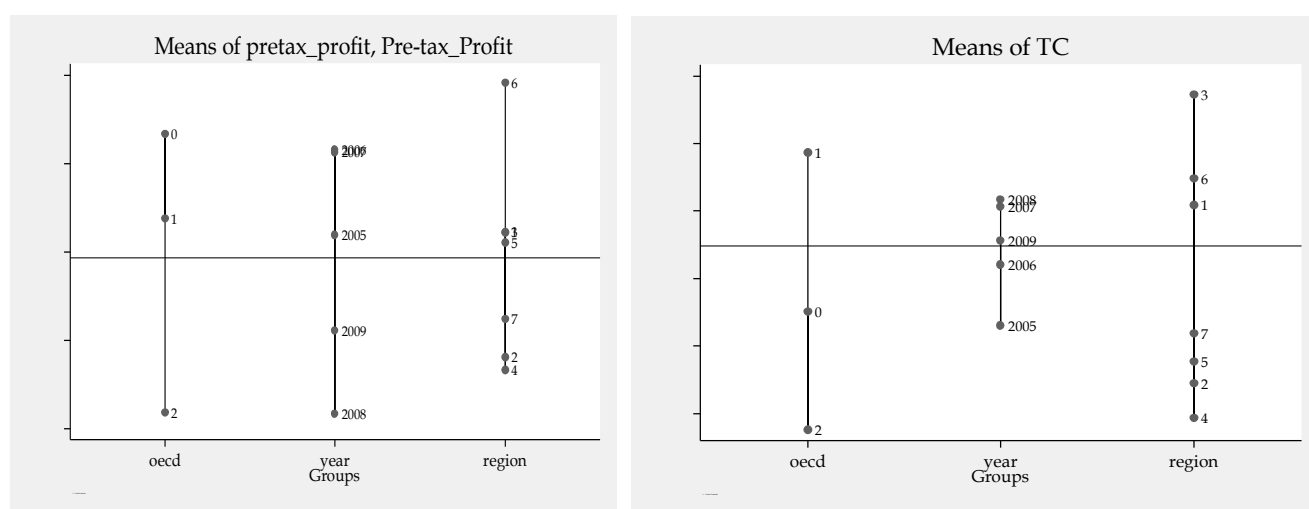
In terms of liquidity (*Figure 4-6*), the BRIC countries attain a level of 24% for the analyzed period while the mean for the OECD countries was around 15%.²¹ The crisis had an impact on the liquidity as well. The year 2007 was on average the most liquid year for the international banking system while 2009 proved to be on the other extreme. However the difference between the averages of liquidity are not significantly different. The regional

²¹ We define the liquidity ratio the ratio of total liquid assets to deposits and short term funding.

distribution of liquidity in the banking sector is quite interesting. Three groups of banking systems can be distinguished. Low liquidity systems (the US and Japanese), with averages for the liquidity ratio between 5-10%; Medium liquid systems (Europe and Asia), with averages between 20-25%; and high liquidity systems (Latin America and Middle East) with averages between 25-30%.

The last variables inspected are the total cost and pre-tax profits. It is of prime interest to inspect these two variables to get a clear picture of how banks behaved during the crisis in terms of cost management and in terms of their overall resilience to the crisis and capacity to generate profits in distress time. This should also clarify the latter results we may find when computing the cost and profit inefficiency ratios.

Figure 4-7: Means of Total Costs and Pre-tax Profits by Groups



Source: Computed by Author using Bankscope data

Investigating the mean value of total costs a rather complex picture emerges (Figure 4-7). Some unique pattern is hard to identify. The OECD countries' banking systems have on average higher total costs than BRICs and the rest of the world (\$5 bn on average compared to only \$2.5 bn). The yearly data on the whole banking system is revealing an gradual increase in the total costs on a yearly basis up till 2008, when an average of approximately \$4.3 bn was recorded, and then it slumped in 2009 to an average of \$3.5 bn. As for the regions, the highest average was recorded for European banks (\$6.8 bn. approximately) while on the other extreme with less than \$1 bn. the Middle Eastern banks reported. Japanese, Asian and Latin American

banks all have averages lower than the sample average, while the US based banks recorded an average of approximately \$4 bn. for the period.

In terms of profit, *Figure 4-7*, the most profitable there seem to be, on average, the BRIC banks. Yearly, the worst for the international banking sector was 2008, while the most profitable were 2006 and 2007. In 2009 the banks recovered, in big part from a disastrous 2008 year. Regionally, Middle Eastern and Japanese recorded rather low profits for the period, while on the other extreme banks from Africa, Australia and Oceania emerged as highly profitable. Asian, European and the US banks were close to the whole sample averages.

The uncovered patterns are encouraging from at least a few perspectives. It seems that the crisis did not have an equal impact on banks from different regions and so it may be reasonable to suppose that the inefficiency scores of banks from different regions were also asymmetrically affected. The profitability, although decreased drastically during 2008, recovered substantially in 2009, with the only problematic region left – Japan. In terms of costs, the banks were able to contain them at reasonable levels and decrease them in 2009 as compared to 2008. Thus, technically speaking it can be concluded that the world banking system has overcome the crisis and is already ahead the curve with countries and world economy still lagging behind. What can not be inferred from the information presented above is the story of particular banks and their individual performance. But a closer look will be given to this matter in the next Chapter when the results of the models will be discussed.

CHAPTER 5

Results

Following the methodology in Chapter 2, in this, fifth, chapter the results and the main inferences are presented. The SFA technique was used, both on an unbalanced panel of banks and on cross-sections, to determine the main rankings of the world banks in terms of cost and profit efficiency. Comparisons of banking efficiency are undertaken on different groups of banks and the rankings of the banks from our analysis are compared to the rankings from the "Top 1000 World Banks". The ranking correlation between cost and profit efficiency is also undertaken. The structure of the chapter is determined by the three hypotheses that we investigate.

The estimation was done using *NLOGIT 4.0*, software developed by Professor William Greene from Stern Business School of New York, which includes frontier models and allows for a wide range of estimation possibilities.

1.5. Panel Estimation of the Cost Frontier

1.5.1. Regression Results

A trans-logarithmic cost function for an unbalanced panel is specified and estimated using Stochastic Frontier Analysis model.²² The specification assumes a half-normal distribution for the inefficiency term, time invariant. The function to be estimated is represented by equation 3.12. Unfortunately, given the normalization of the inputs and outputs as well as of the total costs using total equity and the price of funds, although we obtain a function which is homogenous in prices and is not susceptible to the scale bias, we lose the straight forward economic interpretation of the model. In *Table 5-1* the results of the Limited Dependent Variable Model from the SFA are presented. The elasticity terms do not represent a big interest for our case. But a few comments on the results will luckily ensure a better understanding of the individual inefficiencies of the sample of banks, mostly in the context of regional and country differences, but also when individual banks are compared among each other. An important remark before proceeding to the analysis of the results is that the

²² The use of a trans-logarithmic form was justified, except the already mentioned flexible form, by its diagnostic and comparison with the Cobb-Douglass specification. Both for the profit function and for the cost function the logarithmic form proved to yield higher log-likelihood ratios than the Cobb-Douglass. Nevertheless, except higher individual ratios, both models predict the same rankings of the individual firms according to the inefficiencies, and thus the preference for either of them is given by the diagnostics of the model (log-likelihood or Akaike criterion).

estimation was done on the 2005-2009 period, which is a rather peculiar and interesting age for the banking industry worldwide.

The most enticing part of the results pertains to the significance and signs of the environmental variable and bank control variable coefficients. First finding is that GDP per capita, the coefficient is negative and minute, has no significant effect on the costs of banks. Inflation, on the other hand, is positive and significant at 1% level.

Table 5-1: Stochastic Cost Frontier Model

TC	Coefficient	Standard Error	z	Prob. z >Z*	95% Confidence Interval	
Primary Index Equation for Model						
Q1	.11756***	.01033	11.38	.0000	.09731	.13781
Q2	.01043***	.00293	3.56	.0004	.00469	.01617
P1	.61509***	.00331	185.74	.0000	.60860	.62158
Z1	1.10408*	.01071	103.12	.0526	1.08309	1.12506
SQ1	.09474***	.00795	11.92	.0000	.07917	.11031
SQ2	-.01013	.00052	-19.46	.3246	-.01116	-.00911
SP1	.07023***	.00031	227.72	.0000	.06963	.07084
SZ1	-.35023***	.00396	-88.40	.0000	-.35799	-.34246
Q2Q1	-.07250***	.00338	-21.45	.0000	-.07912	-.06587
Q1P1	.05146***	.00185	27.89	.0000	.04784	.05508
Q2P1	-.00220***	.00046	-4.74	.0000	-.00310	-.00129
Q1Z1	.11039***	.00547	20.19	.0000	.09968	.12111
Q2Z1	.05401***	.00353	15.29	.0000	.04709	.06093
P1Z1	-.07581***	.00201	-37.79	.0000	-.07974	-.07187
NIM	.00687***	.00039	17.52	.0000	.00611	.00764
CIR	.00010**	.4590D-04	2.18	.0290	.00001	.00019
LIQ	.00029***	.7055D-04	4.12	.0000	.00015	.00043
ROAA	-.00604***	.00093	-6.50	.0000	-.00786	-.00422
ROAE	.00028***	.7901D-04	3.50	.0005	.00012	.00043
GDP	-.47830D-07	.1271D-06	-.38	.7066	-.29686D-06	.20121D-06
INF	.00346***	.00033	10.41	.0000	.00280	.00411
POP	.21808D-04***	.6137D-05	3.55	.0004	.97799D-05	.33835D-04
GOV	-.21094***	.01076	-19.61	.0000	-.23202	-.18986
Variance parameters for compound error						
Lambda	4.54385***	.34652	13.11	.0000	3.86469	5.22302
Sigma (u)	.30998***	.01059	29.28	.0000	.28923	.33073

Note: nnnnn.D-xx or D+xx => multiply by 10 to -xx or +xx.

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

Source: NLOGIT 4.0 output for COST FRONTIER

The number of people of the country in which the bank carries out its operations is also significant at 1% level and has a positive sign. This means that the costs of banks which operate in countries with a higher number of populations incur more costs to service them. This might be true, although the minute coefficient indicates that we could disregard it or try to find a better proxy for the demand of banking services. An interesting result is that the dummy for the ownership structure yields a negative and significant sign. This could mean

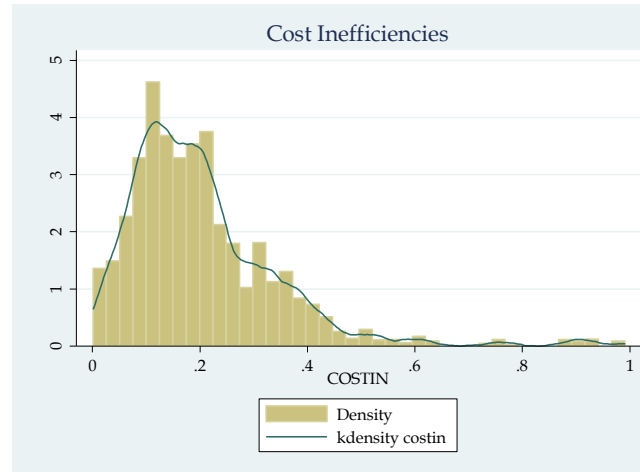
that government owned banks have on average lower costs, and thus lower inefficiency ratios. This finding, albeit not entirely intuitive, could be explained at least from a few different viewpoints. First, we might indeed think of the government owned banks as more constrained in their spending behavior, with lower salaries of the personnel, lower spending for the banking infrastructure in general and thus lower, on average, costs than the privately owned banks. On the other hand, we investigate the 2005-2009 era, when during the days of turmoil and distress many banks have been salvaged by their countries' governments and thus became majority government owned. To account for the transfer of technology, and thus lower costs and inefficiencies from the private to the public sector, is not the goal of the paper and is not feasible in the current setting so we confine to presenting the result, leaving the subject for future scrutiny.

The bank control variables are all significant at a 1% level (except CIR which is significant at 5%) and yield the expected signs except ROAA and NIM. The sign of ROAA is predicted to be negative, which is counter-intuitive. This result shows that banks with higher efficiencies under the frontier do not necessarily exhibit the same high performance ratio when compared to its peers. The NIM sign on the other hand might indicate that banks that have a higher net interest margin face lower levels of competition and are more negligent in terms of spending. The LIQ has the expected positive sign and is significant at 1% level, banks with higher liquidity incurring higher costs. The variance parameters of the compound error term are both significant which means that the inefficiencies are significant and should be kept in the model.

2.5.1. Cost Inefficiencies, Bank Rankings and Bank Size

To get a general picture of the main inefficiencies estimated for the sample we plot the histogram and fit a Kernel density function.. The plot of the histogram is given in *Figure 5-1*. The highest density of inefficiencies is around the 0.08-0.25 values. Most of the banks being situated in that range. The figure also indicates that there are some banks that perform poorly and have cost inefficiencies higher than 60% with some of them attaining, under the unique cost frontier, inefficiencies close to 100%. The mean value of cost inefficiency for the entire sample for 2008 is 20.45% with the minimum being 1.28% and the maximum reaching 99.13% (see *Appendix 4-A*). Thus we can infer that the most efficient bank can improve its efficiency with 1.28 percentage points, while the most inefficient of the banks has a scope of efficiency improvement of about 99 percentage points.

Figure 5-1: Cost Inefficiencies Histogram and Kernel Density



Source: Computed by author

Of high interest for us remains to determine whether there is any statistically significant relation between the size of the bank and its cost inefficiency. Specifically, the question is whether bigger banks enjoy higher rates of cost efficiency than smaller banks. To do this we use the Spearman rank correlation coefficient as proposed in Spearman (1904).

Spearman's rank correlation is a measure of the monotonic relationship between two variables. This correlation is given by:

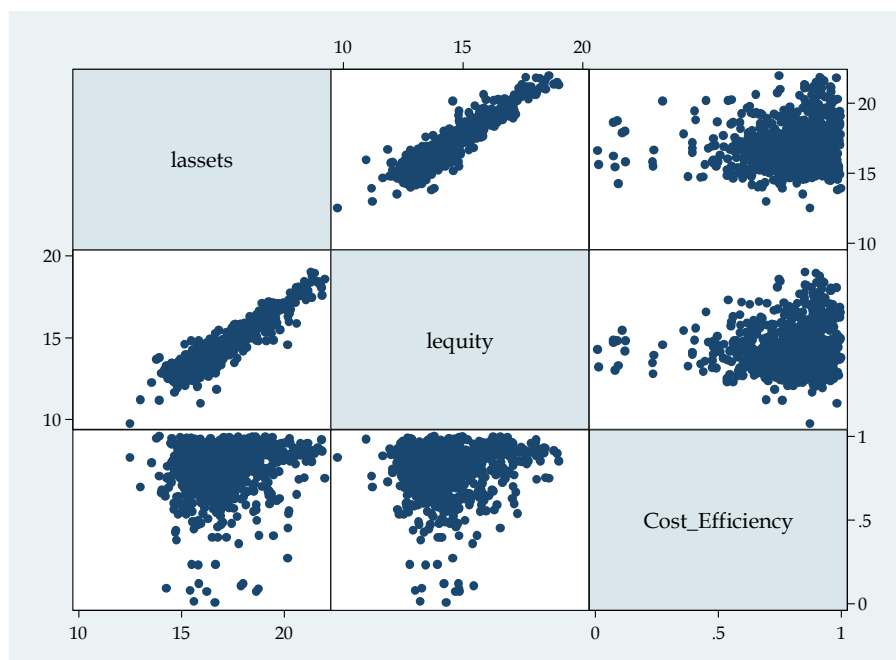
$$\rho = 1 - \frac{6 \cdot d_i^2}{n(n^2 - 1)} \quad \text{Equation 5-1}$$

where d_i is the difference between the ranks of observations from the inspected variables; n is the length of the variables and ρ is the Spearman's correlation ($\rho \in [-1; 1]$).

In order to determine whether there is any relation between the efficiency of a bank and its size we estimate the Spearman's rank correlation between the value of equity of a bank and its cost efficiency and then we do the same estimation but we use instead of equity the total assets of a bank as this can be considered a more appropriate measure of the size of the bank. For the first measure we obtain a $\rho=6.94\%$ significant at 5% level. At 1% level we accept the null – "equity and cost efficiency are independent". In other words, there is little or no dependence between the size of the bank, as measured by the volume of equity, and its cost efficiency ratio. Spearman's rank correlation between Total assets and cost efficiency is 11.39% and this time its significant at 1% level. But ρ is too small for us to conclude that there is a monotonic relation between cost efficiency and the size of the bank as given by its

Total Assets. The weak dependency between the size of the bank and its cost efficiency can also be seen in the graph below (Figure 5-2)²³.

