# UNIVERSIDADE TÉCNICA DE LISBOA

## INSTITUTO SUPERIOR DE ECONOMIA E GESTÃO

### DOUTORAMENTO EM: GESTÃO

# Market Structure, Competition and Efficiency in Brazilian Banking: 2002-2011

Mark Edward Wolters

Orientação: Professor Doutor Eduardo Barbosa do Couto

Composição do Júri:

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## Abstract

The past two decades have seen dramatic changes in the Brazilian banking sector. Deregulations in the 1990's and financial pressures in the 2000's have led to a more concentrated banking sector, though not overly concentrated. The Panzar Rosse model finds that Brazil was in monopolistic competition for the 2002-2011 period, and that the financial crisis of the late 2000's had a negative effect on competition.

Using Data Envelopment Analysis we find that over the 2002-2011 period Brazilian banks have become slightly less efficient, and that public banks are the most efficient while foreign banks are the least efficient. The larger banks are also more efficient than their smaller counterparts. The financial crisis also had a negative impact on efficiency with all ownership types and bank sizes losing efficiency, but less of a loss for larger banks. In terms of efficiency bigger is better in the Brazilian banking sector. Finally, due to multiple factors we find that the Brazilian banking sector is not participating in the "Quiet Life" scenario of concentrated markets.

## Resumo

As duas últimas décadas viram mudanças dramáticas no setor bancário brasileiro. Desregulamentação na década de 1990 e as pressões financeiras nos anos 2000 levaram a um setor bancário mais concentrado, embora não excessivamente concentrado. Utilizando o modelo de Panzar Rosse conclui-se que o Brasil estava em concorrência monopolística para o período 2002-2011, e que a crise financeira do final dos anos 2000 teve um efeito negativo sobre a concorrência.

Utilizando Data Envelopment Analysis descobrimos que ao longo do período 2002-2011 os bancos brasileiros se tornaram um pouco menos eficientes, e que os bancos públicos são os mais eficientes, enquanto os bancos estrangeiros são os menos eficientes. Os maiores bancos também são mais eficientes do que suas contrapartes de menor dimensão. A crise financeira também teve um impacto negativo na eficiência com todos bancos a perder a eficiencia independentemente do tamanhos e tipo de propriedade, apesar das perdas serem de menor dimensão para os bancos maiores. Em termos de eficiência quanto maior, melhor no setor bancário brasileiro. Finalmente, devido a múltiplos fatores puramos que o setor bancário brasileiro não está a aderir ao cenário "Quiet Life" de mercados concentrados.

Key Words: Banking, Brazil, Competition, Market Structure, Efficiency

# Table of Contents

# Abbreviations Index

AE – Allocative Efficiency

BOVESPA – Bolsa de Valores Mercadorias & Futuros de Sao Paulo

BRIC – Brazil, Russia, India, China

CAMEL (Capital adequacy, Asset quality, Management quality, Earnings ability and Liquidity position)

CDI – Certificate of Inter-Financial Deposit (Certificados de Deposito Interfianceiro)

CR – Concentration Ratio

CRS – Constant Return to Scale

DEA - Data Envelopment Analysis

DFA - Distribution Free Approach

DMU – Decision Making Unit

EE – Total Economic Efficiency

EU – European Union

FDH – Free Disposal Hull

FF – Fourier Flexible Functional Form

GDP – Gross Domestic Product

HI – Herfindahl Index

IA – Intermediation Approach

PROER – Program of Incentives to the Restructuring and Strengthening of the National Financial System

PA – Production Approach

PR – Panzar Rosse Model

PROES – Program of Incentives to the Reduction of the State-Level Public Sector in Bank Activity

ROA – Return on Assets

ROE – Return on Equity

SCP – Structure Conduct Performance Paradigm

SELIC – Sistema Especial de Liquidacao e Custodia or Overnight Rate

SFA - Stochastic Frontier Analysis

SME – Small and Medium Size Enterprises

TA – Total Assets

TD – Total Deposits

TFA – Thick Frontier Analysis

TE – Technical Efficiency

TL – Total Loans

VRS – Variable Return to Scale

WLS – Weighted Least Squares

# Figures, Tables and Charts Index

# Chapter 1: Introduction

## 1.1 The Purpose of the Thesis and Main Research Questions

This thesis sets out to analyze the Brazilian banking sector from 2002 to the first quarter of 2011. The thesis analyzes the developments in concentration and market structure in the industry. Additionally, it uses an established competition measure, the Panzar Rosse H-Statistic, to measure competition in the Brazilian banking sector. It further develops the relative efficiency scores for Brazilian banks with an input oriented Data Envelopment Analysis. Finally, the effects of the current financial crisis on competition and efficiency are calculated and analyzed. The main research questions deal with the developments in each of these areas over the period and are as follows.

- Has the Brazilian banking sector continued to consolidate over the period of the study?
- Has the Brazilian banking sector become concentrated to the point that the government should take action?
- What is the level of competition in the Brazilian banking sector?
- Has the concentration of the sector had a negative effect on competition?
- How has the current financial crisis effected the concentration in the Brazilian banking sector?
- Has the current financial crisis affected competition in the Brazilian banking sector?
- How efficient is the Brazilian banking sector?
- Does ownership type have any relation to efficiency in the Brazilian banking sector?

- Did the current financial crisis have any effect on efficiency in the Brazilian banking sector?
- Does the level of efficiency effect competition in the Brazilian banking sector?
- Is Bigger Better? Does Bank Size have any relation to efficiency in the Brazilian Banking Sector?
- Is the Quiet Life in effect in the Brazilian banking sector?

## 1.2 Introduction and Brief Summary of the Thesis

Over the past two decades Brazil has become an economic power on the world stage. Whether it is their increased voice in world affairs, e.g. World Trade Organization negotiations, continued developments in energy independence, agricultural commodities and industrial raw materials or increased participation in the world banking markets; Brazil has arrived on the world stage. Over this period of general development and change, the Brazilian banking sector has changed as well. From an economy of hyperinflation in the early 1990's to government liberalization and privatization in the late 1990's (resulting in a boom and bust of foreign banks) and finally the rise of dominant domestic banks, the result of all of these incidents is a concentration of the Brazilian banking market in the 2000's.

The Brazilian banking sector has seen not only an intense amount of concentration in terms of total assets, total deposits and total loans, but a high level of competition from 2002-2008, with a drop in competition in the 2009-2011 period due to the effects of the financial crisis. Competition itself is vital to any industry and with it comes winners and losers, regardless of government plans or actions. As a result certain banks have become more efficient and the more efficient banks have been able to win new customers as they are able to bring more value to their customers than their less efficient/competitive rivals. This can be seen in the

increase in market share of the largest banks as well as their consistently higher efficiency scores. Competition and the need for efficiency drives industries to be more concentrated and thus the stronger more efficient banks have become even larger at the expense of their less efficient/competitive rivals. This seems to be the scenario playing out in the Brazilian banking sector during the period of study.

Given the many recent changes in competition and market structure within the Brazilian banking sector, we set out to investigate how the banking market structure, banking efficiency, and overall competition have changed from 2002 to the beginning of 2011 in order to show their individual developments and to also see the effect of the financial crisis on each of them. Our study focuses on the 50 largest universal banks in Brazil on a quarterly basis and in terms of Total Assets. We analyze the market structure in terms of market concentration in Total Assets, Total Deposits and Total Loans with regard to bank size as well as ownership type (Public Banks which are owned by the federal or individual state governments, Domestic Private Brazilian Banks and Foreign Banks) in order to determine at what pace and in which way the Brazilian banking market structure has changed during the period.

Additionally, we apply the Panzar Rosse (PR) model in order to test for competition and hence market structure within the Brazilian banking sector. The Panzar Rosse model uses a so-called H-statistic as a measure of banking competition. It is based on a reduced revenue equation that uses factor input prices in order to test for competition while using concentration as a proxy for competition. We assessed the development of the H-Statistic over the period by dividing the 2002-2011 period into two separate time periods based on the

pre- and post-financial crisis point divided at the end of 2008 (2002-2008 and 2009-2011 being the two periods) in order to gauge market competition developments over the period.