Figure 5-2: Scatterplot Matrix for Cost Inefficiency and Size of the Bank



Source: Author's computations

This inconclusive results find some suport in the literature as well. In Berger and Mester (1997b) the authors find inconclusive relationship between the size of the bank and their cost efficiency for a sample of US banks for 1980s. But differences appear during the 1990s, with smaller banks being more efficient. In Rossi, Schwaiger and Winkler (2008) the authors also find evidence that size matters, and that bigger banks have somewhat higher cost efficiency ratios than small banks. If we use the same procedure as mainly used in the literature and split the whole sample in two subsamples which we label "Big" and "Small". The subsamples are created by just splitting the group in two parts, the big banks being those who have total assets bigger than the average and the smaller the remaining. If we compute the average inefficiency scores then we indeed find that for the "Big banks" it amounts to 17.84% while for the "Small banks" it reaches 20.89%²⁴. The differnce is about 305 percentage points. So conventionaly, depending on the technique we use, we can say that bigger banks have a higher cost efficiency (see also Kumbhakar and Tsionas (2002)) by exploting economies of scale.

²³ We plot log of Total Assets and Total Equity against Cost Efficiency (1-Cost Inefficiency)

²⁴ The sample of big banks is represented by 140 banks while the small banks group is represented by 814 banks

We do however employ the Spearman's Rank correlation technique for other subsamples – regions, OECD and by type of property. The findings are summarized in the *Table 5-2*. For different countries and different regions the relationship between bank's ranking according to the size of equity and assets with that of cost efficiency is rather different and has no discernable pattern. The US banks for instance have a negative relationship for both cases, however, for assets it is insignificant. Japan banks, on the other hand, have a rather strong dependence between the rank of the bank as determined by size and its rank as determined by cost efficiency. Russian big banks have poor performance when compared to their smaller peers.

Table 5-2: Cost Efficiency Spearman's Rank Correlation

REGION	Variables	Spearman's rho	REGION	Variables	Spearman's rho
US	Equity vs. CE	-17.11% (0.0376)	BRIC	Equity vs. CE	-5.35% (0.5394)
	Tassets vs. CE	-5.4% (0.5143)		Tassets vs. CE	3.82% (0.6608)
Japan	Equity vs. CE	42.39% (0.0000)	OECD	Equity vs. CE	11.18% (0.0075)
	Tassets vs. CE	43.67% (0.0000)		Tassets vs. CE	13.73% (0.0010)
Europe	Equity vs. CE	6.46% (0.2579)	Rest of the World	Equity vs. CE	12.14% (0.0551)
	Tassets vs. CE	13.8% (0.0152)		Tassets vs. CE	13.63% (0.0312)
Middle East	Equity vs. CE	1.24% (0.9004)	BRASIL	Equity vs. CE	34.55% (0.3282)
	Tassets vs. CE	-7.52% (0.4457)		Tassets vs. CE	24.85% (0.4888)
Asia	Equity vs. CE	2.81% (0.6979)	RUSSIA	Equity vs. CE	-45.19% (0.0397)
	Tassets vs. CE	14.40% (0.0457)		Tassets vs. CE	-42.47% (0.0550)
Latin America	Equity vs. CE	13.05% (0.3984)	INDIA	Equity vs. CE	-1.18% (0.9507)
	Tassets vs. CE	17.9% (0.2450)		Tassets vs. CE	-9.45% (0.6192)
Rest of the World	Equity vs. CE	34.3% (0.0104)	CHINA	Equity vs. CE	16.23% (0.1828)
	Tassets vs. CE	32.29% (0.0162)		Tassets vs. CE	33.88% (0.0044)
Note: In brackets we included the P-values for H0: "There is no dependence between two series"					

Source: Computed by Author

Chinese banks have a positive dependence between the rank of the banks, as measured by Total Assets, and their rank given by their cost efficiency scores. When assessed according to the type of ownership we once again find very low Spearman's correlation values (12.16% and 18.42% by Equity and Total Assets respectively for privately owned banks). So generally speaking, there is a timid tendency for privately owned banks that have a higher ranking in terms of assets or equity to have a higher cost efficiency ratio. The same tendency is attested for the government owned banks (19.4% for equity rankings and 15.93% for asset rankings) but the correlations are significant at a 5% and 10% respectively as compared to 1% level significance for the correlations of privately owned banks.

2.5. Panel Estimation of the Profit Frontier

1.5.2. Regression Results

For the estimation of the profit function for our sample of banks for the 2005-2009 period we undertake the same steps as described for the cost function. The only difference is that on the left-hand side of the equation we substitute natural log of normalized costs with natural log of normalized profits before-tax.

The estimation results are presented in *Table 5-3*. This output has some interesting outcomes.

Table 5-3: Stochastic Production Frontier Model

		Standard		Prob.	95% Confidence	
PRO	Coefficient	Error	z	z >Z*	Interval	
-----+-----						
	Primary Index Equation for Model					
Q1	-.41078***	.13036	-3.15	.0016	-.66629	-.15527
QA	-.36009***	.02179	-16.53	.0000	-.40280	-.31739
P1	.79096***	.02699	29.31	.0000	.73807	.84386
Z1	1.70001***	.12274	13.85	.0000	1.45944	1.94058
SQ1	.31131***	.09220	3.38	.0007	.13059	.49203
SQA	-.04341***	.00545	-7.97	.0000	-.05408	-.03274
QAQ1	-.14984***	.02771	-5.41	.0000	-.20415	-.09553
SP1	.05154***	.00203	25.36	.0000	.04756	.05552
Q1P1	.31489***	.02227	14.14	.0000	.27125	.35853
QAP1	.01838***	.00407	4.52	.0000	.01041	.02635
SZ1	-.37915***	.07638	-4.96	.0000	-.52885	-.22946
P1Z1	-.26973***	.02376	-11.35	.0000	-.31629	-.22317
Q1Z1	.00635	.07565	.08	.9331	-.14192	.15463
QAZ1	.21632***	.02746	7.88	.0000	.16250	.27014
NIM	.00486	.00365	1.33	.1822	-.00228	.01201
CIR	-.01745***	.8101D-04	-215.46	.0000	-.01761	-.01729
LIQ	-.00012	.00040	-.29	.7690	-.00091	.00067
ROAA	.12212***	.00416	29.33	.0000	.11396	.13029
ROAE	.00250***	.00030	8.26	.0000	.00191	.00310
GDP	-.28531D-05***	.5895D-06	-4.84	.0000	-.40D-05	-.16D-05
INF	-.00368*	.00197	-1.87	.0614	-.00753	.00018

POP	.00015***	.3298D-04	4.63	.0000	.00009	.00022
GOV	-.00617	.02715	-.23	.8203	-.05938	.04705
Variance parameters for compound error						
Lambda	.96309***	.03364	28.63	.0000	.89715	1.02902
Sigma (u)	.40817***	.01329	30.72	.0000	.38213	.43422

-----+-----
Note: nnnnn.D-xx or D+xx => multiply by 10 to -xx or +xx.

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

Source: NLOGIT 4.0 output for PROFIT FRONTIER

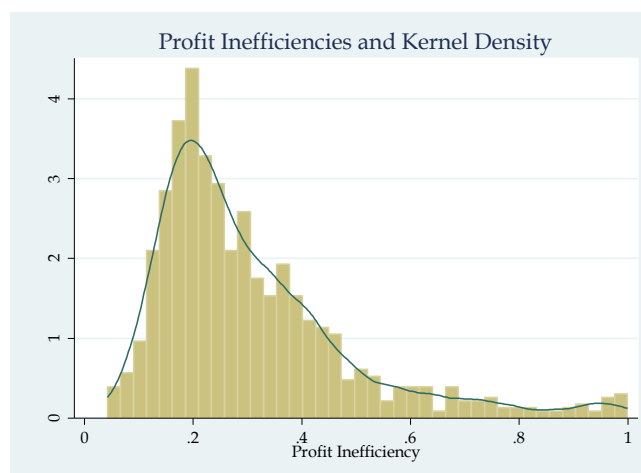
Liquidity, net interest margin and the dummy variable for the ownership type are all insignificant. Both ROAE and ROAA have the expected signs and are significant at 1%. Population is significant and has a positive impact on the profit of banks, which is again intuitive. Cost to income ratio is negative and significant and GDP per capita is negative and significant although it has a minute coefficient. This is an interesting finding from at least two perspectives. First it indicates that banks from higher income countries had lower levels of profit for the 2005-2009 period as compared to their counterparts from lower-income countries. On the other hand, it might serve as a valid indication of the fact that banks from the developed countries were susceptible and had to suffer the most during the crises due to their more direct exposure to the credit crunch. The inefficiency term "Sigma (u)" is highly significant, and thus the predicted inefficiencies are to be considered as such.

2.5.2. Profit Inefficiencies, Bank Rankings and Bank Size

The predicted mean alternative profit inefficiency for the whole sample for 2008 reaches 30.87% and is higher than the mean cost inefficiency for the same year. This finding is in line with most of the studies in this area (see Berger and Mester (1997b), Maudos, et al. (1999), Vennet (2002), Kumbhakar and Tsionas (2002) and others). Most of these papers find profit inefficiencies around or higher than 30%. The comparability of our results with other results is hampered by the rather peculiar dataset we employ and a very recent period that we investigate.

The 20% profit inefficiency is the highest frequency found in the sample (*Figure 5-3*). There are also banks that exhibit complete inefficiency under this frontier. The lowest profit inefficiency is around 4% which means that 4% of the profit is given up to inefficiency (see *Appendix 4-A*). The highest inefficiency rate is 99.96% and in this case the bank has serious misallocation problems, or it might be the case of that the bank is a victim of the credit crunch, in which case it is more of an outcome of "bad luck" than mismanagement. Our intuition is that both, bad luck and mismanagement played an equal role for some of the banks for the 2005-2009 era.

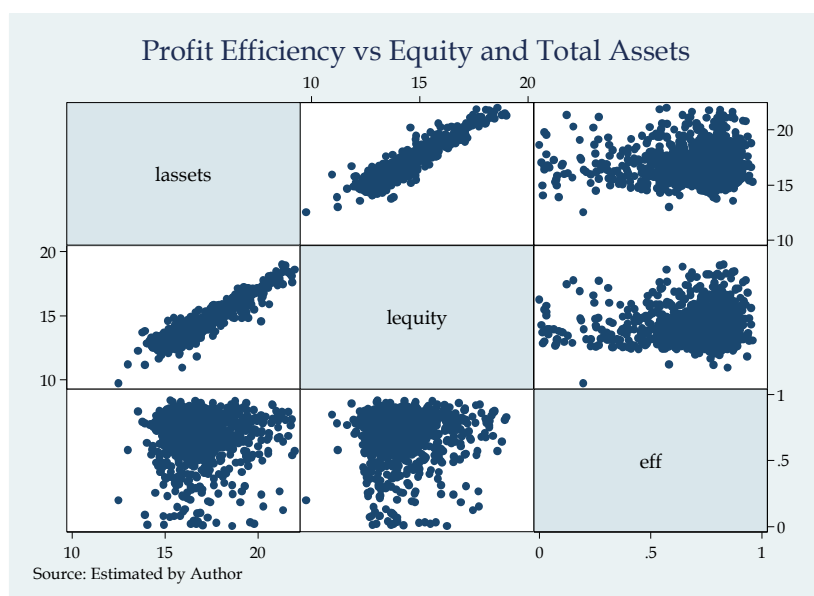
Figure 5-3: Profit Inefficiencies and Kernel Density



Source: Computed by Author

Spearman's rank correlation is computed as in the case of cost inefficiencies for profit inefficiencies. As in the previous case, for cost efficiency, for profit efficiency the correlation between the ranks of the banks as measured by total assets and equity and rank as given by the profit efficiency ratio are very low. For the rank of equity it is 7.72% and is significant at 5% level. For Total Assets measure the correlation is even lower, at 4.39% and is insignificant. The scatterplot, *Figure 5-4*, is indicative of the very low dependency between the value of the assets and the efficiency score as well as between the value of the equity of a bank and its efficiency score.

Figure 5-4: Profit Efficiency vs. Equity and Total Assets



Source: Estimated by Author

The Spearman's rank correlation coefficient between cost and profit inefficiency is also very low, negative and insignificant. This result is somewhat puzzling as we expected a positive and significant relationship as in Fries and Taci (2005) or Berger and Mester (1997b). A possible explanation for this might be the fact that cost efficiency is an outcome of managerial performance while profit efficiency is in big part determined by the revenue side which is more susceptible to shocks and uncontrolled factors. Our intuition is that, by investigating a crisis period such an outcome is plausible. Furthermore this outcome might also be plausible in the context in which we deal with banks from very different business cultures and as such many of them might be "lucky" enough to generate high profits but be "ungainly" in managing their costs as this requires more skills and abilities.

Table 5-4: Profit Efficiency Spearman's Rank

<i>REGION</i>	<i>Variables</i>	<i>Spearman's rho</i>	<i>REGION</i>	<i>Variables</i>	<i>Spearman's rho</i>
<i>US</i>	<i>Equity vs. PE</i>	6.17% (0.4565)	<i>BRIC</i>	<i>Equity vs. PE</i>	-17.29% (0.0458)
	<i>CE vs. PE</i>	-9.54 (0.2486)		<i>CE vs. PE</i>	14.64% (0.0913)
	<i>Tassets vs. PE</i>	5.54% (0.5037)		<i>Tassets vs. PE</i>	-10.52% (0.2266)
<i>Japan</i>	<i>Equity vs. PE</i>	44.62% (0.0000)	<i>OECD</i>	<i>Equity vs. PE</i>	6.63% (0.1139)
	<i>CE vs. PE</i>	29.74% (0.0027)		<i>CE vs. PE</i>	-12.12 (0.0038)
	<i>Tassets vs. PE</i>	46.21% (0.0000)		<i>Tassets vs. PE</i>	4.55% (0.2780)
<i>Europe</i>	<i>Equity vs. PE</i>	1.22% (0.8303)	<i>Rest of the World</i>	<i>Equity vs. PE</i>	29.22% (0.0000)
	<i>CE vs. PE</i>	-12.72% (0.0253)		<i>CE vs. PE</i>	-3.80% (0.5503)
	<i>Tassets vs. PE</i>	1.05% (0.8542)		<i>Tassets vs. PE</i>	24.88% (0.0001)
<i>Middle East</i>	<i>Equity vs. PE</i>	16.12% (0.1004)	<i>BRASIL</i>	<i>Equity vs. PE</i>	22.42% (0.5334)
	<i>CE vs. PE</i>	-10.26 (0.2975)		<i>CE vs. PE</i>	-33.33 (0.3466)
	<i>Tassets vs. PE</i>	4.98% (0.6138)		<i>Tassets vs. PE</i>	34.55% (0.3282)
<i>Asia</i>	<i>Equity vs. PE</i>	7.19% (0.3204)	<i>RUSSIA</i>	<i>Equity vs. PE</i>	-1.43% (0.9510)
	<i>CE vs. PE</i>	12.12% (0.0930)		<i>CE vs. PE</i>	13.38% (0.5632)
	<i>Tassets vs. PE</i>	6.69% (0.3551)		<i>Tassets vs. PE</i>	-6.75% (0.7712)

Latin America	Equity vs. PE	5.51% (0.7194)	INDIA	Equity vs. PE	-7.05% (0.7111)
	CE vs. PE	-49.84% (0.0005)		CE vs. PE	-34.10 (0.0651)
	Tassets vs. PE	-2.27% (0.8825)		Tassets vs. PE	-11.01% (0.5624)
Rest of the World	Equity vs. PE	-5.16% (0.7107)	CHINA	Equity vs. PE	-12.78% (0.2954)
	CE vs. PE	-14.95% (0.2805)		CE vs. PE	10.47% (0.3918)
	Tassets vs. PE	-6.85% (0.6226)		Tassets vs. PE	-1.26% (0.8923)

Source: Author's computations

Table 5-4 shows the Spearman's rank correlations computed for each region separately. As in the case of cost efficiency, the only banking system which has a rather predictable and intuitive behavior is the Japanese one. It has a very high correlation between the rankings of cost and profit efficiency as well. Latin American banks have a negative correlation between cost efficiency rankings and profit efficiency rankings, which means that banks with higher cost efficiency have lower profit efficiency.

If we split our sample in two groups, "Big" banks and "Small" banks and estimate the average profit inefficiency scores we find that big banks have on average – 30.90% profit inefficiency and the small banks have 30.86% inefficiency. The difference is minute and inconclusive to whether it pays-out to run bigger scales of production or not. Table 5-5 summarizes the means of cost and profit inefficiencies by regions.

Table 5-5: Cost and Profit Inefficiency by Size

REGION	COST INEFFICIENCY		PROFIT INEFFICIENCY	
	BIG	SMALL	BIG	SMALL
US	21.14%	22.00%	29.43%	28.98%
Japan	19.29%	24.92%	13.95%	33.42%
EUROPE	17.41%	19.96%	35.76%	31.68%
MIDDLE EAST	23.43%	24.35%	31.13%	29.24%
ASIA	14.07%	17.77%	25.83%	28.84%
LATIN AMERICA	10.16%	26.05%	45.79%	37.78%
OECD	17.82%	20.46%	31.50%	31.91%
BRIC	12.52%	17.18%	30.92%	32.20%
RoW	9.11%	18.97%	32.55%	31.20%
TOTAL Sample	17.84%	20.89%	30.90%	30.86%

Source: Compiled by the Author

I would put here some subtitle as conclusion or something – otherwise the reader gets lost in the text. I guess this is the main part = the result of testing of hypothesis number one.

3.5.2. Final Remarks

In terms of cost efficiency it definitely pays out to be "BIG" irrespective of your country or region of origin. All the big banks in the sample enjoy lower inefficiency ratios than their smaller counterparts. While for the US, Europe and Middle East the differences are rather insignificant, for Japan and the rest of Asia they become sizeable and reach astounding differences in Latin America and the Rest of the World. It would ensue then, that in Latin America big banks do have some special treatment by having access to the best human resources and/or preferential funding. The playground seems to be less distorted in other parts of the world, primarily in the US and Europe, where small banks seem to be competitive enough and on equal footing with the big banks.

The profit efficiency side of the coin is rather tarnished. While it still pays out to be big in Japan and the rest of Asia, it is better to enjoy a smaller niche in the rest of the countries and regions. Japan seems to tell us a completely separate story from the rest of the world. Its biggest banks enjoy the lowest profit inefficiency when compared to the peers from the other parts of the world, with an amazing 13.95%. At the same time its smaller banks fare on the other side of the spectrum with an average profit inefficiency of 33.4%. This explains much of the loss that Japanese banks posted for 2008 and 2009. But it also tells us that the big Japanese banks are far from subsiding and their competitiveness is at the very high.

Conclusive for this section is that we do not find a strong correlation between the ranks of banks given by cost efficiency scores nor by profit efficiency scores. Simply speaking, being in the top by the volume or total assets or equity does not result in a necessarily high cost or profit efficiency. However, when a less sensitive analysis is undertaken and the sample is split in two subsamples, for big and small banks, we find a slightly higher efficiency on the cost and side for big banks. On the profit side, being small means being more profit efficient, on average. The story has the same composure when we analyze the cost inefficiency by regions. Regardless of the main geographical provenience of the banks it pays out to be big and enjoy economies of scale when dealing with cost inefficiencies. As for profit inefficiency, Japanese big banks hold a preferential niche in comparison with its peers from other regions which are worse off. The ranking correlation analysis reveals mixed results, except for Japanese banks.

For Japan we find that being situated higher in the ranking, either by the amount of assets or by equity means having higher efficiency ratios, both cost and profit.

Our results find wide support, both in theory as well as in other research papers for banking. Of course the findings are sensitive to the approaches employed. Spearman's rank correlation, while more sophisticated, does not allow us to decipher the relationship between size and efficiency. But we found that it had a rather high predictive power for the case of Japan. This alone is a vivid indication that such a method deserves credit for its accurateness. On the other hand, we once again resorted to archetypal analysis of the relationship between size and efficiency. This enabled us to answer the question of inter-relatedness between the size of the bank and its cost and profit efficiency. This holds true, for the particular sample and particular setting.

3.5. Cost and Profit Efficiency Analysis by Country

Whether the developed countries preserved their dominance in finance, but more importantly whether they are more efficient in terms of cost and profit efficiency than the developing countries is a question we will address in this section. In order to pursue with our analysis a few methodological remarks have to be made. First, all the analysis will be based on the efficiency scores predicted by the panel estimation in the previous section. Second, we estimate the weighted averages for the efficiency scores of every country. This might have some implications on the rankings of the countries, due to the fact that some of them are represented by really big banks in terms of total assets and thus their individual efficiency could determine the average. For instance in Switzerland UBS accounts for a 45% share of the assets in the sample. The same situation is encountered in the USA where Citigroup, Morgan Stanley and Bank of America represent around 30% of total assets. The last remark relates to the countries which are represented by very few banks in the sample. We discriminate in this case, and exclude all countries that we believe are under-represented. By underrepresentation we mean countries which have fewer than 5 banks in the sample. The exclusion of these countries is determined by the necessity to impose a more uniform representation in such a way that our inferences are less biased. The total results by country are presented in -A. Rankings and partial results will be presented in the text.

1.5.3. Cost and Profit Efficiency Country Rankings

At the very top of the rank of the most cost efficient banks are the banks from Thailand which have weighted average cost inefficiency score of only 5.53%. The Top (*Table 5-6*) concludes

with Qatar which yields an inefficiency score of 13.78%. Developed and emerging markets are equally represented in the Top. The most notorious occurrences are those of the Chinese, Brazilian, South African and Nigerian banks. All of these nations are on the verge of sustained economic growth and development, and their banking systems development seems to resemble the general trend of development. A legitimate presence in the Top is that of the Scandinavian banks – Sweden and Norway, as well as that of Canadian, French, Spanish, Italian and British. All of which have strong and, as proved by the crisis, resilient to severe economic shocks. The top does not include the US banks, which this time proved to be outpaced in terms of efficiency by other nations. This might be primarily due to the crisis period which is encompassed in our research²⁵.

Table 5-6: TOP 15 Cost and Profit Efficiency Banking Systems²⁶

Cost Efficient				Profit Efficient			
Country	Rank	CI	PI	Country	Rank	PI	CI
<i>Thailand</i>	<i>1</i>	<i>5.53%</i>	<i>24.48%</i>	<i>Saudi Arabia</i>	<i>1</i>	<i>15.13%</i>	<i>16.35%</i>
<i>Canada</i>	<i>2</i>	<i>6.03%</i>	<i>32.21%</i>	<i>Qatar</i>	<i>2</i>	<i>15.63%</i>	<i>13.78%</i>
<i>Sweden</i>	<i>3</i>	<i>6.73%</i>	<i>20.55%</i>	<i>Kuwait</i>	<i>3</i>	<i>16.16%</i>	<i>21.67%</i>
<i>South Africa</i>	<i>4</i>	<i>6.88%</i>	<i>28.14%</i>	<i>Malaysia</i>	<i>4</i>	<i>16.67%</i>	<i>26.84%</i>
<i>Norway</i>	<i>5</i>	<i>6.91%</i>	<i>20.08%</i>	<i>UAE</i>	<i>5</i>	<i>17.22%</i>	<i>29.34%</i>
<i>France</i>	<i>6</i>	<i>7.88%</i>	<i>36.54%</i>	<i>Pakistan</i>	<i>6</i>	<i>17.31%</i>	<i>20.98%</i>
<i>Brazil</i>	<i>7</i>	<i>8.56%</i>	<i>50.73%</i>	<i>Greece</i>	<i>7</i>	<i>19.49%</i>	<i>16.77%</i>
<i>China</i>	<i>8</i>	<i>11.42%</i>	<i>21.08%</i>	<i>Norway</i>	<i>8</i>	<i>20.08%</i>	<i>6.91%</i>
<i>Oman</i>	<i>9</i>	<i>11.56%</i>	<i>20.78%</i>	<i>Sweden</i>	<i>9</i>	<i>20.55%</i>	<i>6.73%</i>
<i>UK</i>	<i>10</i>	<i>12.01%</i>	<i>25.86%</i>	<i>Oman</i>	<i>10</i>	<i>20.78%</i>	<i>11.56%</i>
<i>Israel</i>	<i>11</i>	<i>12.03%</i>	<i>40.07%</i>	<i>China</i>	<i>11</i>	<i>21.08%</i>	<i>11.42%</i>
<i>Spain</i>	<i>12</i>	<i>12.40%</i>	<i>27.42%</i>	<i>Japan</i>	<i>12</i>	<i>24.14%</i>	<i>22.00%</i>
<i>Nigeria</i>	<i>13</i>	<i>13.28%</i>	<i>30.70%</i>	<i>Thailand</i>	<i>13</i>	<i>24.48%</i>	<i>5.53%</i>
<i>Italy</i>	<i>14</i>	<i>13.64%</i>	<i>29.28%</i>	<i>Denmark</i>	<i>14</i>	<i>25.56%</i>	<i>15.99%</i>
<i>Qatar</i>	<i>15</i>	<i>13.78%</i>	<i>15.63%</i>	<i>UK</i>	<i>15</i>	<i>25.86%</i>	<i>12.01%</i>

Source: Compiled by Author

The profit efficiency ranking is a complete surprise for us. It is dominated by the Gulf Banks, namely by banks from member countries of Gulf Co-operation Council comprising Saudi Arabia, Qatar, Kuwait, United Arab Emirates and Oman. Although most of them were exposed to "Dubai World", they managed to maintain a profitable 2009 and increase their Tier 1 capital significantly. Bahrain banks are not part of the list and this is not surprising given their elevated exposure to the international financial crisis and to the Dubai World and AHAB

²⁵ More consideration to the issue of the crisis and its impact will be given in the next section of the thesis

²⁶ We refer to the sample of banks from a given country as the banking system although we acknowledge that such a misuse might be confusing

defaults. Middle Eastern banks and Islamic banks represented by Pakistani banks and Malaysian banks performed very well during 2005-2009. Unwillingly, we proved the hypothesis that Islamic banks have weathered the 2007 credit crunch better than other types of banks. Apparently the Sharia principles, which are widely applied in Islamic banking, were the driving force which sheltered these banks from most of the external, toxic exposures.

The ranking of the bottom performers is given in *Table 5-7* below. The general picture is rather inconclusive, but at the same time we do not find any major surprises. Most of the banking systems represented here had and still have major challenges to face. The ranking unravels some of the suspicions and intuitions we had regarding some of the countries. Moreover a few interesting stories about some of the banking systems involved might reveal the roots of and main causes of such scores for some particular countries.

Table 5-7: Bottom 15 Banking Systems According to Cost and Profit Efficiency

Cost Inefficient				Profit Inefficient			
Country	Rank	CI	PI	Country	Rank	PI	CI
<i>Egypt</i>	<i>1</i>	<i>43.70%</i>	25.83%	<i>India</i>	<i>1</i>	<i>60.58%</i>	25.01%
<i>Iran</i>	<i>2</i>	<i>38.62%</i>	55.18%	<i>Iran</i>	<i>2</i>	<i>55.18%</i>	38.62%
<i>Argentina</i>	<i>3</i>	<i>38.41%</i>	30.78%	<i>Switzerland</i>	<i>3</i>	<i>53.82%</i>	16.70%
<i>Lebanon</i>	<i>4</i>	<i>37.41%</i>	32.18%	<i>Germany</i>	<i>4</i>	<i>53.02%</i>	25.90%
<i>Bahrain</i>	<i>5</i>	<i>36.63%</i>	25.93%	<i>Brazil</i>	<i>5</i>	<i>50.73%</i>	8.56%
<i>Ukraine</i>	<i>6</i>	<i>33.58%</i>	19.52%	<i>Turkey</i>	<i>6</i>	<i>43.47%</i>	16.60%
<i>Russia</i>	<i>7</i>	<i>32.98%</i>	26.59%	<i>Israel</i>	<i>7</i>	<i>40.07%</i>	12.03%
<i>Vietnam</i>	<i>8</i>	<i>31.76%</i>	20.04%	<i>Portugal</i>	<i>8</i>	<i>38.94%</i>	14.75%
<i>UAE</i>	<i>9</i>	<i>29.34%</i>	17.22%	<i>France</i>	<i>9</i>	<i>36.54%</i>	7.88%
<i>Indonesia</i>	<i>10</i>	<i>27.39%</i>	29.73%	<i>Netherlands</i>	<i>10</i>	<i>34.59%</i>	22.80%
<i>Malaysia</i>	<i>11</i>	<i>26.84%</i>	16.67%	<i>Hong Kong</i>	<i>11</i>	<i>33.39%</i>	18.61%
<i>Germany</i>	<i>12</i>	<i>25.90%</i>	53.02%	<i>Philippines</i>	<i>12</i>	<i>32.74%</i>	20.02%
<i>India</i>	<i>13</i>	<i>25.01%</i>	60.58%	<i>Canada</i>	<i>13</i>	<i>32.21%</i>	6.03%
<i>Netherlands</i>	<i>14</i>	<i>22.80%</i>	34.59%	<i>Lebanon</i>	<i>14</i>	<i>32.18%</i>	37.41%
<i>Japan</i>	<i>15</i>	<i>22.00%</i>	24.14%	<i>Australia</i>	<i>15</i>	<i>31.63%</i>	14.58%

Source: Compiled by Author

The cost inefficiency of Egyptian and Iranian banks is nothing of a surprise. Most of the banks representing these countries are owned by the respective governments. For Iran from 12 banks in the Top 1000 six are owned by the Iranian government and six are privately owned. The most staggering thing is that privately owned banks have cost and profit efficiency scores of 17.98% and 36.68% while the government owned banks record an incredible 61.1% and 75.3%, respectively. The Egyptian and Argentinian stories are the mirror versions of the Iranian. Ukrainian and Russian banks appearing in this ranking are not a surprise as well. The

Russian banking sector is a very peculiar one. Albeit large, it is still majority owned and controlled by government. Moreover, the supervision and regulation of the sector is tough. The foreign players are interested in entering just the markets of Moscow and Saint Petersburg, while the rest of the regions are of little or no interest. Ukrainian banking system seems to be in a bad shape since at least the 1998 Russian crisis. Although much has been achieved in terms of consolidation there still remains room for further improvement in terms of banking technology. At this stage, both, the Russian and Ukrainian banks seem to be crippled in the dysfunctions of the economies they operate in.

Indian banks on the other hand have a challenging future. Not only do they operate in an urban overbanked environment (according to some estimates top five banks account for about 50% market share) they also face the effects of the crisis and a stalemated consolidation process. When factored in all this mix makes a perfect recipe for low efficiency and hampered development. Prompt and bold policy actions have to be undertaken to overcome all these challenges.

Germany, Netherlands and Japan are three stories about one thing. The advent of the Japanese banks dates back to the 1970s and 1980s when Japanese economy was booming. But the root problems that Japanese banks face today date the same period as well.

The rapid expansion of banks' balance sheet was done at the expense of quality and prudent risk taking. The consequences appeared a decade later when the Japanese banks entered a prolonged crisis (See *Figure 1-1* in the Introductory Chapter).

The German banking system is well known for being domestically dominated by the, so called, "Landensbanken". These are banks owned by local, "land", governments. During the current crisis most of these banks were hard hit, due to their exposure to toxic assets, and state intervention was needed to prevent a systemic collapse the whole banking system²⁷. Notwithstanding the painful experience the local governments remain resilient to conspicuous changes in the way these banks function. But lately, both the Federal German Government as well as European Commission is mounting its pressure for an orderly resizing of the balance sheets, privatization and consolidation of these banks.

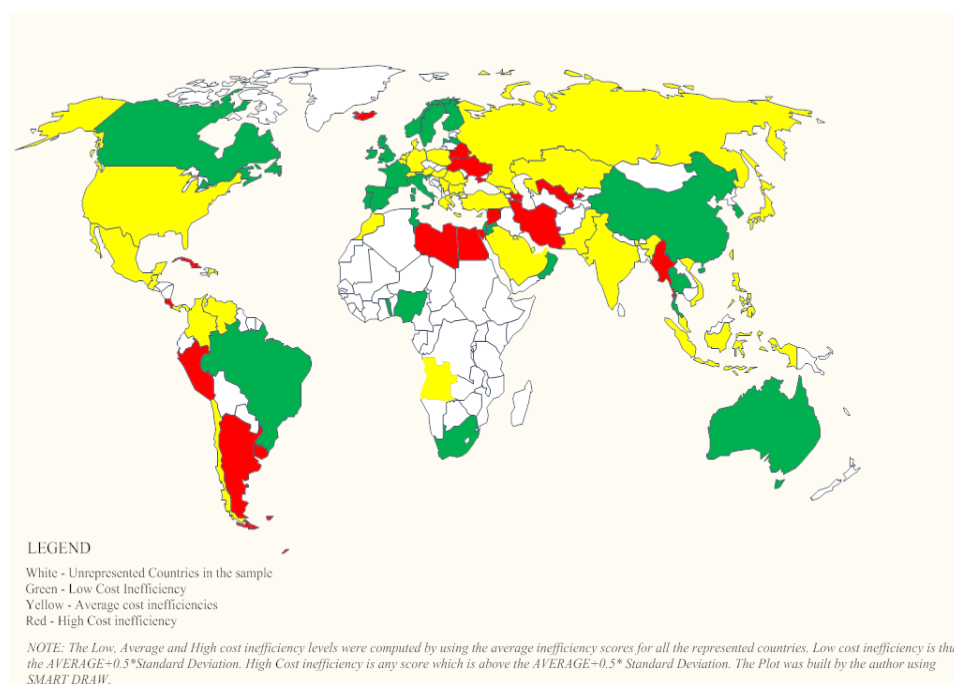
²⁷ Financial Market Stabilization Fund (SoFFin) was widely used to stabilize the market through guarantees and clearing services as well as direct capital injections. The fund was created on 17th of October 2008, through the German Financial Market Stabilization Act, a month after the collapse of Lehman Brothers in the USA.