Furthermore, we test for efficiency developments in the Brazilian banking sector using Data Envelopment Analysis (DEA) that allows us to surmise if banks' managerial decisions on cost controls are being affected by the concentration in the market and how efficiency may be affecting competition in the sector.

The results from our analyses show that over the period in question the concentration ratios for the top five and top ten banks in Brazil increased considerably over the period in terms of Total Assets and Total Loans with a less severe concentration increase in Total Deposits, while the total market share for the top 50 banks remained relatively unchanged over the period. This tells us that the big banks in Brazil are getting larger at the expense of their smaller competitors. The Herfindahl Index, which is another measure of concentration, shows an increase in concentration over the period as well in terms of Total Assets, Total Deposits and Total Loans, however they have not reached levels of an over concentrated market that would cause government concern.

The Panzar Rosse H-Statistic was used as a proxy for competition and it showed that over the 2002-20111 period the Brazilian banking sector was found to be monopolistic competition. When analyzing the differences in competition levels before and after the financial crisis we see that the competition fell drastically due to the effects of the financial crisis, however it was still categorized as being in monopolistic competition.

The DEA analysis over the period showed that the largest banks are considerably more efficient than their smaller counterparts and the gap between the two has widened over the period. Also public banks (state or federally owned) were the most efficient banks in the study. Therefore, we can say that large Brazilian banks are not taking the "Quiet Life" approach and becoming less efficient as they grow larger.

However, the slight overall decline in the banking sector in overall relative efficiency was mostly influenced by a dip in efficiency over the 2009-2011 period. This dip was due to the effects of the financial crisis facing the banks during the 2009-2011 period. In relation to the financial crisis and efficiency, regardless of ownership type efficiency fell around 10% across the board. However, if looking at bank size the largest banks only had a small dip (about 2%) in relative efficiency from pre-financial crisis levels.

Therefore we can say the less competitive banks were being driven out of the market or at least to a less important position. This exodus is in accord with Demsetz' Efficiency Hypothesis that states that more competitive and efficient banks will win market share from less efficient/competitive rivals as they can pass on their savings from efficiency onto their customers by charging a lower price. This would seem to be the case for the Brazilian banking industry as we see in our results on banking efficiency.

## 1.3 Structure of the Thesis

The thesis continues with Chapter 2 discussing the makeup and recent history of the Brazilian banking industry and contains the literature review on competition measures and on efficiency measures. Chapter 3 focuses on the research questions of the thesis. Chapter 4 follows with an overview of the data and methodologies used in the studies. Chapter 5

contains the developments in terms of market structure and concentration in the Brazilian banking sector over the period of the study. Chapter 6 contains the empirical results of the Panzar Rosse and Data Envelopment Analysis models. And Chapter 7 summarizes the findings, notes the thesis' contribution to scientific knowledge and suggestions for further research.

# Chapter 2: Literature Review

## 2.1 Overview of the Literature

This study contains information and data from various scientific and professional sources in order to give the reader a better background into competition measures, efficiency measures and the Brazilian banking sector's history. This is in order for readers to better understand the changes that have occurred over the analyzed 2002 to 2011 period. The topics covered in the literature review are as follows.

- Historical financial background of the market structure, banking regulation/deregulation and the overall functioning of the Brazilian Banking Sector.
- Literature review on competition measures and specifically for the Panzar Rosse Model.
- Literature review on various efficiency analyses.

## 2.2 Historical Financial Background of the Market Structure and Functioning of the Brazilian Banking Sector

### 2.2.1 A Historical Perspective on the Brazilian Banking Sector

In Chapter 5 the market structure and ownership developments within the Brazilian Banking sector are fully analyzed. These results show that the sector has increased in concentration in terms of Total Assets, Total Loans and Total Deposits from 2002 to 2011 in the top 3, 5 and

10 banks. However, before we can go in depth into the explanation of these results in Chapter 5 it is important to know the historical and financial background that led up to the consolidation of the Brazilian banking sector. This is done in order to better understand and explain these developments. Therefore, we must look over the past twenty years in Brazilian banking and develop an understanding of how the market has transformed over the time period. These past twenty years have been marked by reform, new regulations, foreign investment, new bank entry and exit, privatization, consolidation, and changes in competition and efficiency.

Additionally, the banking system in Brazil allows for banks to operate in multiple areas of financial activity. They can combine the activities of commercial, investment, development, leasing, and mortgage lending banks into a conglomerate bank. This conglomerate bank is then the bank that reports to the Central Bank and is also reported and analyzed in our studies. This is an important factor when looking at the securitizations that took place in order to circumvent certain Central Bank reserve requirements which will be discussed later.

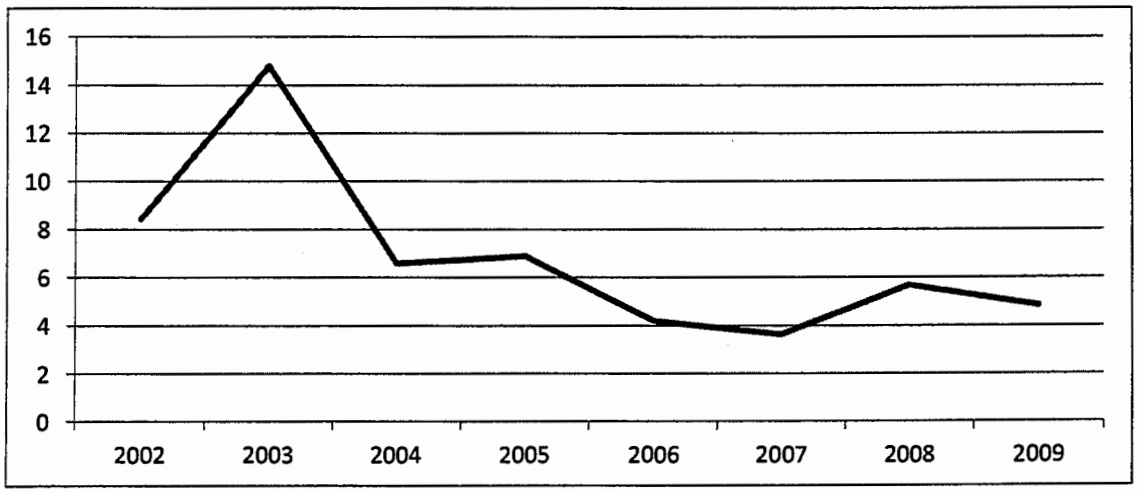
### 2.2.2 The Real Plan

When focusing on the Brazilian government's participation, influence and instituted changes in the sector the first step in these series of changes was the Real Plan. This was a major stabilization plan developed by the Brazilian government in order to reign in years of runaway inflation[1] and fiscal irresponsibility. The Real Plan used a semi-fixed exchange rate in conjunction with more open trade and investment policies. This led to a quasi-dollarization of the Brazilian Real. It was not a direct one to one dollarization as was the case in Argentina (Hallwood et al 2006). The Real Plan gave some leeway in its exchange pattern as was seen

[1] Average annual inflation rate for Brazil in the 1980's was 336% (Fraga 2004).

after the Mexican crisis in 1994-1995 when the Brazilian government began to allow the Real to devalue little by little. This led to a full free float of the Real in 1999 after a period of intense speculative pressure on the currency leading up to the free float (De Paula and Alves 2003). After the free float of the Real the government focused on inflation targeting. This inflation targeting helped maintain single digit inflation even after the free float and continues to today.

## Chart 2.1 Yearly Average Consumer Price Inflation in Brazil 2002-2009




Source: International Monetary Fund World Economic Outlook 2009.