The Dutch banking system, albeit competitive, remains caught in the clichés of the 21st century. Highly leveraged banking institutions, exposure to toxic assets, fragmented market, lax supervision and regulation and a structural high base cost in the Dutch banking business as well as credit crunch upheaval have all played a role in the rather low efficiency ratios, both on the profit and on the cost side. Moody's Investors Service report from June 2010 on Dutch banking system was negative and cautiously optimistic about the future prospects of the Dutch banks.

The unifying story of all of these banking systems is the principal agent problem related to politics and reform. Any reform is a very painful and usually undesired event for most of the politicians. Likewise these reforms come to address problems of the past and disregard those present and prospective ones. Merely, the political agenda is lagging the economic and financial one. All of these three systems must undergo wide and deep reforms to remain competitive and viable in the medium and long run. The timely and orderly reform is the only key to success in these cases.

To summarize the main findings in terms of bank performance in different countries of the world and different regions we plot World Map comprising congested information about them (see *Figure 5-5 – Cost Inefficiency* and *Figure 5-6 – Profit Inefficiency*).

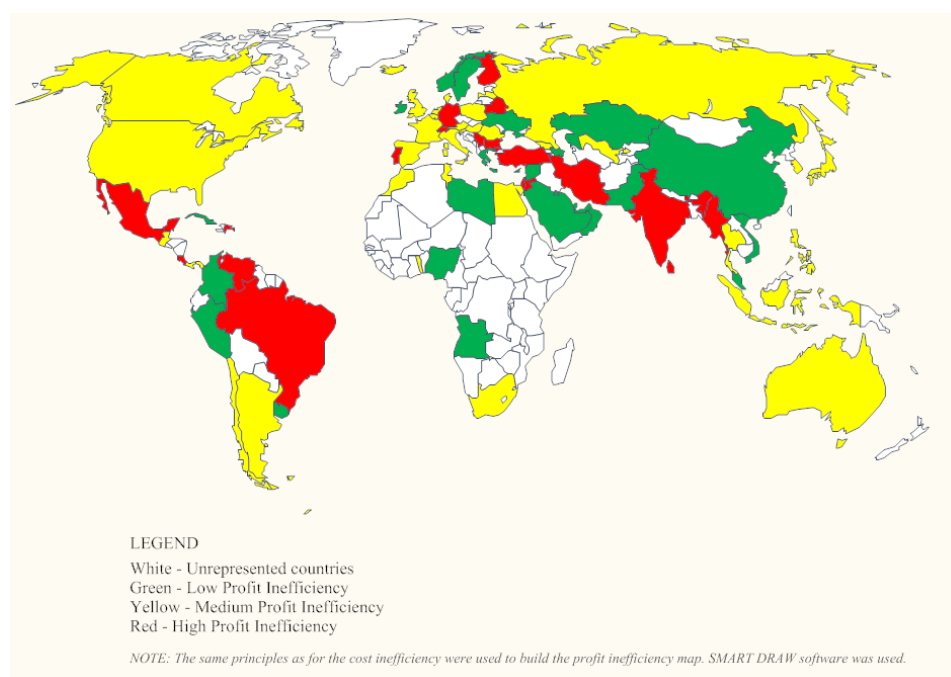
Figure 5-5: Map of Cost Inefficiency



The plot depicts all the countries in the world. The countries depicted in white have no banks representing them in the sample. The "green" represent the countries with the lost weighted average cost inefficiency predictions. The lower bound was computed by taking the average value and subtracting half of the standard deviation. In our case, cost efficient banking systems were defined as having cost inefficiencies lower than 15.5%, the higher bound was defined by adding up to the average a half of standard deviation – 33%. The medium inefficiency was comprised in the 15.5% - 33% interval.

The Figure clearly indicates that most of the Western European banking systems fared cost efficiently in 2005-2009. The exception was Germany, Belgium and Netherlands. The Eastern European counterparts had average scores, with Belarus and Ukraine as exceptions. Middle Eastern countries had a more heterogeneous performance with Iran and Syria on the high cost inefficiency end and Oman on the high efficiency extreme. In Asia the Chinese and Thailand's banks were the main benchmarks in terms of cost efficiency with Myanmar at the opposite extreme. The cost frontier has been attained by South African, Togolese and Nigerian banks in Africa, with Egyptian and Libyan banks limping. Latin America was dominated by Brazil in terms of cost efficiency. Argentina, Costa Rica, Cuba and Peru were on the worst end. North America, surprisingly, tracks the Canadian performance, albeit understandably given the financial malaise in the USA.

Figure 5-6: Map of Profit Inefficiency



The Profit inefficiency map was built on the same principles as the cost inefficiency map. The only difference regards the bounds. In the case of profit inefficiency the lower bound was 23.5% and the higher bound reached 38%. The values for profit inefficiency are higher than cost inefficiency.

The map turns to be yellowish for the Western Europe, with German and Swiss banks recording inefficiencies above the upper bound²⁸. The map also reveals the dominance of Islamic banks, as most of the Middle Eastern as well as Pakistani banks have high levels of profit efficiency. Chinese banks are benchmarks in terms of profit efficiency for Asia. African banks should follow the models of Nigerian and Angola's banks. Latin America must shift its consideration from Brazilian to Colombian and Peru's banks when it comes to profit generation. North America is even on profit efficiency, with both Canadian and the US based banks recording medium level inefficiency score.

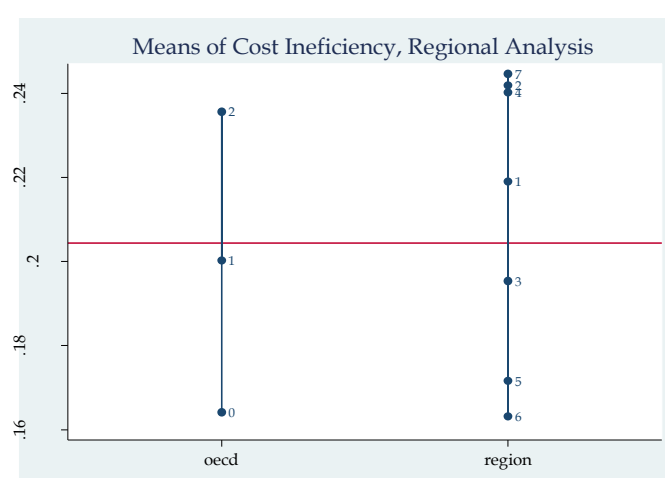
Overall, from the profit inefficiency perspective the banks are more susceptible to incur and bear high levels of inefficiency. Whether insulated cases of weak performance or not, is yet premature to establish. There appears to be a link between the general economic situation in a country and the performance of its banking sector, although there are exceptions to this rule (see Germany, Switzerland, and Libya). The political organization and political regimes might have also an important role to play. Unfortunately we did not account for that factor. Nonetheless some patterns are discernable from the data. It appears that countries with autocratic regimes, with majority state owned banks, are successful in monetizing profits and attaining high levels of profit efficiency even at the expense of a high cost basis. The intuition is that these nations use their banks as money making machines or as instruments in managing the revenues from the oil exploitation sector. In this context, these nations' banks are outliers for the whole sample as their business model implies direct state interventionism and facilitation of profitable operations and deals. Nonetheless, it has to be emphasized once again that no control variables were used to account for this and further scrutiny is required.

We further undertake an analysis by region. The analysis follows the principles and notations set up in Chapter 3, in the preliminary analysis of banking data section. For a reminder of the

²⁸ The average profit inefficiency score for Switzerland was determined by the individual score of UBS AG - 87.8%, due to incredible losses it suffered during 2008 and 2009, and due to the fact that when weighing by assets UBS represents 45% of the assets from the Swiss sample. If we exclude UBS, the average profit inefficiency score is only 14.22% - well below the lower bound. Thus the average inefficiency score for Switzerland has to be given a more cautious interpretation, as problems in one single institution cannot be extended to the whole system, albeit the discussion is about a systemically important institution.

notation please refer to that section. For the OECD group we find that banks in the OECD based banks have average inefficiencies larger than those in BRIC countries but lower than for the rest of the world (see *Figure 5-7*). The regional comparison reveals the same picture as the mapping, with Asia and Rest of the World being the most cost efficient. European average inefficiency is below the total average and below the USA's average. Latin American, Japanese and Middle Eastern banks share the worst places. From this figure we can see a more explicit dominance of the Asian banks (Chinese to be more precise) and a rather poor performance from Latin America and Middle East – in terms of cost efficiency.

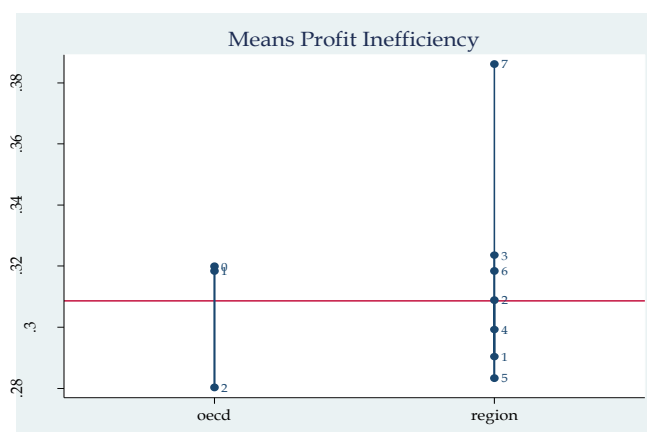
Figure 5-7: Means of Cost Inefficiency



Source: Author's computation

In terms of profit inefficiency, Figure 5-8, the picture is more uniform with the only visible dissenter being Latin America. Asian dominance is no longer as visible as in the previous case, as US based banks are in close proximity. The Middle Eastern banks have inefficiency averages below the general average. This figure also depicts no difference between BRIC and OECD countries in terms of bank profit inefficiency as they have almost the same average with BRIC countries recording a marginally higher inefficiency. An important note to this analysis is that the averages depicted in these pictures are simple averages as opposed to weighted averages in the case of the maps.

Figure 5-8: Means of Profit Inefficiency



Source: Author's computations

The BRICs themselves are not homogenous. The Chinese and Brazilian banks have on average lower cost inefficiencies than their Indian and Russian counterparts. Whereas only the Chinese banks record low levels of profit inefficiency. The Brazilian banks, although cost efficient, are profit inefficient. Their average profit inefficiency amounts to 60% and is higher than any others inefficiency in the BRIC block.

I would put somewhere here or elsewhere a Conclusion subtitle as well... so that the reader knows where the outcome is

2.5.3. Final remarks

Unfortunately we cannot draw definite conclusion for this section. There is no certain trend or inference concerning the difference between developed and emerging countries' banking systems. Some of the OECD nations, such as Norway, Sweden, Italy, France, UK and even the US, with all of its latest problems, remain in very good shape despite elevated levels of skepticism and criticisms of their banking sectors. Japan, Germany, and Netherlands should, on the other hand, find a way to substantially and qualitatively reform their banking sectors if they intend to preserve their dominating power in a very dynamic and changing, 21st century, financial environment. The domineering positions of the west seem to be, once again, challenged by an emerging, buoyant and ambitious Asia, with China as a powerhouse, and now as a benchmark for banking technology for the whole region. Not only did the Chinese banks increase in number and size. Their efficiency is also a leading indicator of the profound and lasting changes that are taking place in the region.²⁹ The story is somewhat mixed for Latin America. That region is now dominated by a successful Brazil, with a rather proficient

²⁹ The conclusion holds with the sole assumption that the banking data provided by the banks to the Bankscope database corresponds to the highest standards in the industry

banking system which still has room for further improvement. A revelatory finding refers to the Middle Eastern banks. The Sharia complaint principles have helped these banks weather the financial malaise, albeit not without casualties. The banks from the region have lately gained enough size and expertise to become serious competitors to their western counterparts. American banks, although at the epicenter of the crisis, had very promising efficiency scores. Disregarding them, even now when they experience the worst of their times, would be a simple miscalculation. As the previous section proved, the size matters, and in this respect the American and European behemoths have little to fear about in the near future.

The overall conclusion could be stated in the words of Thomas Friedman – "The world is flat". The banking technology is flat. At least this is what appears to be the reality given the results we obtained. Of course, we do not account for the quality of services, customer satisfaction and many other aspects that could have a determining role in distinguishing between different banks from different countries, but we believe that the advent of technology and the actual speed of the spread of knowledge and technology levels up the once ever present discrepancies between countries and economic systems. There still are, metaphorically speaking, "deserted islands" such as Iran, Syria, Myanmar, Libya, Egypt, Peru, Venezuela and Cuba – which are lagging behind the entire world. .

4.5. Cross-section Analysis – The credit crunch impact assessment

In this section we analyze the impact of the crisis on the efficiency of banks from our sample. Besides a general assessment we will also give special consideration to assessing the impact of the crisis on banks according to their country of origin. In this way we want to evaluate which banking systems were exposed the most to the financial crisis malaise. To grasp the change of the inefficiency in time we employ the technique used in Berger and Mester (1997b). We estimate the cost and profit frontier on the sample of banks using the cross-section data, i.e. we estimate the model on each year separately and then compare the results and try to assess the changes in cost and profit inefficiency. We employ Spearman's rank correlation to assess the changes in rankings from year to year and then compare the overall averages of inefficiency in a dynamic setting. This method lacks consistency in that respect that the change in inefficiency cannot be attributed solely to the impact of the crisis, and other factors might influence the results. However, in order to get comparable results across cross-sections we force the estimation of the same specification. As in the panel data case, we use a trans-logarithmic cost and profit function with environmental as well as bank level variables.

1.5.4. The 2007 credit-crunch impact on the cost inefficiency of banks

First we estimated the cost inefficiency for each of the five years in the interval 2005-2009 (see *Appendix 5-A*). Then the total sample average for each year is estimated. For a more explicit and detailed analysis of the cost inefficiency scores we divide the total sample in the following subsamples. Europe, Asia, US, Japan, Latin America, Middle East and the Rest of the World subsamples are created. Additionally, BRIC and OECD country samples are created for comparison. Spearman's rank correlation and graphical analysis of the samples is then undertaken.

The Spearman's rank correlation matrix (*Table 5-8*) reveals a rather strong relationship between 2005 and 2006 rankings. The correlation coefficient decreases from 0.755 to 0.612 for the 2006 – 2007 rankings and then slips to 0.545 for the 2007-2008 rankings. This is an indication that the crisis had an impact on the banks operation and the uncertainty and high risks on the markets had an adverse impact on some of the banks which lost their positions. The situation stabilized again in the next, 2009, year. However the 2009 year rankings are by far not the same as the 2005 or 2006 years rankings (0.39 and 0.38 correlation coefficients respectively).

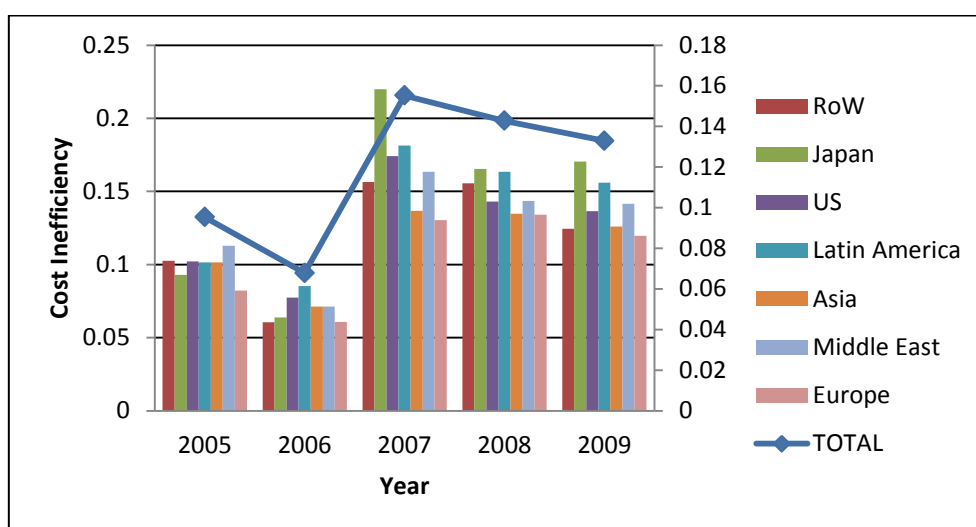
Table 5-8: Spearman's Rank Correlation for Cost Inefficiency

	CI 2005	CI 2006	CI 2007	CI 2008	CI 2009
CI 2005	1				
CI 2006	0.7549	1			
CI 2007	0.5329	0.6123	1		
CI 2008	0.4038	0.4407	0.5446	1	
CI 2009	0.3978	0.3826	0.5328	0.6417	1

Source: Author's computations

The most surprising evolution is the jump upward in cost inefficiency in 2007 as compared to 2006. To find a reasonable explanation for such an evolution is hard. The underlying intuition is that 2007 was still a year with monetary tightening across the world, but also a year with a lot of bank activity expansion which might have had a direct impact on the increase of the basis costs of the banks, mainly in the developed countries.