The Real Plan had a striking and significant effect on inflation after its introduction in 1994, and continued to help control inflation even after the devaluation of the Brazilian Real in January of 1999 (De Paula and Alves 2003). According to the Brazilian government the inflation rate in 1994 was 2,240% and by 1998 it had fallen to 4.85%. In the year 2000 after the floating of the Brazilian Real inflation stayed at a respectable 8.03% even with the added pressure of the ending of the true semi-fixed exchange rate portion of the Real Plan in 1999. This stabilization of inflation has continued throughout the study. Focusing on consumer

price inflation, as seen in Chart 2.1, there was a slight increase in inflation during the Argentine financial crisis of 2002/2003 and a brief upturn in inflation at the beginning of the 2008/2009 financial crisis.

Before the Real Plan, Brazilian banks made a profit from inflation charges. Inflation charges are felt by non-interest bearing deposits and cash deposits. Since the banks are the issuers of the deposits they receive a part of the inflation charges. This charge was a significant percentage of Brazilian banks' profits. In the early 1990s inflation charges for banks accounted for 3.4% of GDP (Nakane and Weintraub 2005).

However, after the instatement of the Real Plan and Brazil changing from a high inflation country to a low inflation country the inflation charges as a percentage of GDP dropped to 0.03% in 1995 (De Paula and Alves 2003). If we take into account that the average yearly inflation rate was over 336% for the 1980's in Brazil we see that this had been a long standing income generator for Brazilian banks (Fraga 2004). However, this dramatic drop in income from inflation charges led banks to more risky loan agreements with clients that may not have been deemed credit worthy before. This led to more loan defaults and more bank bailouts by the federal government. Additionally, with low levels of legal protection for creditors in the 1990s did not help the situation (Lucinda 2010).

There were two further effects of the high inflation rates. First, the over branching of banks as they opened up extensive branch networks in order to obtain deposits as soon as possible as

to limit the downside effects of the high levels of inlfation. These extra branches became less profitable after the Real Plan was instituted as the need for extensive branch networks waned.

The second and more positive effect was a high level of investment in information technology. This investment was done in order for the banks to be able to quickly clear inter-bank balances so as to suffer the least amount of negative effects from the high levels of inflation. This helped to institute more efficient bank transactions throughout the banking system (Lucinda 2010).

The increase in bailouts along with other financial and economic problems led to additional measures being taken by the Brazilian government in order to reign in some of the inefficient state banks within Brazil as well as inefficient and unsafe private banks. These measures set out to facilitate the exit or purchase of inefficient or risky banks. Belaisch (2003), Beck et al. (2005), Neto et al (2005), and Nakane and Weintraub (2005) take a specific look at the transformations in the Brazilian banking sector from before the Real Plan to after the deflation of the Brazilian Real roughly the period 1990-2002.

### 2.2.3 PROES – Program of Incentives to the Reduction of the State-Level Public Sector in Bank Activity

Before the Real Plan the state-owned banks in Brazil, (that would be the banks owned by the individual states within the country, i.e. Sao Paulo, Espirito Santo, Parana, etc.) had a long history of financial difficulties. These difficulties led to the federal government needing to

bail the state banks out of financial problems on numerous occasions. This in itself led to more problems as state banks knew that the federal government would bail them out if their financial situation became to dire. The federal government decided it needed to do something with their financially troubled state banks (Beck et al 2005). The proposal for dealing with the state banks need for reform came about in 1996 with the PROES program (Program of Incentives to the Reduction of the State-Level Public Sector in Bank Activity).

Within PROES a state bank had essentially five choices. The first choice was to leave the market completely through liquidation. Second, the bank could allow the federal government to take control and privatize or liquidate the bank. Third, the bank could privatize on its own. Fourth, the bank could be restructured and continue running as a state bank. There was a further fifth option of turning the bank into a developmental agency (Beck et al 2005). Due to a long history of state governments using their state banks as patronage mechanisms it would seem that the state governments would prefer to restructure their banks and keep them under their control.

However, in order to maintain control of their state bank the state governments would have to cover at least half of the restructuring costs and institute full scale management changes. These criteria set by the federal government were meant to force states' hands in the matter and make them privatize their banks. With that purpose in mind the PROES was successful due to the fact that in 2002 there were only 14 of the original 32 public banks remaining in operation from 1994. Of those 14 banks 9 were ranked in the top 50 in terms of total assets in 2002 and in the first quarter of 2002 they held 29.4% of Total Assets, 45.5% of Total Deposits, and 24.6% of Total Loans.

**Table 2.1 Market Structure of the Brazilian Banking System by Branches and Ownership, 2002-2011**

| Institutions | 2002Q1 | 2006Q1 | 2009Q1 | 2011Q1 |
|---|---|---|---|---|
| Number of Branches in Top 50 | 16,790 | 17,936 | 19,047 | 19,795 |
| Number of Employees in Top 50 | 453,214 | 485,816 | 547,424 | 611,116 |
| Employees per Branch | 27 | 27 | 29 | 31 |
| Public Banks[2] | 2002Q1 | 2006Q1 | 2009Q1 | 2011Q1 |
| Public Banks in Top 50 | 9 | 9 | 9 | 9 |
| Share of Total Assets | 29.4% | 30.3% | 28.7% | 40.9% |
| Share of Total Deposits | 45.5% | 42.2% | 40.2% | 44.1% |
| Share of Total Loans | 24.6% | 26.3% | 30.0% | 44.0% |
| Domestic Brazilian Private Banks | 2002Q1 | 2006Q1 | 2009Q1 | 2011Q1 |
| Domestic Private Banks in Top 50 | 16 | 21 | 22 | 21 |
| Share of Total Assets | 40.8% | 44.2% | 52.6% | 41.1% |
| Share of Total Deposits | 33.7% | 33.7% | 42.5% | 39.5% |
| Share of Total Loans | 46.6% | 49.7% | 53.4% | 40.9% |
| Foreign Bank Penetration[3] | 2002Q1 | 2006Q1 | 2009Q1 | 2011Q1 |
| Foreign Banks in Top 50 | 25 | 20 | 19 | 20 |
| Share of Total Assets | 29.8% | 25.5% | 18.6% | 18.0% |
| Share of Total Deposits | 20.7% | 24.1% | 17.3% | 16.4% |
| Share of Total Loans | 28.8% | 23.9% | 16.6% | 15.1% |

Source: Banco Central do Brasil and author calculations. Top 50 based on Total Assets.

It would be safe to say that the PROES program had run its course by the beginning of 2002. Looking at Table 2.1 we note that the number of public banks ranking in the top 50 stays constant over the period 2002-2011 with nine banks ranking in the top 50 (with an occasional appearance of small public banks reaching the lower parts of the top 50 in terms of assets and on a few occasions giving them ten banks in the top 50, see Table 2.1 and Appendix 7). Total

[2] Banks that are either federally or state controlled.
[3] Foreign Bank: Any bank that has foreign control or foreign participation.

Assets held by public banks in the top 50 held relatively constant from 2002 to 2009, 29.4% in Q1 2002, 30.3% in Q1 2006, and 28.7% in Q1 2009 then there is an uptick to 40.8% in Q1 2011[4]. While their percentage of Total Loans increased from 24.6% in Q1 2002, to 26.3% in Q1 2006, to 30.0% in Q1 2009 to 43.4% in Q1 2011. This increase is attributed to a combination of shrinking influence of foreign banks in the market and a slight jump by the Central Bank's inclusion of the national developmental bank in the government's Top 50 Universal Banks data set.

However, public banks did see stagnation in their market share in Total Deposits over the 2002-2011 period. Their Total Deposits were 45.5% in Q1 2002, 42.2% in Q1 2006 07, 40.2% in Q1 2009 and 44.1% in Q1 2011. This lowering or stagnation of percentages could be attributed to the banks significantly higher initial market share in Total Deposits in comparison to their market shares in Total Assets and Total Loans, as well as an increase in domestic Brazilian banks' shares in the deposits market. Also, consumer sentiment in regards to public banks may have also played a role in the non-correspondence.