Figure 5-9: Cost Inefficiency by Region



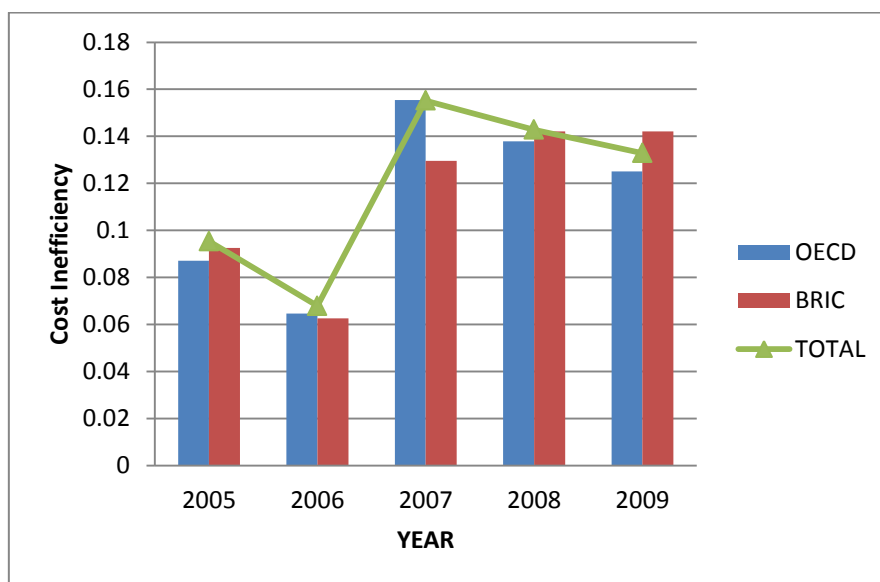
Source: Author's computations

The increase in cost inefficiency is seen across the regions without exception (see *Figure 5-9*). The most notable increase in inefficiency was attested in Japan. Unfortunately, from the given data a precise cause cannot be inferred. Intuitively some of the increase in inefficiency could be attributed to the increase in risk premiums, uncertainty on the markets, strained liquidity conditions and other signs of a deteriorating economic environment. The general increase in credit default swap spreads and in the costs of funding could have lead banks to experience higher costs while still producing the same or even less output. Being at the heart of the credit crunch, banks reacted restrictively on their activity by artificially creating a shortage of interbank resources which lead to a standstill in the activity of many banks. This might have led to the shrinkage and deleveraging of the balance sheets, and thus a general decrease in the output of each bank could have occurred. However, while the trend of deleveraging continued throughout 2008 and into 2009, the management was adaptive enough to compensate the loss of output by cutting down costs, both – interest and non-interest. Moreover, the intervention of governments insured an increase of liquidity in the interbank market and increased the availability of funds. Such an impact is especially visible in the USA (from 17.4% to 13.6% in a two year period) where the bailout package and the quantitative easing have been particularly generous compared to the rest of the regions. The decrease in inefficiency cannot of course attribute solely to the bailout and government intervention, and could very well be the result of timely optimization undertaken by the management. Evidently many factors played an important role in the decrease of cost inefficiency across most of the regions. A more thorough analysis of these causes and their impact could be interesting areas for future research.

Other regions experienced slightly different outcomes. Asia, for instance, had steady cost inefficiency in the 2007-2009. Latin America followed the path of the USA and Middle East. Apparently these three regions share a lot in common in terms of economic linkages and financial linkages.

Japanese banks, on the other hand, experienced an improvement in cost inefficiency in 2008 (16.5%) compared to 2007 (22%) but worsened its prospects in 2009 (17%). European banks have also had a different path from their US counterparts. Their average cost inefficiency increased in 2008 compared to 2007 from 13.1% to 13.4%. The increase was negligible. The picture regarding the evolution of the cost inefficiency changes if we split Europe in European Union member countries and non-EU countries. The non-EU countries have banks for which the average cost inefficiency increases continuously throughout the period. From an average of 10.9% in 2005 it slips to 6.8% in 2006 only to increase gradually from 13.6% in 2007 to 18% in 2009. Whereas, average cost inefficiencies decrease from 12.9% in 2007 to 10.6% in 2009 for the EU countries. A country by country analysis within the EU would reveal which banking systems are more integrated with the leading banking systems in the Union and which are lagging behind. However this would be left for future research as this is beyond the scope of this paper.

Figure 5-10: BRIC and OECD Cost Inefficiency 2005-2009



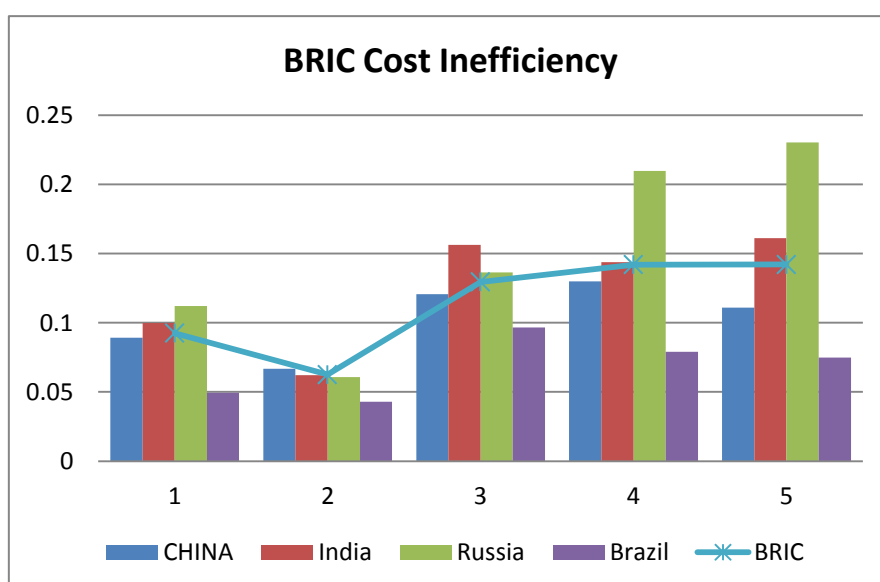
Source: Author's computations

Figure 5-10 is the plot of the evolution of average cost inefficiencies of the OECD based banks and BRIC countries based banks. This figure is very similar to the previous one (Figure

4.9). A jump in inefficiency is attested for 2007, and then a gradual decrease can be accounted for the OECD countries while the opposite is true for the BRIC countries. It is obvious from this picture that the OECD countries have more synchronized banking systems while the banks from BRIC countries dissent from the general global trend.

A closer look is given to the BRIC group (*Figure 5-11*). The plot reveals that Russian and Indian banks have cost inefficiencies higher than the BRIC average while Chinese and Brazilian banks have lower than average inefficiencies. Moreover, Brazilian banks are the only banks that have decreasing cost inefficiencies during the crisis while Russian banks have an increasing trend.

Figure 5-11: BRIC Cost Inefficiency Evolution



Source: Author's computations

The Indian and Chinese banks behave alike during the crisis. They initially have a slight increase in the average inefficiency and then they also decrease their cost inefficiencies. This picture has a revealing nature in terms of the economic conditions and their reaction to the shocks from the outside, primarily from the US credit crunch. The Russian economy seems to have been hit the worst from the group, with its banks being unable to weather the distress and optimize the cost side.

2.5.4. Credit crunch and the Profit Inefficiency of banks

For the profit inefficiency analysis under credit crunch, the same procedure as for the cost inefficiency applies. The Spearman's rank correlation was first computed (*Table 5-9*).

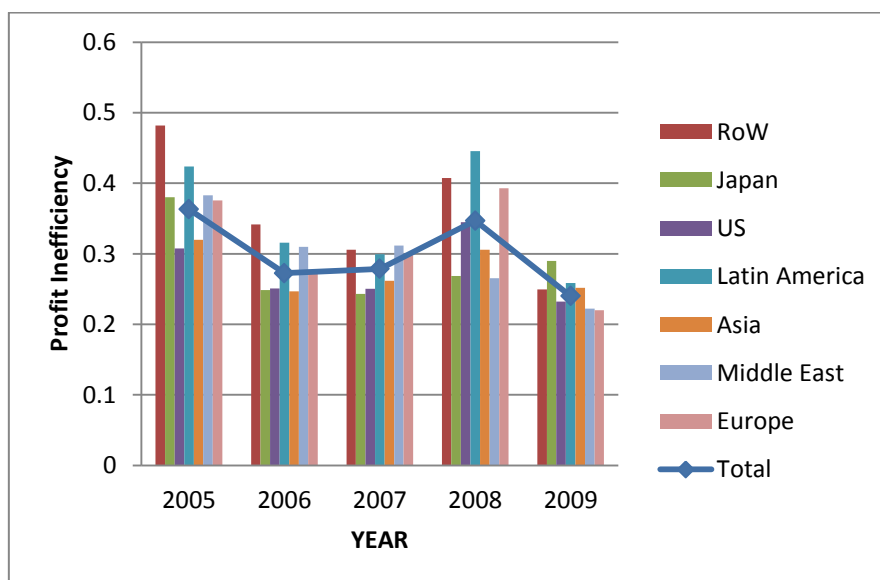
Table 5-9: Spearman's Rank Correlation for Profit Inefficiency

	PI 2005	PI 2006	PI 2007	PI 2008	PI 2009
PI 2005	1				
PI 2006	0.6866	1			
PI 2007	0.466	0.643	1		
PI 2008	0.3985	0.4869	0.5343	1	
PI 2009	0.3092	0.3649	0.4535	0.5154	1

Source: Author's computations

The results indicate a moderate correlation between ranks of profit inefficiencies from each year. A decreasing correlation can be spotted for each pair of years. This is an argument for a rather unstable profit efficiency score for most of the banks. This finding is intuitive given the period under investigation and the fact that under financial and economic distress the cash flows of companies are unstable. The lowest correlation, 0.515, is attested for the 2008-2009 pair of years. This can be explained by the fact that 2008 was the worst year in terms of profitability for banks, while 2009 was a year of recovery when many banks returned from loss to profit again.

The regional analysis of the change in profit inefficiency (Figure 5-12) reveals three important aspects.

Figure 5-12: Average Profit Inefficiency 2005-2009

Source: Author's computations

First, average profit inefficiency improved across the regions in the 2005-2007, Japan, Latin America, Europe, Middle East and Asia being the biggest gainers. Japanese banks alone improved their average from 38% in 2005 to 24.3% in 2007. Latin American banks also

improved their profit performance from 42.4% in 2005 to a 29.9% indicator in 2007. For the same period, the US based banks and Asian banks had averages below the global profit inefficiency average.

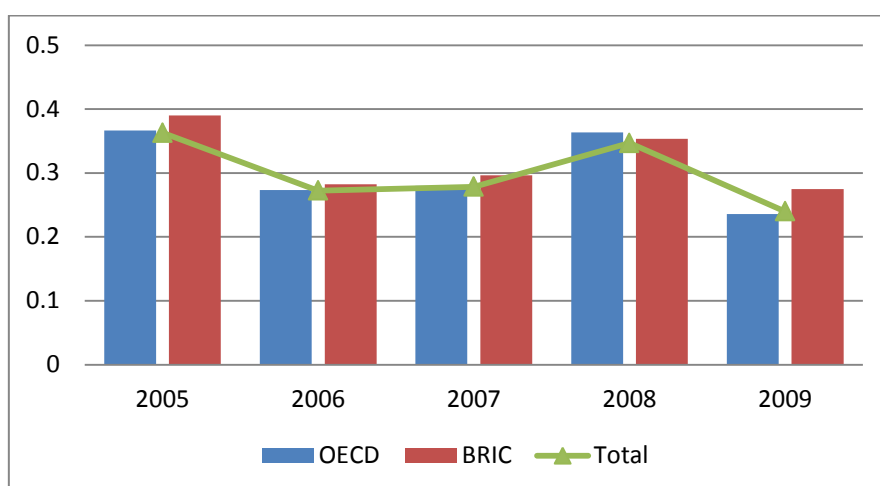
Second, the strike of the crisis had sizeable result on the profitability at the end of 2008. The impact was felt across all regions, except Middle East. In line with our findings in the previous (panel-data analysis) section, the Middle Eastern banks were quite resilient to the crisis, even when accounting for profit. The US, Latin American and European banks seem to have been hit the hardest, all of them recording average inefficiencies above the global average. European average was close to 40%, US – 34.5% and Latin America – 44.5%.

The third finding is that all of the hardest hit regions recovered the fastest, with US banks shrinking their profit inefficiencies from 34.5% to 23.2%, European from 39.3% to 22% and Latin American from 44.5% to 25.2%. The only exception to the general picture was the Japanese banks, average inefficiency score of which deteriorated from 26.9% to 29%. This last finding is in line with the rather poor year in profitability for the Japan based banks – as noted in the data description section of the paper.

The last finding is that banks from different regions entered the recession on equal terms, having uniform inefficiency scores. The crisis had a disproportionate impact. The Middle Eastern banks remained rather insulated from the financial malaise, while the Asian, European, Latin American, US, Japanese and banks from the rest of the world were hit hard. The main victims of the crisis were, of course, the American, Latin American and European banks. The EU based banks were hit by the crisis harder on the profit side than their non-EU based counterparts – inefficiency jumped from 31% to 41% as compared to only 25.1% to 33.3% respectively in 2008 compared to 2007. The recovery was also stronger for the EU based banks as after the crisis they evened out and reached 22.3% profit inefficiency, close to the post-crisis 20.8% for non-EU banks.

When comparing OECD and BRIC countries banking system profit inefficiencies (*Figure 5-13*) little if any difference can be spotted. In the pre-crisis period OECD and BRIC countries had almost equal profit inefficiencies with BRIC being slightly more inefficient than OECD. The crisis hit the OECD countries' banking systems harder but they emerged more efficient from the crisis than their BRIC counterparts.

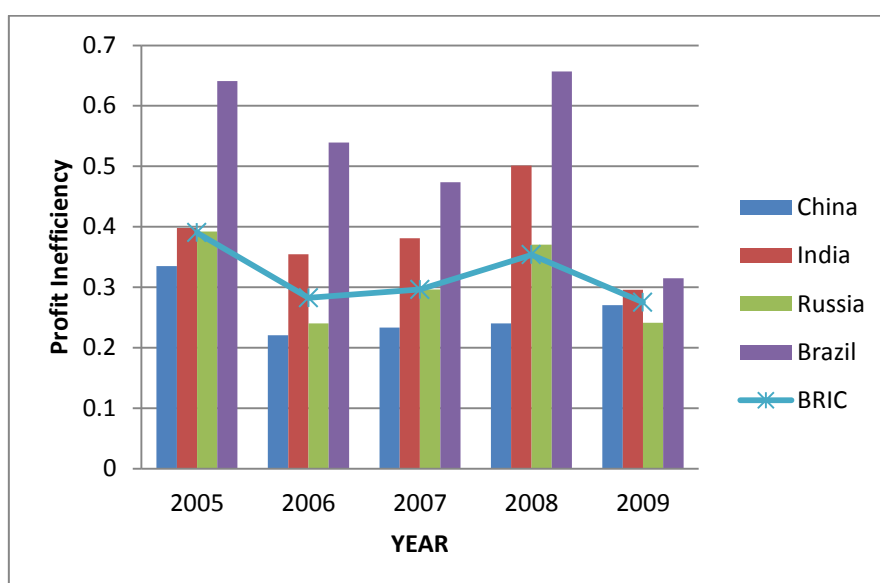
Figure 5-13: OECD vs. BRIC Profit Inefficiency 2005-2009



Source: Author's computation

When analyzing BRIC countries alone (see *Figure 5-14*) a few interesting inferences can be made. First, the crisis had a disproportionate impact on banks from different countries of origin, with Indian and Latin American banks being hit the most.