We must keep in mind that though the largest public banks in Brazil are owned by the federal government they are not fully public. They do list their shares on the Brazilian stock market, the BOVESPA, as well as other markets around the world and therefore have private management groups and some private investors who apply pressure to maintain a profit regardless of government initiatives. Though the public banks in Brazil are majority controlled by the federal or state government, they perform the same tasks as their domestic and foreign counterparts. They offer current and savings accounts, different forms of credit

[4] The jump is partially related to Brazilian Central Bank.

for private as well as professional customers and work in the foreign exchange and fund markets.

Therefore, we can say that the public and private banks are competing fully throughout the market. Yet the main difference between the public and private banks in terms of duties is the requirement of public banks to provide services to the Brazilian government and their social policies, i.e. retirement benefits or micro-credit schemes. These policies may raise public banks costs due to the unevenness of government policy and actual costs incurred by said policies. The banks would then pass a burden onto the banks customers to cover costs arising from government policy decisions that raise banks' operational costs.

### 2.2.4 PROER – Program of Incentives to the Restructuring and Strengthening of the National Financial System

PROES was only the first step in shoring up the banking sector. Additionally, the private sector banks were compelled to change ownership structure and business style by the PROER program in 1995 (Program of Incentives to the Restructuring and Strengthening of the National Financial System). Under PROER weak, inefficient or threatened banks had the option to either increase their capital, transfer shareholder control or be merged with another bank. In order to facilitate the transition and sales of the weaker private banks the central bank enacted measures to make it easier for stronger banks to purchase their weaker competitors (Nakane and Weintraub 2005).

The PROER program saw a dramatic decrease in the number of private domestic banks within Brazil, from 146 in 1994 to only 75 in 2002, of which 16 were in the top 50 universal banks. This drop in real numbers of banks did not mean a drop in the share of the banking market held by Brazilian domestic banks. In terms of share of deposits, domestic private banks had a 38.85% share of the market in 1993 and a 37.16% share in 2002. Additionally, their share of the loan market increased from 31.55% in 1993 to 40.45% in 2002. This increase in the loan market was due in part to the extreme drop off in the share of public sector banks, which fell from 61.88% of the loan market in 1993 to a mere 29.07% in 2002 (Nakane and Weintraub 2005). Consequently, again, we could say that the PROER program was a success in what it set out to do, eliminate inefficient and unsafe private Brazilian domestic banks.

It is important to note that the changes instituted by the PROER program helped to solidify the private domestic banking market and set it up for its continued growth post-2002 by helping to eliminate the inefficient and unsafe banks it was meant to weed out. In Chapter 5 looking at Table 5.1 we can see that the true "winner" of the 2002-2011 period is the domestic private banks. Just in terms of the participation of the private domestic banks in the top 50, their market share has increased in Total Assets from 40.8% in Q1 2002, to 44.2% in Q1 2006, 52.6% in Q1 2009 and a decline to 41.1% in Q1 2011[5], Total Deposits from 33.7% in Q1 2002, to 33.7% in Q1 2006, 42.5% in Q1 2009 and 39.5% in Q1 2011, and in Total Loans increased from 46.6% in Q1 2002, to 49.7% in Q1 2006, and 53.4% in Q1 2009, and 40.8% in Q1 2011. However, contrary to the post-PROES and PROER period (1994-2002), this time the domestic private banks gained more from the failings of foreign banks as opposed to public banks.

[5] The dip in Total Assets is misleading as the Brazilian Central Bank started to reformulate their top 50 bank criteria.

With the conclusion of the Real Plan, PROES and PROER programs some would surmise that the government would take a smaller part in other banking activities in order to allow the market to dictate rates and borrowing. However, due to the limited amount of long term loans available from private banks within Brazil the federal and state governments play a key role in long term financing projects as well as long term financing for corporations and individuals as their goals are more geared toward long term development and less toward profit maximization (Teixeira and Mollo 2006).

### 2.2.5 Foreign Bank Participation in Brazil

In terms of foreign participation in the Brazilian market, the opening of the banking sector and ability of foreign banks to purchase Brazilian domestic banks, in correspondence with the Real Plan, led to a large investment by international banks within Brazil. With the overall banking industry consolidating from 246 banks in 1994 to 155 in 2002, the number of foreign controlled banks rose from 37 to 56 in the same time period. Additionally, the share of the market of foreign banks in terms of net worth, assets, deposits, and share of the loan market increased at an astounding rate. The share of the net worth of the Brazilian banking sector controlled by foreign banks rose from 7.3% in 1993 to 33.6% in 2002, while the share of assets rose from 8.4% to 27.7%, deposits from 4.8% to 20.1%, and share of the loan market increased from 6.6% to 30.5% (Nakane and Weintraub 2005).

Claessens et al's study (2001) found some interesting results when comparing foreign banks in developed versus developing nations. While in developing nations foreign/international banks have higher profits than domestic banks the opposite is true in developed nations. This

would show that the structures used by international banks in developing nations are more efficient and productive than their domestic developing nations' counterparts. Conversely, this did not hold true in developed nations. This may be due to a level of trust or entrenchment in the domestic developed banking sector where the domestic banks have already asserted their own level of trust and reputation thus, cutting off one of the international banks' main selling cards, i.e. a stable reputation.

The Brazilian example of the 1990's is a common occurrence across Latin America and the consolidation of the domestic banking sectors did not have a negative effect on the foreign banks numbers. The foreign banks may not have been as negatively affected by the downturn as the domestic banks since they were geared toward more long-term strategies and had better cost efficiencies than the domestic inefficient banks that went out of business (Levine 1996 and Nakane and Weintraub 2005).

Some of the benefits enjoyed by the domestic banking client with the onset of foreign bank competition in the industry include an improved level of service, an increase in the number of financial products available to the domestic consumer and increased regulation that would allow for a more stable domestic banking environment (Levine 1996). Levine (1996) also points out that the simple presence of internationally respected banks helps countries to be able to gain access to international capital, because the international banks add credibility to the domestic banking market.

Additionally, as the market became more concentrated and inefficient firms were exiting the market, the margins earned by the banks were reduced. This should be positive for the consumer as they enjoy the benefit of lower cost banking (Claessens et al. 2001). These lower bank margins of the surviving, more competitive banks would result in lower profits. Thus, domestic banks were forced to become more cost efficient in order to stay competitive and profitable (Claessens et al. 2001).

The main negative for the domestic banks would be the increased costs in competing against a larger international bank with a stronger reputation than the domestic bank. The domestic consumer may lose out as well, as international banks may not be as willing to offer riskier loans for smaller domestic customers (Claessens et al 2001, Beck et al 2005).

Further studies on foreign owned banks in domestic markets have shown interesting findings. For example, foreign owned banks in the United States were shown to be significantly less efficient than their US domestic counterparts (Chang et al., 1993, DeYoung and Nolle, 1996, Mahajan et al., 1996). These studies ran through the early 1990s when foreign banks were making a large push into the US banking market. Hence, we could say that the foreign banks are not bringing new efficiency gains with them.

However, further research and conjecture would suggest that these non-US and non-Brazilian banks were trading off efficiency for rapid growth in market share in ways that may not be monetarily efficient, but do help them achieve their long term goals. The Data Envelopment Analysis results for the 2002-2011 period shows that the foreign banks in Brazil were also

less efficient than their Brazilian domestic private and public counterparts, however for further discussion on efficiency in the banking sector based on ownership see the Results chapter below.

Regardless of the foreign banks efficiency actions upon entering, the reforms and globalization of the financial sectors in Brazil and indeed all of Latin America throughout the 1990's, lead to a marked increase in foreign bank participation (Yildirim and Philippatos 2007). According to Nakane and Weintraub (2005) from 1994 to 2002 Brazil saw an increase in the number of foreign owned banks of over 150% while the total number of banks in the country fell to 63% of their 1994 numbers. This contrast in the success of foreign banks versus the overall consolidation of the Brazilian banking market shows that the downfall of the state and federal banks in Brazil due to PROES and the private banks due to PROER did not necessarily transfer to the foreign banks within Brazil during the initial 1994-2002 period.

However, this honeymoon period for foreign banks within Brazil after the reforms of the 1990's was relatively short lived. Belaisch (2003) noted over the period 1995-2000 that foreign banks were growing by buying up private domestic Brazilian banks. Their growth in the market was significant, as stated above. Pre-reforms foreign banks were insignificant players in the market; yet by 2001 they represented 28 of the top 50 banks in terms of Total Assets. However, post-2002 the boom was over. Either by domestic private bank growth or housing market problems brought on by the late 2000's world financial crisis, foreign bank presence in Brazil slowly eroded over the 2002-2011 period.

The highs that Belaisch (2003) and Nakane and Weintraub (2005) wrote of had started to wither from 2002. Foreign banks' influence in the top 50 banks Total Assets also slowly diminished over the 2002-20011 period. Foreign banks represented 50% of the top 50 banks in Brazil in Q1 2002, but only held 19 of the top 50 spots by Q1 2009. The erosion of market power did not limit itself to just the number of banks in the top 50, from a market share point[6]-of-view Total Assets declined from 29.8% in Q1 2002 to 25.5% in Q1 2006 to a further reduction to 18.6% in Q1 2009 and 18.0% in Q1 2011. Their share of the loan market fell even more starting at 28.8% in Q1 2002 to 23.9% in Q1 2006 to 16.6% in Q1 2009 to a further loss to 15.1% in Q1 2011.

The news was not all gloom and doom as the foreign banks held up better in terms of Total Deposits, in Q1 2002 they had 20.7% of the market and rose to 23.9% of the market by Q1 2006, however, by Q1 2009 they had sunk back to 17.3% then 16.3% in Q1 2011 of Total Deposits. The post crisis drops are more an effect of the flight of foreign banks from Brazil than a loss of desirability of their services by Brazilian customers. For a full analysis of the concentration ratios and market structure developments please see Chapter 5. For a full list of quarterly developments in Total Assets, Total Deposits and Total Loans by Ownership see Appendices 8, 9 and 10.

The shrinkage in foreign bank participation toward the end of the study fell dramatically as some foreign banks had to re-evaluate their positions during and after the world wide banking and financial crisis of 2008 to 2011. Still, some foreign banks had already decided to leave

[6] Market Share of Total Assets, Total Deposits, and Total Loans is based on banks represented in the top 50 banks only, and does not include foreign banks that are not in the top 50.

the market or change their participation before this crisis. For example, as Staub et al (2010) points out Bank of America sold its Bank Boston Brazilian assets to Itau in 2006 as they found they were having difficulties increasing their market share in Brazil. There were continued mergers and acquisitions throughout the late 2000's with the majority being larger banks buying out their smaller niche rivals (Staub et al 2010).

Additionally, as the market concentrated over the period mergers and acquisitions also changed. It is no longer solely larger banks buying out their smaller competitors, they have moved to buying other larger players as well. When Unibanco merged with Itau to become, briefly, the largest bank in Brazil at the end of 2008 beginning 2009 it signaled that consolidation within the large banks was a possibility as well.

With Foreign bank participation, the effects of the PROES and PROER plans the market did consolidate (this is discussed in length further in chapter 5). However, if one looks at the top ten banks in terms of assets in Q1 2002 versus the top 10 banks in terms of asset size in Q1 2011 the list has not changed very much[7].

The top 10 in 2002 had three public banks (two federal and one state), three private domestic banks and five foreign owned or participated banks. In 2011 that had changed to two public (two federal banks, the one state bank having been acquired by Banco do Brasil (federal public), four private domestic banks, and four foreign participation banks. Of the top 10 from

[7] A developmental bank is left out of the top ten calculations for 2002 and 2011 as the central banks rankings did not rank developmental banks in the Top 50 in 2002.

2002 three banks were no longer in existence having been acquired by other top ten banks (Unibanco #6 in 2002 by Itau, ABN AMRO #7 in 2002 by Santander, and the previously mentioned state bank of Nossa Caixa #10 in 2002 being absorbed by Banco do Brasil). And the new additions to the top ten in 2011 HSBC from #12 to #6 (foreign), Votorantim from #15 to #7 (private domestic), and BTG Pactual from #23 to #10 (foreign) were all major players in 2002 as well.

**Table 2.2 Top 10 Banks by Total Assets Q1 2002 versus Q1 2011**

| Ranking | Q1 2002 | Q1 2011 |
|---|---|---|
| 1 | Banco do Brasil | Banco do Brasil |
| 2 | CEF | Itau |
| 3 | Bradesco | Bradesco |
| 4 | Itau | CEF |
| 5 | Santander | Santander |
| 6 | Unibanco | HSBC |
| 7 | ABN Amro | Votorantim |
| 8 | Safra | Safra |
| 9 | Citibank | Citibank |
| 10 | Nossa Caixa | BTG Pactual |

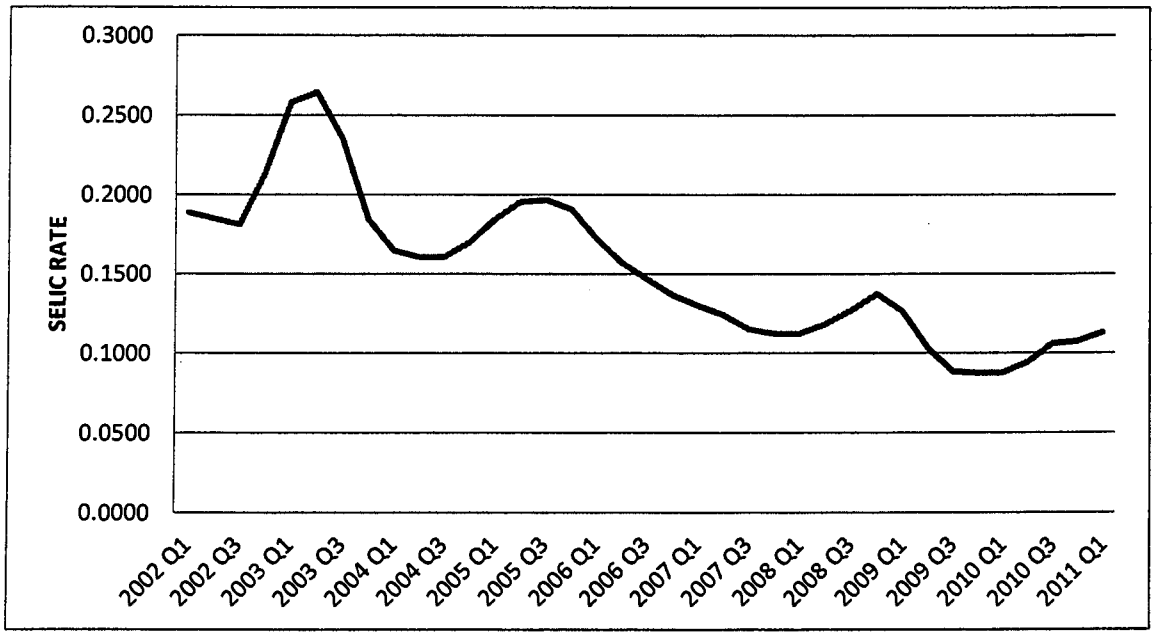
Source: Brazilian Central Bank statistics

## 2.2.6 Economic Indicators

There are other influences and characteristics within the Brazilian banking and financial sector that should be noted. Brazilian banks have dealt with a history of inflation, fluctuations in exchange rates, as well as domestic and international economic and financial issues. This history of unstable macroeconomic factors have helped increase pressures from within and without on the banking sector. The SELIC overnight money market interest rate for Brazilian banks in Chart 2.2 illustrates the effects of exogenous macro economic factors

on the overnight rate for Brazilian banks. The peaks in 2002, 2005 and 2008 all are during economic crises and/or pressures facing Brazil and international markets. Therefore, in order to see what the true cost of capital was over the period using the SELIC rate gives the reader an overall idea of the interest rates facing banks in the overnight market and thus, what could be passed on to bank customers.