Figure 5-14: BRIC Profit Inefficiency 2005-2009



Source: Author's computations

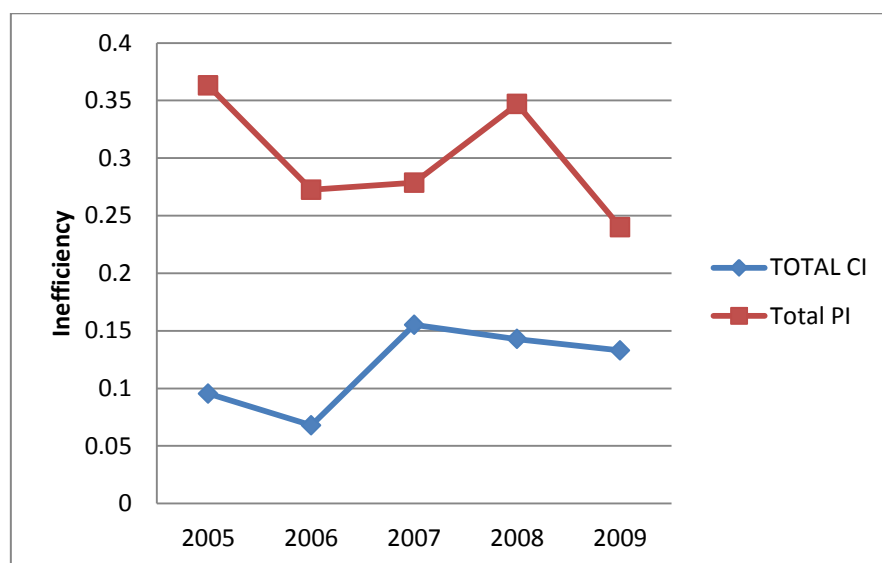
Second, the Latin American banks seem inherently more profit inefficient than the rest of the sample. Chinese banks' profit inefficiency seems totally unrelated to the credit crunch crisis and it follows a trend of its own. The profit inefficiency in the Chinese banking system increases and this might be the sign of an increasing competition among banks with shrinking margins and reduced profits across the board. This might be also a sign of looming problems ahead for the Chinese banking system which might face quite severe conditions in case of an economic slowdown.

The last remark refers to the tantamountization³⁰ effect of the crisis on the profit efficiency of the banks, as there is a general tendency of bank inefficiencies to converge to some equal value, close to the global average, in the very aftermath of the crisis. This effect has been detected in most of the settings. We believe this effect could be attributed to a certain convergence, which appears due to the swift move of banks from one business model to another. During the 2007 credit crunch the main shift was related to deleveraging, capitalizing and a return to deposit-based, classical banking business model. Whether these were the main causes of such a global convergence of profit efficiency of banks remains unclear and more investigation is to be undertaken.

3.5.4. Profit vs. Cost Inefficiency

From the results that we have obtained so far it appears that cost and profit efficiency behaved in a different way during the crisis. A thorough comparison of the two related notions reveals that while cost inefficiency decreased during the crisis the profit inefficiency did not (see Figure 5-15).

Figure 5-15: Cost vs Profit Inefficiency 2005-2009



Source: Author's computations

Although cost and profit inefficiency were synchronized up until 2007, during and after the crisis their evolution was independent of each other. It is obvious to get such a result which resembles closely the intuition. The cost side of the production is usually easier to control and influence by the management than the revenue side which is dependent on the demand. During crisis demand is usually severely strained, as was the case in 2007. But apart from the

³⁰ By this term we mean a flattening out or a leveling off of the profit inefficiency across regions and countries.

natural fall in demand, banks during the credit crunch resorted to a purposeful wind-down of their crediting activity while still collecting depository and other cheap funding sources. Thus, for many banks, 2007 meant a year of survival and rethinking of the business model by emphasizing on constraining the spending. This trend proved quite successful for most of the banks as 2009 proved to be a profitable year across all regions with Japan as an exception.

Table 5-10: Spearman's Rank Correlation between Cost and Profit Inefficiencies

	CI 2005	CI 2006	CI 2007	CI 2008	CI 2009	PI 2005	PI 2006	PI 2007	PI 2008	PI 2009
CI 2005	1									
CI 2006	0.7549	1								
CI 2007	0.5329	0.6123	1							
CI 2008	0.4038	0.4407	0.5446	1						
CI 2009	0.3978	0.3826	0.5328	0.6417	1					
PI 2005	-0.3031	-0.2921	-0.0129	-0.0618	-0.1162	1				
PI 2006	-0.2245	-0.3225	-0.0403	-0.0984	-0.122	0.6866	1			
PI 2007	-0.1342	-0.2146	-0.2354	-0.067	-0.1062	0.466	0.643	1		
PI 2008	-0.1257	-0.1575	-0.0966	-0.0965	-0.1054	0.3985	0.4869	0.5343	1	
PI 2009	-0.0072	-0.0871	-0.0473	-0.0402	-0.0719	0.3092	0.3649	0.4535	0.5154	1

Source: Author's computation

The Spearman's rank correlation matrix (*Table 5-10*) confirms a weak monotonic relationship between the rank of cost and profit inefficiency, albeit negative. This means that banks with higher profit inefficiencies tend to have lower cost inefficiencies and vice-versa. Moreover the relationship weakens substantially and becomes insignificant during the crisis and in the immediate aftermath. This can be viewed as an impact of the crisis. In other words the crisis weakened the already fragile connection between the cost and profit inefficiency, or between the cost management and revenue management of a bank. This occurrence seems natural as in times of distress the levels of uncertainty increase and creates a much more volatile environment in which decisions are more difficult to argue and execute.

4.5.4. Final Remarks

Overall the findings in this section confirm our initial expectations. The cost inefficiencies had a diminishing tendency during the crisis while the profit inefficiencies imploded into the system. Apparently these two dichotomous occurrences helped banks weather the financial stress and remain competitive.

The impact of the crisis was disproportionate but had a tantamountization effect on the level of profit efficiency across the regions, banks from different regions hovering around the global average inefficiency values. The US, Latin American and European banks were hit

most by the crisis, the malign effects of which were weathered in a very short period of time. After an abysmal 2008, the results of 2009 showed that even those regions that seemed the most endangered and prone to lasting regressions in terms of efficiency regained and even improved their overall efficiency. The most eloquent example in this sense is the US. Being at the very heart of the crisis its banks seemed doomed for a black era. The reality shows a completely different story, with the US based banks emerging stronger and more efficient from the crisis. On the other hand, although highly competitive, the Chinese banks seem to be poised for serious challenges ahead, as their profit inefficiency starts to mount even though the 2007 credit crunch had no effect on the overall state of the Chinese banking system.

Japanese banks are also facing mounting pressure and most importantly the troubles for them seem pick-up momentum. The profitability of the Japanese banking sector remains to be at historic lows, moreover, even in terms of cost inefficiency the banks less competitive than their neighboring countries.

The analysis also helped us spot a few important findings. European banks can be divided in two big groups. The first group is represented by EU countries - with high levels of integration and synchronization and harmonization between banks and another group, non-EU, which has a rather heterogeneous and highly non-harmonized group of banks.

Another aspect relates to the OECD based banks, which we find to have many common features and to share the same vulnerabilities and challenges. The BRIC countries and their banking systems is probably the most interesting subject yet to be researched and discussed. Although dubbed and considered the most dynamic group of emerging countries, the group itself proved to be quite heterogeneous in terms of banking. The evident leader among the four nations is China. Brazil is faring well on the cost management side but is still facing difficulties on the revenue side. India and Russia are trailing heavily behind China and Brazil. Thus although this group remains of elevated interest for some investors and for academia, we find it to be mainly unipolar in terms of banking and a highly irrelevant and arbitrary assemblage. Taiwan, for instance, as well as such nations as South Africa or Nigeria is far more competitive in terms of banking than India and Russia.

The last remark was reserved for the Middle Eastern banks, which fared surprisingly well in terms of efficiency pre-crisis, during and in the immediate aftermath of the crisis. Both on the cost and profit side, the Islamic banks from the region proved resilient to the crisis. Moreover, while all the Western nations and their banks lost in profit efficiency during the crisis, the

Middle Eastern banks improved their average efficiency scores defying the malignant 2007 financial crisis. It remains for further research to determine which factors explicitly helped the Islamic banks overcome the hurdles posed by the financial crisis and remain at the forefront challenging the dominant positions, in terms of banking, of the Western nations.

CHAPTER 6

Conclusion

In the pursuit of assessing the state of the global banking system an orthodox but still risky approach was undertaken by constructing a common frontier for 1000 banks from 90 different countries using Stochastic Frontier Analysis. The procedure is not new in essence and as many as over 100 international comparison studies in bank efficiency have been completed over the years (see A. N. Berger (2007)). The difference of our approach from all of the rest is that we use a specific set, of so called "Top" banks, that we regard as the benchmark banking institutions for the whole industry both in terms of size as well as quality of services, management and financial expertise. The choice proved to be fruitful in at least three respects.

We managed to construct a simple frontier model and assess the link between the banks ranking in the Top and their efficiency scores and also determine the difference in efficiency between big and small banks, on one hand. On the other hand, by splitting all of the banks by country of origin and grouping those by different regions that they belong to, we determined the standing of countries relative to each other in terms of bank efficiency. And the last aspect that we addressed in the thesis was the assessment of the 2007 credit crunch impact on the bank efficiency, both from the cost side as well as profit side perspective. In a nutshell, these are the primary aspects that we were able to investigate using the simplest version of the frontier analysis technique, namely Stochastic Frontier Analysis as proposed by Aigner, Lovell and Schmidt (1977) and Meeusen and van Den Broeck (1977). But the main storylines can be nicely complemented by secondary findings that revealed interesting facts about the development process in the world as a whole. We did not dig in the private story of each bank, as the scope and time constraints did not allow for such an intrusion, but further research could be undertaken in this direction and some answers could be provided even at a more discrete level.

The Top 1000 World Banks ranking published by "The Banker" magazine every year appears to be a useful guideline in terms of banking trends, but it lacks the rigor of an academic research and thus provides just a glimpse inside an industry which is far too intricate to be grasped in a single edition. Moreover, the publication takes as the primary measure for its ranking the Tier 1 capital, which reflects the size of a bank, on one hand, and its soundness on the other hand. As this thesis proved, there is little or non-existent link between the rank of a bank in the Top and its rank as given by profit or cost efficiency. Japanese banks are the only

one in the sample for which we find that a higher rank in the Top 1000 is associated with both higher profit and cost efficiency. Such a finding confirms once again that a more thorough and a more into depth approach to ranking and assessing the performance of banks rather than pure size comparison is required. Thus, although an interesting guide, the Top 1000 ranking cannot be viewed more than just a preliminary introduction into the world of global banking.

This thesis also reveals as many other papers that the cost efficiency of big banks is on average higher than those of small banks. This finding is consistent across all regions. In some of the regions the differences are staggering, which indicates that, in terms of supervision and regulation as well as competition and competency some latent distortions are present. It is pertinent mostly for such regions as Latin America and African and some of the BRIC countries. However, we do not impinge for policy action; rather we encourage further scrutiny of the issue.

The profit efficiency and bank size is a more complex story. On the whole sample the profit inefficiencies for both, big and small, banks are almost equal. Across the regions, the situation is different. In Japan the difference in efficiency between big and small banks is overwhelmingly in the favor of the big banks. As the research reveals, small Japanese banks were hit by the crisis disproportionately harder than their bigger peers. In Europe the opposite situation is attested. The US big and small groups share similar efficiency scores while for the rest of the world the results are mixed and no discernible pattern can be revealed.

The size of the bank matters in terms of cost efficiency while there is no conclusive evidence for the profit efficiency. Apparently, in times of financial distress, it pays out to have a smaller balance sheet size as this ensures a higher rate of adjustment and a more mobile reorientation of the resources and thus a higher profit efficiency ratio. This inference is primarily based on the fact that Asian big banks fared relatively better than small Asian banks. Whether this is really the case, remains an issue for further research.

In our quest to determine which countries have a more efficient banking system, the developed or the emerging economies, an equivocal result was obtained. There are two reasons that might have determined it. The first one relates to the period for which we undertake the analysis. It contains a period of distress for most of the banks in the sample and thus it might distort sizably the overall picture. The second reason pertains to the fact that there might have been un-grasped changes in banking technology, in a XXI century world which is dominated by high speed information sharing and a tremendous flow of financial and

human capital from one region to another. In other words we might be the witnesses of convergence in banking technology across the globe. In such an environment is a rather short period of time we would not be able to talk about the dominance of one nation over the other. It seems that banking, as a proxy for financial power, and politics go hand in hand in a globalized economy in which a flattening of the world is witnessed – and it takes place on all directions – both horizontally as well as vertically.

Exceptions to the above are, however, legitimate. There seems that countries with autocratic regimes share common features in terms of banking as well. First, their banking systems are dominated by huge governmental banking machines. Institutions that lack rigor and are disdainful in cost management whereas capitalize on their dominant positions and reap handsome profits and market shares disadvantaging the privately owned banks. The private banks from such countries; Egypt and Iran namely, have a rather competitive profile and record inefficiencies comparable to the banks from the developed countries. Thus it seems that the business and financial potential of these countries are far from being fully explored and could be fructified in a much better way. In the context of this year's Arab Spring the prospects for the banks in the region change substantially and we might witness new and stronger players in terms of banking on the global arena in the very near future.

The country analysis also revealed the weakest spots in banking apart from those in the autocratic states. Worrisome trends have been attested for German, Japanese and Dutch banks. All of these banking systems face challenges that have to be addressed in a bold and timely manner by the respective authorities. Otherwise their banking systems might lose ground in terms of competitiveness in the very near future. Moreover it might pose systemic threats and disrupt the natural economic processes with repercussions on the social side as well. The political elites in these countries should acknowledge the severity of such problems and act in a responsible and proficient manner.

The most surprising, yet worthy, finding is related to the Middle Eastern banks. Their average performance in terms of efficiency was above the average for the whole period. The emergence of Islamic banking is thus a sure and attested thing. Moreover, the Sharia complaint principles earned the attention of both academics and policy makers in the West. Apart from spotting the rise of the Islamic banking the thesis did not address any other related issues. It could, however, serve as a good starting point for a more thorough analysis and assessment of the Islamic banking *per se*.

The crisis impact, the last aspect treated in the thesis, had also revealed some interesting facts. First of all we attested a disproportionate impact on banks from different regions. Although it was expected the clear delimitation was rather surprising. Three different groups could be patterned. The first one comprises banking systems that were severely hit by the crisis – the USA, Latin America, Europe, Australia, Canada and South Africa. The second group is that of countries with mild repercussions from the crisis – Asia, Japan and Africa. And the last category consists of banks that were unaffected by the crisis. This group is formed only by Middle Eastern banks, which on average had better profit efficiency scores during the crisis than before it.

Second, the impact on the same banks was different from the point of view of cost and profit efficiency. It was attested that banks managed to improve their cost efficiency during the crisis while they lost in terms of profit efficiency. This finding is not counterintuitive. On the contrary it resembles well the theory. In times of distress bank management tries to alleviate the mounting pressures from the shareholders, supervisory authorities and depositors by optimizing the bank activity to the maximum. On the other hand the profit efficiency is primarily a reflection of the revenue side which is tougher to manage and remains primarily at the discretion of the market, the demand side. We also find that occasionally the most profit inefficient banks are the most cost efficient banks, although this finding is hard to extend to the whole sample – as the Spearman's rank correlation shows.

The last finding refers to what we call the tantamountization effect, i.e. we find that although the crisis increased the profit inefficiencies for the banks situated in some countries they shrunk in the immediate aftermath. Moreover a uniform amount of inefficiencies seem to have been posted by all the regions in the aftermath. Thus we attest a flattening of the world, Thomas Friedman's metaphor, of the global banking industry. Of course this flattening process is bumpy and many banking systems are still shadowy of what they could really be.³¹ The developed economies, albeit hit harder, were able to recover faster than the emerging markets. Thus while many experts, academics and politicians expressed their worries regarding the prospects for future development of the banking sector in the actual format, these results come to alleviate some of them and show that banks can adapt swiftly to the new conditions and can even progress by eliminating some of the inefficiencies. The causes of such abrupt but efficient adjustments remain to be determined. At a very shallow look it

³¹ See the discussion about Egyptian and Iranian banks on the previous page

appears that changes in management, stricter corporate governance rules with stiffer internal controls and limited bonus packages have already played a role. All of these are evidently just a tiny part of the overall causes. It might turn out that government intervention with huge bailout packages and quantitative easing had a far greater role in the recovery of the banking sectors, mainly in Europe and the USA.

Although all of the findings we discussed so far offer an intuitive picture regarding the global banking industry, we must remain cognizant of the main assumptions behind the model and its interpretation. First we would like to remind that the simplest of the now available model specifications was used. This, albeit parsimonious, fails to account for a variety of situations and important settings that could otherwise create outcomes that are more robust than the one we presented. In terms of methodology the model may suffer substantial changes – from the form of the cost and profit function, choice of inputs and outputs and to the final model specification, different distributional forms and even different iteration procedures.

The choice of the form of the function remains irrelevant as the impact on the ultimate results is marginal. On the other hand, the choice of inputs and outputs is crucial. We were constrained to use only aggregate level variables, such as Total Earning Assets as an output which hampered our inference potential and left us without much of an economic interpretation of the model. Moreover, by using a more detailed input and output framework we could have spotted the main reasons that determined the loss of profit efficiency during the crisis and also we could have determined what specific techniques were used by the management of the banks to improve cost efficiency. We could have also been able to determine the impact of the government aid to certain financial institutions during the crisis, and this could have provided insights to whether such interventions are worthy or have undesired consequences.