## Chart 2.2 Quarterly Average SELIC Rate 2002-2011




Source: Banco Central do Brasil and author calculations determining average SELIC rate for the quarter.

The overnight rate shows how economic/financial events, domestic or foreign, can affect the interest rate in Brazil. If we take a look at the two peaks in the data, Q3 2002, and Q4 2008 the first represents the economic crisis in Argentina, Brazil and Uruguay in 2002, and 2008 the international banking/financial crisis of the late 2000s. These events also adversely

affected the Real's value in the currency markets, see Chart 2.5, as well as the Brazilian stock exchange the BOVESPA, as can be seen in Chart 2.6.

Brazil's termination of their quasi-dollarization of the Real in 1999 had a knock on effect throughout South America. It along with other economic factors led to severe speculation on the Argentine Peso which had been using a dollarization plan for quite some time. As speculation on the Argentine Peso continued it led to an eventual devaluation of the Peso and this had a further knock on effect hurting the Brazilian Real and economy as well. This was mainly due to Brazil being one of Argentina's largest trading partners and neighbors. One can see that during the peak of the crisis the SELIC rate went from a third quarter 2002 average of 18.10% to 26.44% by the second quarter of 2003. The 2002 crisis bump in the SELIC rate was a combination of the effects of the flight from Brazilian government debt of investors, an increase in inflation and a dip in the Real (Robitaille 2011).

During the global banking and financial crisis of 2008/2009 we can see a bump in the SELIC rate from 11.25% in the first quarter of 2008 to 13.75% for the fourth quarter of 2008. However by the second quarter of 2009 the average quarterly rate was back down to 10.35%. The knock-on effect of Argentina's currency crisis of the early 2000's is especially negative as can be seen by the Brazilian Real losing approximately 40% of its value against the US Dollar during the crisis.

However, it is important to note the overall downward trend in the SELIC rate as well as the quick recoveries within the Real Dollar exchange rate and the BOVESPA Index after these

shocks. These would seem to allude to a more stable financial system that is more adept to handling shocks in the market than had been the case in previous decades.

Furthermore, the SELIC interest rate is important in our analysis as it gives us banks cost of capital and thus will allow us to see what banks have to pay for capital. Additionally, the large fluctuations in the SELIC rates between Q1 2002 and Q1 2011 (minimum 8.75% Q4 2009, maximum 26.44% Q2 2003) could lead to difficulties in lending and changes in lending practices in each quarter. Thus it is important to note the SELIC rate as it can better show the financial situation facing banks in each quarter. However, it is important to note that the SELIC rate is only for interbank practices and do not reflect as well the actual loan rates passed on to the banking institutions corporate and private customers, this is further discussed below and shown in Chart 2.4.

An additional financial note is that the threat of a return to high inflationary times has led to a significant level of financial indexation in Brazil. This is seen in the high degree of deposits linked to the SELIC overnight rate or a price index (Robitaille 2011).

However, the SELIC rate does not give the full picture on the interest rates faced by Brazilian companies and individuals. Brazil has a history of high (by international standards) bank spreads. Teixeira and Mollo (2006) note the combination of a history of high inflation, a concentrated banking market, and the attractiveness of secure return government debt have led banks to depend less on consumer credit for income. The main factor being the attractiveness of high interest rates paid by government notes and their high level of liquidity,

thus firms have been tempted away from medium and long term investments for the safer government option.

Therefore in order to maintain a return equal or better than the government rates the spreads have been kept artificially high. For example in 2002/2003 the average spread for firms was 14-15% while personal or private loan spreads were as high as 50%. This is well above the spreads found in developed nations at the time, approximately 5%. The reasoning behind this difference is that the government needed to attract foreign investment and capital and help guard against future exchange rate shocks and inflation (Teixeira and Mollo 2006).

Of note is that at the beginning of the study the percent of credit given to the private sector in terms of GDP was a mere 25% which was lower than that of their South American neighbors or the Asia Tiger economies of the period. Fortunately by 2007 the increase in private credit led to a 35% ratio to GDP for Brazil, however this was still below the norm for comparable economies (Robitaille 2011).

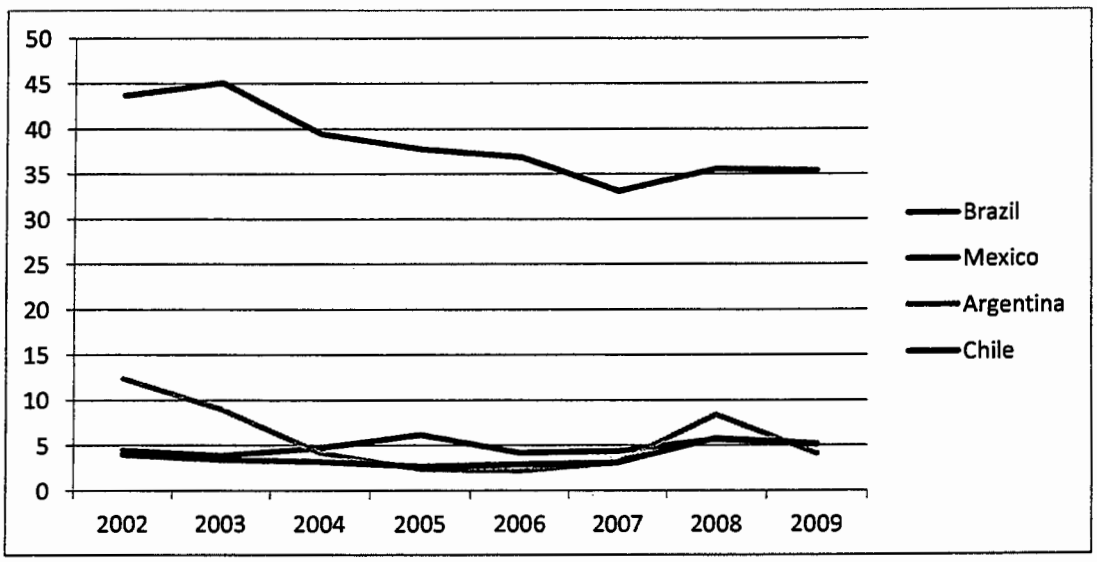
It is important to add that long term private credit is generally difficult to obtain in Brazil with the BNDES being the main supplier of private long term credit. The majority of financial instruments used by the private sector are connected with short-term rates such as the SELIC or price index while debts of maturities of over five years are rather rare (Robitaille 2011).

However, the high by international standard loan spreads in Brazil have been declining over the majority of the period of the study (2002-2009). This is in part due to the increase use of

payroll and vehicle loans which gave banks more lending options to private clients (Robitaille 2011).

This decrease was insignificant in comparison to the spreads found in comparable Latin American banking sectors. Chart 2.3 shows the average lending spreads for banking clients in Brazil, Mexico, Argentina and Chile. The fact that Brazilian spreads on average are eight times that of their Latin American counterparts shows that there is room for lowering of the effective interest rate charged to non-bank borrowers. Additionally, the high spreads may be hampering the development in non-banking industries that use bank credit in order to develop their businesses. An analysis on this area is beyond the scope of this research.

## Chart 2.3 Comparison Bank Interest Rate Spreads for Average Lending Rates for Brazil, Mexico, Argentina and Chile 2002-2009

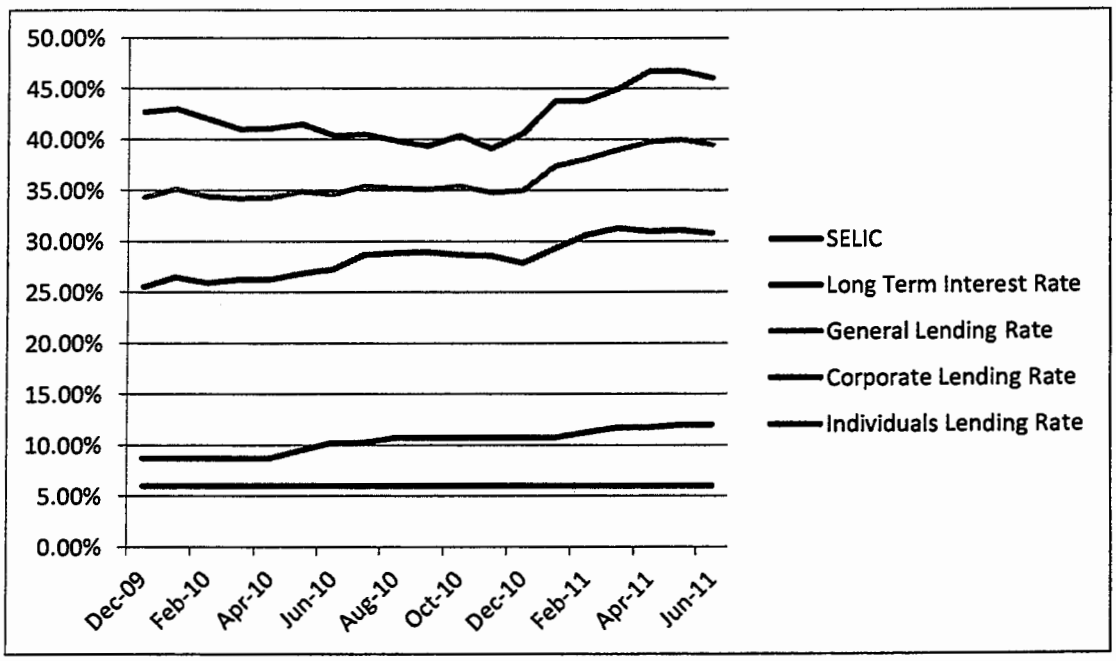



Source: The World Bank and International Monetary Fund International Statistics 2011.

If one looks at only the December 2009 – June 2011 period in Chart 2.4 the differences between the lending rates given to different institutions and borrowers becomes more

apparent. Though the SELIC Overnight rate has hovered around 10% for the 18 month period and the long term rate stayed at 6% the actual rates facing businesses ranged from 25% to over 30% while individuals faced interest rates ranging from 40% to 47%. These wide differences in lending rates showcase the need for further developments of credit options within the Brazilian economy in order to promote growth and reduce the debt burden on businesses and individuals.

**Chart 2.4 SELIC Overnight Rate, Official Long Term Interest Rate, General Lending Rate, Corporate Lending Rate, and Individual Interest Rate in effect in Brazil from December 2009 to June 2011**



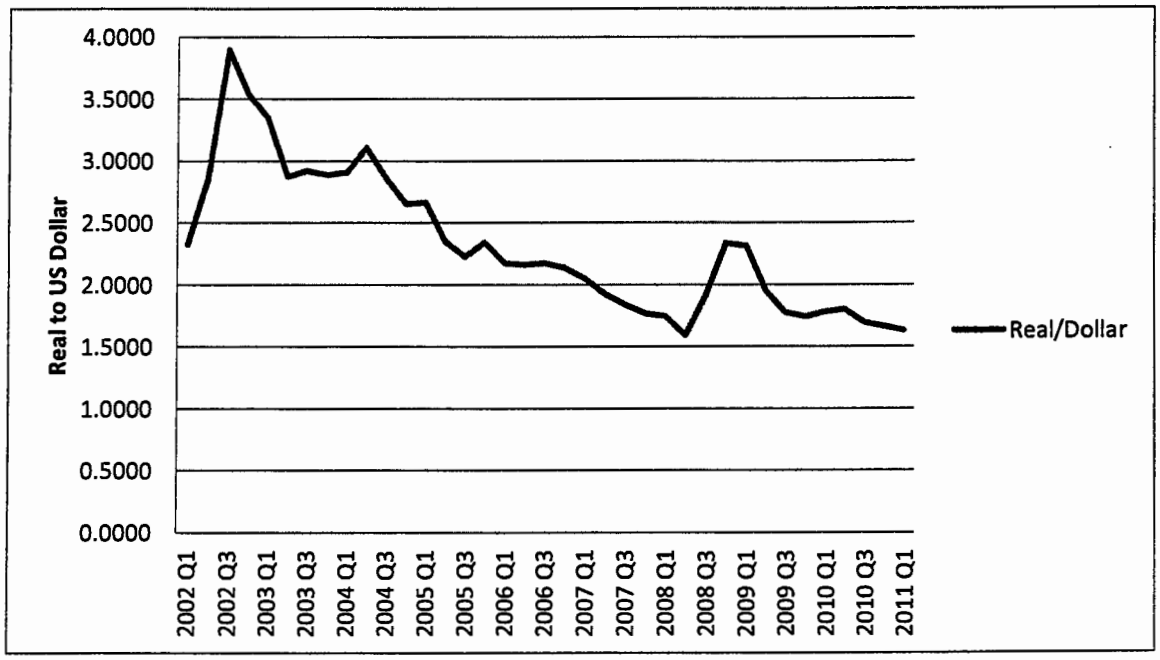

Source: The World Bank and International Monetary Fund International Statistics 2011.

Additionally, in Brazil the corporate bond market is relatively underdeveloped and reinforces the importance of banks in financing private investment by firms. As Staub et al (2010) point

out, the public banks in Brazil hold the public sector payroll and thus have an advantage over private banks in that regard and as noted above, the PROES program helped write off the bad debt of many state banks and allowed them to start over without old debt burdens or bad loans.

These factors led Staub et al (2010) to analyze efficiency in Brazilian banking. They found that indeed the public banks were more efficient than their private domestic counterparts as well as their foreign bank competition for the years in the early 2000s. However, in comparison to US or EU banks Brazilian banks seem to fall behind in cost efficiency; however their superior spreads enable them to financially cover much of the efficiency gap.

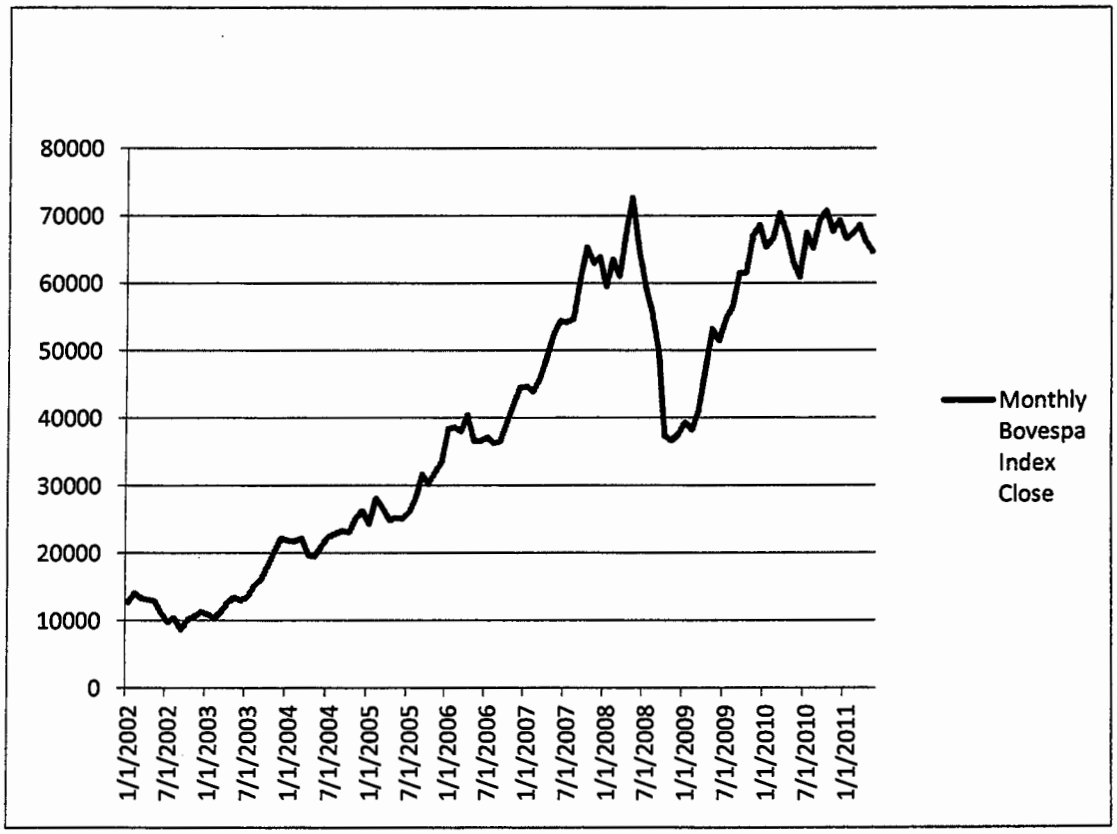
## Chart 2.5 Quarterly Real/Dollar Exchange Rates Q1 2002 to Q1 2011