In terms of the model specification the discussion is more extensive. There is no consensus in the literature regarding the best model specification. Anyway for a thorough and conclusive study we would recommend a panel data setting, but a balanced panel rather than an unbalanced one. The balanced panel offers a wider range of specifications and is more flexible than the unbalanced one. Using a balanced panel dataset both Fixed Effects as well as Random Effects models can be applied. It is argued in the literature that the Random Effects is better at capturing differences in efficiency in time than the Fixed Effects model. We applied a model with time invariant inefficiency which given the economic distress of 2007-

2008 is of course a strong assumption. To alleviate such problems panel data models with time-varying inefficiency could be used instead, as for instance in Farsi, Filippini and Greene (2005), Farsi, Filippini and Greene (2005a) or W. Greene (2005). The model could also be allowed to include latent classes as in Orea and Kumbhakar (2004). The Alvarez, Amsler and Orea (2006) scaling model or Alvarez, Arias and Greene (2004) model of unobservable firm specific characteristic models might also produce interesting results that would shed light on the managerial practices around the globe. These are just a few of all possible formulation that exist nowadays in the field of efficiency estimation. The choice of the model and its robustness checking remains an open question. Unfortunately there is no consensus with regard to the most suitable model, and every single time a researcher tries to apply any of these models he has to be able to consider all the characteristics of the data he has and then try fit and test the results among the models according to P. W. Bauer, A. N. Berger, et al. (1998) criteria.

The hypothesis we tested could also be extended or particularized to certain issues. A more thorough analysis of the crisis could be undertaken on a regional level. For instance the assessment of European, Chinese, Japanese, American Latin American bank efficiency under financial distress could be assessed using single, regional frontiers. The impact of the shrinking leverage, worsening of the market liquidity, government intervention, changes in the regulatory environment, changes in the corporate governance rules, prohibition of exaggerated performance bonuses, quality of the loan portfolios, diversification of banking services, branching, international or local activity profile and many other factors could be accounted in to determine the inefficiency and its change in time.

Another plateau for research would be to use the sample of the biggest banks from different countries with foreign and local ownership and test whether the domestically owned banks weathered the crisis in a better way than the foreign owned subsidiaries or not. In the same realm a comparative efficiency analysis could be undertaken to see whether there is any difference in efficiency between the central bank and its subsidiaries or banks it owns. This would provide information for countries that are still to privatize their banking sector whether there is any spill-over effect in terms of efficiency from the center to the periphery.

By dividing the banks by their specialization or line of business we would also be able to determine which business model was more resilient to the crisis and which model performs better in normal economic conditions. This could also, potentially, be of high interest for

policy makers and investors, as they would know the kinds of activity that have to be incentivized and which have to be restricted or monitored vigilantly.

The area of issues and extensions to this thesis subject does not, in any case, culminate with the ones we have spotted. On the contrary many other, more intricate and interesting could be formulated. The topic itself is broad and current crisis makes it even more challenging and engaging as many more issues emerge out of it. For instance, financial regulatory reforms have been put on the agenda both in the USA and Europe. The Basel Committee on Banking Supervision has already commenced its extensive revision of Basel II framework and formulated a new, more severe Basel III framework. The impact of such a change in regulatory framework on bank efficiency could on its own serve as a good starting point for further research.

This thesis is just a "scratch of the surface" to put it metaphorically. The area of productivity research in banking in the light of the most recent events seems an insatiable undertaking. For this reason we did not aim at disentangling the whole complexity of the global banking issue. Instead we shed some light on pertinent aspects that directly relate to crisis issues. There might not be a general consensus regarding which of the banking systems is the best, but there is a general picture forming, and this picture shows a very uniform banking technology across nations. With further advances in technology and communication, the only significant factor in determining the relative advantage of one banking system over the other will remain the human factor – the most unpredictable and hard to measure.

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Appendix

Appendix 1-A - Write-downs by Firm 2008 (USD billions)

Firm	Country	Write-down	Credit Loss	Total
Citigroup	US	37.3	5.6	42.9
UBS	CH	38.2		38.2
Merrill Lynch	US	37		37
HSBC	UK	6.9	12.6	19.5
IKB Deutsche	DE	16		16
Royal Bank of Scotland	UK	15.2		15.2
Bank of America	US	9.2	5.7	14.9
Morgan Stanley	US	12.6		12.6
JPMorgan Chase	US	5.5	4.2	9.7
Credit Suisse	CH	9.5		9.5
Washington Mutual	US	1.1	8	9.1
Credit Agricole	FR	8.3		8.3
Deutsche Bank	DE	7.7		7.7
Wachovia	US	4.6	2.4	7
HBOS	UK	6.9		6.9
Bayerische Landesbank	DE	6.7		6.7
Fortis	BE	6.6		6.6
Societe Generale	FR	6.3		6.3
Mizuho Financial Group	JP	6.2		6.2
ING Groep	NL	6		6
Barclays	UK	5.2		5.2
WestLB	DE	4.8		4.8
Canadian Imperial (CIBC)	CA	4.2		4.2
LB Baden-Wuerttemberg	DE	4		4
E*Trade	US	2.5	0.9	3.4
Dresdner	DE	3.4		3.4

Natixis	FR	3.4		3.4
Wells Fargo	US	0.6	2.7	3.3
Lehman Brothers	US	3.3		3.3
Bear Stearns	US	3.2		3.2
National City	US	0.5	2.6	3.1
Goldman Sachs	US	3		3
BNP Paribas	FR	2.1	0.6	2.7
Lloyds TSB	UK	2.7		2.7
Nomura Holdings	JP	2.5		2.5
HSH Nordbank	DE	2.5		2.5
ABN Amro	NL	2.4		2.4
Bank of China	CN	2		2
Commerzbank	DE	1.9		1.9
Royal Bank of Canada	CA	1.7		1.7
UniCredit	IT	1.6		1.6
DZ Bank	DE	1.5		1.5
Alliance & Leicester	UK	1.4		1.4
Dexia	BE	1.1	0.2	1.3
Caisse d'Epargne	FR	1.2		1.2
Hypo Real Estate	LU	1		1
Gulf Intl	BH	1		1
European banks not listed above(a)		9.2		9.2
Asian banks not listed above (b)		7.5	0.3	7.8
North American banks not listed above (c)		3	1.1	4.1
TOTALS*		332.3	46.9	379.2

Note:

(a) European banks whose losses are less than \$1 billion each are in this group: Allied Irish Banks, Bradford & Bingley, Aareal Bank, Deutsche Postbank, Standard Chartered, Northern Rock, NordLB, Rabobank, HVB Group, Sachsen LB, Intesa Sanpaolo, Landesbank Hessen-Thüringen, SEB AB, Erste Bank, DnB NOR, Anglo Irish, KBC Group, LB Berlin, NIBC Holding.

(b) Asian banks with writedowns of less than \$1 billion: Mitsubishi UFJ, Shinsei, Sumitomo Trust, Aozora Bank, DBS Group, Australia & New Zealand Banking Group, Abu Dhabi Commercial, Bank Hapoalim, Arab Banking Corp., Fubon Financial, Industrial & Commercial Bank of China, Citic International, BOC Hong Kong, Bank of East Asia, China Construction Bank, Sumitomo Mitsui, ICICI Bank, State Bank of India, United Overseas, Wing Lung.

(c) North American banks included in this group: Bank of Montreal, National Bank of Canada, Bank of Nova Scotia, BB&T Corp., PNC Financial Services Group, SunTrust Banks, South Financial Group, Sovereign Bancorp, First Horizon.

Appendix 2-A: Summary Statistics for Profit and Cost Function Variables

Variable	Units		2005	2006	2007	2008	2009
Dependent Variables							
TC	th. USD	MEAN	2302262	3205770	4065036	4167096	3558575
		MIN	4148	5274	5494	8818	15300
		MAX	8.30E+07	1.10E+08	1.39E+08	1.47E+08	9.65E+07
		STD. DEV	7346472	1.04E+07	1.30E+07	1.27E+07	9970376
PRO	th. USD	MEAN	638984.4	831925.5	826351.1	233383.6	421445.1
		MIN	-1454584	-789690	-3324745	-5.95E+07	-1.85E+07
		MAX	3.65E+07	3.20E+07	2.42E+07	2.40E+07	2.72E+07
		STD. DEV	2211649	2639363	2483253	3304449	2291680
Cost and Alternative Profit Function Variables							
Q1	th. USD	MEAN	5.92E+07	7.07E+07	8.52E+07	8.98E+07	9.30E+07
		MIN	104203	96319	243900	234500	280400
		MAX	1.65E+09	1.91E+09	3.48E+09	3.38E+09	2.67E+09
		STD. DEV	1.86E+08	2.21E+08	2.81E+08	2.99E+08	2.82E+08
Q2	th. USD	MEAN	3.07E+07	3.49E+07	4.06E+07	4.34E+07	4.91E+07
		MIN	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		MAX	1.10E+09	1.01E+09	1.37E+09	1.21E+09	1.43E+09
		STD. DEV	9.24E+07	1.03E+08	1.21E+08	1.28E+08	1.44E+08
P1	ratio	MEAN	0.022261	0.022112	0.02139	0.021666	0.021816
		MIN	0.000271	0.000427	0.000335	0.000289	0.000267
		MAX	0.269477	0.386339	0.466387	0.499647	0.298952
		STD. DEV	0.017762	0.020716	0.021636	0.023181	0.01888
P2	ratio	MEAN	0.025208	0.029026	0.032031	0.034219	0.027003
		MIN	0.000238	0.000237	0.000278	9.17E-05	0.000724
		MAX	0.264388	0.207071	0.17119	0.253393	0.291927
		STD. DEV	0.020324	0.019143	0.018882	0.025004	0.023731
Z1	ratio	MEAN	7.05E+07	8.54E+07	1.11E+08	1.16E+08	1.22E+08
		MIN	132308	133874	261400	280200	308000
		MAX	2.03E+09	2.44E+09	4.61E+09	4.13E+09	3.51E+09
		STD. DEV	2.18E+08	2.63E+08	3.84E+08	3.93E+08	3.79E+08
Z2	ratio	MEAN	2991619	3736930	4449411	4464183	5560213
		MIN	-1.46E+07	-1.02E+07	-9.96E+07	-3644436	-1615698
		MAX	1.11E+08	1.32E+08	1.59E+08	1.39E+08	1.94E+08
		STD. DEV	9432857	1.12E+07	1.40E+07	1.24E+07	1.64E+07
Total no. of Observations			856	910	936	955	931

Appendix 3-A Summary Statistics for Profit and Cost Function Variables by Region

		2005			2006			2007			2008			2009		
	Variable	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
US	TC	3228216	9700	8.30E+07	4154935	13600	1.10E+08	4948490	16000	1.39E+08	4350819	16000	1.24E+08	3742102	15300	9.65E+07
	PRO	1065218	-31237	3.65E+07	1210684	-272000	3.20E+07	843498.3	-1942000	2.28E+07	-142831	-4.83E+07	4679000	255608	-7938000	1.86E+07
	Q1	5.30E+07	196100	1.34E+09	5.99E+07	227700	1.71E+09	6.76E+07	243900	1.92E+09	7.28E+07	234500	1.90E+09	7.23E+07	280400	1.75E+09
	Q2	2.54E+07	0	6.35E+08	2.80E+07	0	7.12E+08	3.20E+07	0	8.26E+08	3.88E+07	0	1.01E+09	4.05E+07	0	9.92E+08
	P1	0.030014	0.004549	0.269477	0.031035	0.004475	0.386339	0.031269	0.00378	0.466387	0.033246	0.003659	0.499647	0.034167	0.004407	0.298952
	P2	0.021615	0.008456	0.04939	0.030423	0.01227	0.062095	0.033686	0.011208	0.074043	0.025024	0.007907	0.079782	0.016688	0.00345	0.058884
	Z1	6.35E+07	213900	1.49E+09	7.14E+07	243500	1.88E+09	1.13E+08	261400	3.92E+09	1.19E+08	280200	3.77E+09	1.25E+08	308000	3.33E+09
	Z2	4657410	15200	1.11E+08	5245058	17300	1.32E+08	5717857	18900	1.42E+08	5587227	16900	1.39E+08	7310377	9700	1.94E+08
Japan	TC	1071526	64276	2.25E+07	1177760	59625	2.62E+07	1426846	63171	3.17E+07	1835893	84116	4.18E+07	1691123	91896	3.65E+07
	PRO	354659.8	-1011644	8784351	640545.2	-171210	1.76E+07	541291.6	-510166	1.28E+07	465807.4	-992777	1.02E+07	-214957	-7954128	2728328
	Q1	8.00E+07	4169539	1.65E+09	7.28E+07	3877342	1.34E+09	7.31E+07	3989146	1.37E+09	8.52E+07	4722648	1.63E+09	9.11E+07	4840163	1.75E+09
	Q2	5.62E+07	0	1.10E+09	5.19E+07	0	1.01E+09	5.28E+07	0	1.01E+09	6.26E+07	0	1.21E+09	6.64E+07	0	1.22E+09
	P1	0.012019	0.0018	0.017186	0.011775	0.001656	0.019046	0.011648	0.001641	0.020029	0.011866	0.001797	0.02896	0.012089	0.001634	0.041038
	P2	0.001687	0.000238	0.013073	0.002275	0.000237	0.026359	0.003529	0.001001	0.035886	0.005159	0.002417	0.046913	0.004261	0.00252	0.02064
	Z1	8.56E+07	4295296	1.81E+09	8.04E+07	3972743	1.60E+09	7.97E+07	4087361	1.60E+09	9.45E+07	4864895	1.93E+09	1.01E+08	5015708	2.03E+09
	Z2	1807380	-1.46E+07	3.05E+07	2210034	-1.02E+07	4.16E+07	2558792	-5053973	5.15E+07	3287701	-3644436	6.77E+07	3407580	-1615698	6.75E+07
EUROPE	TC	3400681	14157	6.06E+07	5252660	18175	9.34E+07	6983113	21829	1.24E+08	7230885	25051	1.47E+08	5549947	19448	9.00E+07
	PRO	805416.4	-208572	2.10E+07	1120408	-196365	2.21E+07	1111960	-3324745	2.42E+07	-99001.2	-5.95E+07	1.56E+07	314985	-1.85E+07	1.53E+07
	Q1	9.11E+07	534000	1.56E+09	1.20E+08	672494	1.91E+09	1.53E+08	579806	3.48E+09	1.56E+08	488659	3.38E+09	1.50E+08	1045610	2.67E+09
	Q2	3.56E+07	0	7.39E+08	4.53E+07	0	8.97E+08	5.59E+07	0	1.37E+09	5.34E+07	0	1.12E+09	5.92E+07	0	1.17E+09
	P1	0.020773	0.000271	0.144939	0.020087	0.000427	0.15265	0.018947	0.000335	0.089214	0.018482	0.000289	0.08528	0.018453	0.000267	0.114307
	P2	0.02509	0.002039	0.078416	0.02843	0.000845	0.122376	0.034629	0.000278	0.161902	0.039153	9.17E-05	0.165089	0.030401	0.000724	0.128385
	Z1	1.08E+08	777400	2.03E+09	1.41E+08	818048	2.44E+09	1.88E+08	596506	4.61E+09	1.90E+08	1102208	4.13E+09	1.84E+08	1228728	3.51E+09
	Z2	3979854	5228	9.14E+07	5240155	113730	1.02E+08	6853244	245418	1.59E+08	5978639	-2098671	9.57E+07	7468845	226029	1.34E+08
Middle East	TC	623663.5	4148	3926136	784417.4	5274	5464846	1060112	5494	7763876	1104278	8818	7204628	1037602	55518	6726675
	PRO	288693.5	-26195	1597040	320528.2	357	1949773	384556.6	-757600	2549694	294000.9	-1301323	1788718	372643	-181311	2972567
	Q1	1.05E+07	104203	5.66E+07	1.23E+07	96319	6.29E+07	1.62E+07	450824	7.55E+07	1.78E+07	942802	7.04E+07	1.93E+07	1147442	8.12E+07

	Q2	7737658	0	4.65E+07	8828416	0	5.14E+07	1.18E+07	0	6.03E+07	1.34E+07	0	5.97E+07	1.48E+07	634801	6.61E+07
	P1	0.017281	0.00097	0.043936	0.018979	0.00159	0.063556	0.018473	0.001692	0.118243	0.018212	0.002062	0.068842	0.017636	0.005044	0.049598
	P2	0.037808	0.003608	0.129161	0.041667	0.002756	0.111041	0.043302	0.001808	0.123477	0.041888	0.003119	0.123497	0.03511	0.001732	0.131484
	Z1	1.55E+07	132308	9.84E+07	1.81E+07	133874	9.83E+07	2.46E+07	497692	1.18E+08	2.70E+07	1031401	1.24E+08	2.86E+07	1303053	1.31E+08
	Z2	1199631	63236	5481948	1456214	95742	7277181	1911129	128218	1.02E+07	2045172	137706	7860796	2336723	246658	1.03E+07
ASIA	TC	1209740	11841	1.97E+07	1452826	20503	2.25E+07	1721875	24907	3.05E+07	2173863	32995	3.95E+07	2171862	37728	3.85E+07
	PRO	375895.8	-1454584	8976853	451955.2	-789690	1.07E+07	669887.3	-1284299	1.78E+07	719011.6	-375906	2.40E+07	852350.4	-250455	2.72E+07
	Q1	3.57E+07	193250	7.77E+08	3.90E+07	565801	8.52E+08	4.55E+07	837892	1.16E+09	5.45E+07	973314	1.39E+09	6.78E+07	1311069	1.68E+09
	Q2	2.88E+07	0	7.11E+08	3.15E+07	0	8.13E+08	3.53E+07	0	9.44E+08	4.32E+07	0	1.20E+09	5.41E+07	0	1.43E+09
	P1	0.016898	0.005598	0.08708	0.01617	0.004568	0.052254	0.015701	0.003764	0.066973	0.016582	0.00499	0.17537	0.016897	0.004383	0.157393
	P2	0.025537	0.008179	0.06853	0.029223	0.005824	0.08227	0.030574	0.005475	0.084267	0.033942	0.014521	0.099117	0.028658	0.005717	0.085348
	Z1	4.63E+07	301311	8.54E+08	5.31E+07	811439	1.05E+09	6.12E+07	1025577	1.30E+09	7.42E+07	1186594	1.56E+09	8.96E+07	1728200	1.91E+09
	Z2	1975040	-316076	3.56E+07	2519230	-23371	6.03E+07	2369811	-9.96E+07	7.44E+07	3563481	57326	8.88E+07	4280359	261035	9.94E+07
Rest of the World	TC	2980320	27200	2.05E+07	4031158	29200	2.62E+07	5123210	34900	3.53E+07	4973089	44000	2.83E+07	4980899	67100	3.10E+07
	PRO	707126.6	8260	4589650	1052490	2.05E+04	5500133	1301449	16400	7.44E+06	733889.6	-3501850	6.02E+06	1076055	-82718	1.05E+07
	Q1	5.04E+07	229334	3.71E+08	6.80E+07	318500	4.46E+08	8.55E+07	341200	5.88E+08	8.63E+07	364000	5.44E+08	9.85E+07	2189175	5.66E+08
	Q2	3.07E+07	148200	2.31E+08	3.97E+07	213600	2.70E+08	4.85E+07	117613	3.54E+08	4.83E+07	318900	3.36E+08	5.74E+07	228495	3.58E+08
	P1	0.03505	0.000762	0.074667	0.030036	0.000606	0.065095	0.030107	0.000844	0.096864	0.027339	0.000954	0.072646	0.030494	0.001437	0.086482
	P2	0.035487	0.016877	0.104062	0.036038	0.014914	0.082303	0.037443	0.010618	0.075176	0.038321	0.013088	0.082558	0.036992	0.004741	0.106879
	Z1	6.52E+07	336020	4.61E+08	9.13E+07	372000	5.87E+08	1.19E+08	412400	8.45E+08	1.19E+08	439800	8.62E+08	1.35E+08	2825400	8.90E+08
	Z2	2695147	11560	1.62E+07	3718864	20378	1.88E+07	4726295	29862	2.39E+07	5074769	49199	2.58E+07	6555525	401243	3.42E+07
Latin America	TC	1548624	17839	1.48E+07	1753992	37644	1.68E+07	2291773	82573	2.25E+07	2306065	121819	2.38E+07	2830399	61925	3.63E+07
	PRO	357048.6	12223	3311039	329547.6	-22978	2979131	497158.6	26015	5953868	411970.5	-4428	4686285	619530.7	-213700	8073316
	Q1	1.17E+07	885375	9.20E+07	1.42E+07	864263	1.19E+08	2.02E+07	1572272	1.76E+08	1.95E+07	1615692	1.88E+08	2.88E+07	1688514	3.47E+08
	Q2	6739919	159031	5.65E+07	8208034	166516	7.20E+07	1.14E+07	357974	1.03E+08	1.16E+07	550467	1.10E+08	1.60E+07	618942	1.87E+08
	P1	0.052122	0.004581	0.151044	0.056648	0.002491	0.198023	0.052459	0.001282	0.194729	0.050866	0.001181	0.223276	0.044815	0.001071	0.119575
	P2	0.061498	0.00306	0.264388	0.057062	0.004756	0.207071	0.049457	0.007086	0.17119	0.074217	0.009169	0.253393	0.050729	0.000946	0.291927
	Z1	1.64E+07	1131650	1.45E+08	1.98E+07	1094784	2.00E+08	2.93E+07	2576113	3.07E+08	2.92E+07	3148470	3.31E+08	4.40E+07	3050900	5.91E+08
	Z2	1105011	81324	8102654	1357483	124520	1.16E+07	1851897	130833	1.72E+07	1650680	239491	1.48E+07	2363708	324941	2.44E+07

Appendix 4-A: Panel-Data Cost and Profit Estimation Descriptive Statistics by Group

	Variable	Mean	Std. Dev.	Min	Max
Total	CI	0.204472	0.143021	0.00128	0.99125
	PI	0.310305	0.182492	0.0423	0.999662
Rest of the World	CI	0.142528	0.132283	0.004641	0.727908
	PI	0.31955	0.200625	0.064353	0.979016
Japan	CI	0.199539	0.179189	0.005073	0.926606
	PI	0.287716	0.181786	0.047316	0.999662
US	CI	0.19905	0.127849	0.004321	0.891331
	PI	0.295761	0.166045	0.063733	0.9699
Europe	CI	0.221498	0.144987	0.006465	0.99125
	PI	0.315105	0.191705	0.048632	0.99195
Middle East	CI	0.20354	0.147154	0.009737	0.986
	PI	0.323134	0.187369	0.082283	0.928954
Asia	CI	0.206713	0.133872	0.00128	0.920336
	PI	0.311617	0.174809	0.0423	0.98578
Latin America	CI	0.21107	0.126668	0.009737	0.590185
	PI	0.337774	0.180024	0.047316	0.928954

Appendix 5-A: Cross-section Yearly 2005 – 2009 Cost and Profit Inefficiency

	Variable	Mean	Std. Dev.	Min	Max	Variable	Mean	Std. Dev.	Min	Max
TOTAL Sample	CI2005	0.095319	0.052276	0.008951	0.338888	PI2005	0.362934	0.180425	0.026414	1
	CI2006	0.067838	0.031559	0.008946	0.3387	PI2006	0.272406	0.149834	0.026414	1
	CI2007	0.15519	0.087296	0.010736	0.406449	PI2007	0.278544	0.156861	0.026414	1
	CI2008	0.142769	0.086158	0.011076	0.419307	PI2008	0.34689	0.218881	0.026414	1
	CI2009	0.132876	0.078898	0.009435	0.357185	PI2009	0.239949	0.138873	0.026414	1
Rest of the World	CI2005	0.102574	0.073273	0.024217	0.338888	PI2005	0.481686	0.241262	0.056672	1
	CI2006	0.060533	0.031854	0.017095	0.224365	PI2006	0.341688	0.210034	0.054097	1
	CI2007	0.156497	0.110419	0.025145	0.406449	PI2007	0.305603	0.198251	0.046668	1
	CI2008	0.155551	0.119677	0.024598	0.419307	PI2008	0.407326	0.236943	0.026414	1
	CI2009	0.124441	0.088939	0.019132	0.357185	PI2009	0.249533	0.114617	0.0411	1
Japan	CI2005	0.09296	0.032178	0.02108	0.200641	PI2005	0.379997	0.202752	0.136572	1
	CI2006	0.063739	0.010153	0.023647	0.093808	PI2006	0.248662	0.107314	0.093148	0.67312
	CI2007	0.220001	0.092326	0.03685	0.406449	PI2007	0.243112	0.112847	0.066686	0.581468
	CI2008	0.1653	0.078574	0.055787	0.419307	PI2008	0.268603	0.175152	0.080727	1
	CI2009	0.170517	0.066558	0.043933	0.357185	PI2009	0.290021	0.270298	0.026414	1
The United States	CI2005	0.102231	0.032072	0.043484	0.338888	PI2005	0.3073	0.126439	0.115519	0.913145
	CI2006	0.077293	0.01793	0.032162	0.215149	PI2006	0.250849	0.10189	0.026414	0.722305
	CI2007	0.174154	0.057194	0.040267	0.406449	PI2007	0.250213	0.130418	0.095796	1
	CI2008	0.143067	0.068455	0.049064	0.419307	PI2008	0.344862	0.231534	0.070403	1
	CI2009	0.136457	0.077695	0.038196	0.357185	PI2009	0.231977	0.147334	0.049879	0.936136
Latin America	CI2005	0.101552	0.060831	0.011722	0.253021	PI2005	0.423637	0.206533	0.06294	1
	CI2006	0.08534	0.061194	0.017024	0.3387	PI2006	0.315825	0.2279	0.050094	1
	CI2007	0.181285	0.113723	0.018229	0.406449	PI2007	0.299414	0.169995	0.039467	0.69441
	CI2008	0.163394	0.119764	0.023762	0.419307	PI2008	0.445316	0.230759	0.058535	1
	CI2009	0.156048	0.098098	0.017618	0.357185	PI2009	0.258321	0.109896	0.093677	0.631818
Asia	CI2005	0.101463	0.059442	0.028149	0.338888	PI2005	0.319755	0.169315	0.056677	1
	CI2006	0.07117	0.041385	0.026948	0.309756	PI2006	0.246492	0.14391	0.057835	1

	CI2007	0.136645	0.069224	0.02655	0.406449	PI2007	0.261849	0.141921	0.026414	1
	CI2008	0.134846	0.090736	0.02231	0.419307	PI2008	0.305582	0.180147	0.075423	1
	CI2009	0.12609	0.075737	0.020037	0.357185	PI2009	0.251614	0.094151	0.116078	0.879302
Middle East	CI2005	0.112749	0.078973	0.022861	0.338888	PI2005	0.382876	0.185099	0.026414	1
	CI2006	0.071301	0.044389	0.016124	0.232863	PI2006	0.309954	0.15888	0.02819	1
	CI2007	0.163486	0.099299	0.044604	0.406449	PI2007	0.31148	0.136793	0.047543	1
	CI2008	0.143553	0.090542	0.011076	0.419307	PI2008	0.265095	0.159626	0.040525	0.823986
	CI2009	0.141544	0.082551	0.023518	0.357185	PI2009	0.222118	0.071089	0.097576	0.404073
Europe	CI2005	0.082287	0.044791	0.008951	0.338888	PI2005	0.375491	0.166511	0.064823	1
	CI2006	0.060846	0.021002	0.008946	0.168279	PI2006	0.277244	0.14794	0.089085	1
	CI2007	0.130474	0.081507	0.010736	0.406449	PI2007	0.29797	0.177299	0.045864	1
	CI2008	0.133986	0.074008	0.011076	0.419307	PI2008	0.392766	0.2359	0.044118	1
	CI2009	0.119707	0.074302	0.009435	0.357185	PI2009	0.220029	0.112799	0.043259	0.962834

Appendix 6-A: Cost and Profit Inefficiency by Country

Nr. Of Banks	Country	CE	PE	Nr. Of Banks	Country	CE	PE
2 banks	<i>Andorra</i>	7.04%	16.89%	>5	<i>Israel</i>	12.03%	40.07%
>5	<i>Arab Emirates</i>	29.34%	17.22%	>5	<i>India</i>	25.01%	60.58%
1 bank	<i>Angola</i>	17.89%	8.23%	>5	<i>Iran</i>	38.62%	55.18%
>5	<i>Argentina</i>	38.41%	30.78%	1 bank	<i>Iceland</i>	51.97%	36.33%
>5	<i>Austria</i>	21.80%	27.34%	>5	<i>Italy</i>	13.64%	29.28%
>5	<i>Australia</i>	14.58%	31.63%	3 banks	<i>Jordan</i>	14.06%	55.62%
1 bank	<i>Azerbaijan</i>	33.48%	11.70%	>5	<i>Japan</i>	22.00%	24.14%
3 banks	<i>Belgium</i>	23.94%	34.30%	>5	<i>South Korea</i>	15.44%	30.35%
1 bank	<i>Bulgaria</i>	21.87%	44.76%	>5	<i>Kuwait</i>	21.67%	16.16%
>5	<i>Bahrain</i>	36.63%	25.93%	>5	<i>Kazakhstan</i>	31.50%	12.70%
1 bank	<i>Bermuda</i>	11.67%	78.80%	>5	<i>Lebanon</i>	37.41%	32.18%
>5	<i>Brazil</i>	8.56%	50.73%	3 banks	<i>Lichtenstein</i>	35.74%	17.93%
2 banks	<i>Belarus</i>	43.36%	48.76%	3 banks	<i>Luxembourg</i>	15.32%	48.41%
1 bank	<i>Belize</i>	30.36%	41.88%	1 bank	<i>Latvia</i>	11.09%	29.90%
>5	<i>Canada</i>	6.03%	32.21%	1 bank	<i>Libya</i>	99.13%	4.86%
>5	<i>Switzerland</i>	16.70%	53.82%	3 banks	<i>Morocco</i>	17.89%	30.49%
>5	<i>Chile</i>	16.66%	26.25%	1 bank	<i>Myanmar</i>	76.51%	92.43%
>5	<i>China</i>	11.42%	21.08%	1 bank	<i>Malta</i>	13.89%	21.01%
3 banks	<i>Colombia</i>	20.34%	21.27%	1 bank	<i>Mauritius</i>	14.12%	36.32%
2 banks	<i>Costa Rica</i>	37.86%	51.05%	3 banks	<i>Mexico</i>	26.81%	38.27%
1 bank	<i>Cuba</i>	92.03%	5.65%	>5	<i>Malaysia</i>	26.84%	16.67%
3 banks	<i>Cyprus</i>	17.47%	21.90%	>5	<i>Nigeria</i>	13.28%	30.70%
>5	<i>Germany</i>	25.90%	53.02%	>5	<i>Netherlands</i>	22.80%	34.59%
>5	<i>Denmark</i>	15.99%	25.56%	>5	<i>Norway</i>	6.91%	20.08%
1 bank	<i>Dominican</i>	16.38%	44.38%	>5	<i>Oman</i>	11.56%	20.78%
>5	<i>Egypt</i>	43.70%	25.83%	2 banks	<i>Panama</i>	25.93%	23.86%
>5	<i>Spain</i>	12.40%	27.42%	2 banks	<i>Peru</i>	36.92%	19.11%
1 bank	<i>Finland</i>	7.38%	43.80%	>5	<i>Philippines</i>	20.02%	32.74%
>5	<i>France</i>	7.88%	36.54%	>5	<i>Pakistan</i>	20.98%	17.31%
>5	<i>UK</i>	12.01%	25.86%	2 banks	<i>Poland</i>	18.48%	28.61%
1 bank	<i>Georgia</i>	27.47%	26.17%	>5	<i>Portugal</i>	14.75%	38.94%
>5	<i>Greece</i>	16.77%	19.49%	>5	<i>Qatar</i>	13.78%	15.63%
2 banks	<i>Guatemala</i>	16.57%	36.92%	1 bank	<i>Romania</i>	26.61%	36.92%
>5	<i>Hong Kong</i>	18.61%	33.39%	1 bank	<i>Serbia</i>	24.58%	51.73%
1 bank	<i>Hungary</i>	21.96%	26.59%	>5	<i>Russia</i>	32.98%	26.59%
>5	<i>Indonesia</i>	27.39%	29.73%	>5	<i>Saudi Arabia</i>	16.35%	15.13%
4 banks	<i>Ireland</i>	15.29%	20.52%	>5	<i>Sweden</i>	6.73%	20.55%
3 banks	<i>Trinidad-Tobago</i>	25.27%	25.71%	3 banks	<i>Singapore</i>	11.04%	15.05%
>5	<i>Taiwan</i>	18.23%	26.60%	4 banks	<i>Slovenia</i>	13.62%	25.21%
>5	<i>Ukraine</i>	33.58%	19.52%	1 bank	<i>Syria</i>	54.10%	9.32%
>5	<i>USA</i>	18.47%	31.58%	1 bank	<i>Togo</i>	16.40%	33.73%
1 bank	<i>Uruguay</i>	76.61%	13.80%	>5	<i>Thailand</i>	5.53%	24.48%
1 bank	<i>Uzbekistan</i>	36.10%	35.76%	3 banks	<i>Tunisia</i>	12.72%	23.75%
4 banks	<i>Venezuela</i>	7.69%	43.45%	>5	<i>Turkey</i>	16.60%	43.47%
>5	<i>Vietnam</i>	31.76%	20.04%	>5	<i>South Africa</i>	6.88%	28.14%