Source: Banco Central do Brasil and author calculations.

Belaisch (2003) notes the high demand for credit in the Brazilian market and that the loan market does not fully satisfy demand, as can be seen by the low rate of nonperforming loans in the time period. We could then surmise that banks are selecting only the best credit candidates and thus small and medium size enterprises (SMEs) may be losing out in this increasingly concentrated market.

**Chart 2.6. Monthly Bovespa Index Close January 2002 – May 2011**




Source: Commodity Systems Inc[8] and author calculation.

[8] www.csidata.com

This would lead to the low level of bank intermediation that Belaisch (2003) points out. An additional issue that is brought up in the 1997-2000 period is the relatively inefficient running of the banks as seen by their low efficiency ratings in terms of Operating Costs to Operating Income as well as lax control on personnel costs and overhead. This could be seen as evidence of some of the effects of the "Quiet Life" taking place in Brazilian banking during Belaisch's study. Furthermore, market concentration in developing nations is seen to have a negative effect on banking efficiency (Demirguc et al 2004).

### 2.2.7 Central Bank Reserve Requirements

The actions and measures that central banks can use to influence their banking markets liquidity are wide and depend on the individual market make up. It is important to note that the Brazilian Central Bank's main weapon in controlling liquidity in the Brazilian banking sector is the reserve requirements.

Discussed further below in section 2.2.9 the Central Bank reduced the reserve requirements for banks right after the crisis. However, they are not necessarily lower than the reserve requirements found in many developed nations in terms of relative overall monetary units held in reserve. Robitaille (2011) notes that the Brazilian Finance Minister Guido Mantega stated that in 2008 the reserve requirement for Brazilian banks on demand deposits was over 50% while many developed nations only had a required ratio of less than 10%. The Finance Minister's statement should be read with a slight note that Brazil had an 8% reserve ratio for demand and time deposits, a 10% reserve ratio for savings deposits and the 45% reserve ratio on demand deposits where no interest is earned.

The stated reserve requirement of over 50% is from a combination of the 45% rate and the 8% rate that are both linked to deposits that have a return linked to the SELIC rate. Additionally, banks were required to hold 15% of their time deposits in government securities that paid the SELIC rate. This was in effect for banks that held over 2 billion Reals in time deposits (Robitaille 2011). Theoretically this high reserve requirement may have been a factor in the relatively quick recovery of the larger banks in the Brazilian banking sector from the global banking crisis.

However, even though the sector had a high reserve requirement many banks were able to circumvent theses requirements or as the case for other smaller banks they were exempt from the high reserve requirements if their extraordinary reserve requirement was below $100 million Reals (Robitaille 2011). The desire to circumvent the reserve requirements led Brazilian banks to devise financial innovations in order to avoid the government's requirements on time demand deposits.

The reserve requirements set out by the Central Bank led to banks readjusting their portfolios in order to remain below the cut off level of demand or savings deposits.

### 2.2.8 Financial Innovation

Financial innovations or the developments of new services, products, systems, analytical tools, et cetera have been rapidly growing in the banking industry over the past two decades. The greatest influences have come from information technology growth within the financial sector as well as the speed with which advancements in telecommunication have allowed for a once region dominated industry, to become an interwoven global industry. These advancements have changed the way in which banks handle financial mediation whether by

the development of software packages to analyze credit risk or by developing secondary markets for the securitization of loans or receivables.

Financial Innovation itself can save money and increase productivity for financial institutions by allowing them to do their jobs quicker and more effectively but they also come at a cost. The work hours and resources used to develop these financial innovations can be costly; yet their overall benefits can have a dramatic effect on a firm's bottom line (Teixeira and Mollo 2006).

Frame and White (2009) define financial innovation as anything that is "new that reduces costs, reduces risks or provides an improved product/service/instrument that better satisfies financial system participants' demands (page 3)." This may be in terms of consumer clients, institutional clients or the financial firms themselves. The authors also divide up financial innovations into four groups; new products, new services, new production processes and new organizational forms.

We will start with the first set of financial innovations, new products. As the financial environment changes so must the financial products offered to clients. One of the largest areas of financial product innovation has come in the mortgage lending arena. Traditional loans with a long term fixed rate mortgages with large down payments that were available to those with good credit have morphed over the past two decades into adjustable rate mortgages that no longer guarantee a fixed long term rate for home buyers.

The mortgage market further evolved with sub-prime mortgages where home buyers who previously would not have received loans due to poor credit scores were allowed to borrow,

though they did so at higher interest rates and with larger penalties. These sub-prime loans and the collapse of the sub-prime market were both hallmarks of the 2008/2009 financial crisis. The sub-prime mortgage product was used as a financial innovation in order to attract new customers to banks and increase their bottom lines (Frame and White 2009).

Other new products arose from the new production process of securitization of non-tradable assets into asset-backed securities which then could be sold or traded. These were basically the grouping of cash flows from various loans or other financial instruments that were then sold on the market. The Repo Funding in Brazil would be an example of an asset-backed security. Another example would be the repackaging of multiple loans of various levels of risk. This repackaging would hide the higher risk loans under the cloak of the lower risk loans rating; therefore buyers would not know exactly what loans they were actually buying. This mix led to major difficulties when the sub-prime market collapsed at the beginning of the 2008/2009 financial crisis (Pirosca 2011).

The second set of financial innovations is in the development of new services. Many new financial services have developed around the advancements in information technology and telecommunications that allow for quicker more accurate access to customer accounts. The credit/debit card system with the ubiquitous cash machines on most major street corners and card readers at most retailers are an example of new services. These allowed for customers to buy big ticket items without needing to carry cash or checks. Additional services such as online banking that allows customers 24 hour access to their accounts would be a another example of financial services innovation.

Other financial innovations are seen in the production processes that financial institutions use in order to conduct their daily business. One of the better known production process innovations is the increase in the use of stress tests to determine if banks could survive a financial meltdown. These tests have been developed in order to better account for risk in the financial system.

Another production process innovation is the development of credit scoring for small businesses and individuals so that financial institutions can use technology to analyze data on these groups to deem their credit worthiness. This development helped minimize the personal judgment factor in loan approvals and made the system more transparent (Frame and White 2009).

The final group of financial innovations that Frame and White discuss (2009) is organizational forms and structure. The deregulation of the international banking world has led to banks spreading out from their regional seats of power to become global players. They have redefined themselves in this marketplace in order to better match up with the needs of their ever more globalized clientele with cross country branches and online only banking options.

### 2.2.8.1 Financial Innovation in Brazil

Along with other banking sectors the Brazilian banking sector has been ripe with financial innovations. The most popular for individual customers were the development and expansion of payroll and auto loans. The most prominent innovations over the past decade, however were in order to avoid reserve requirements.

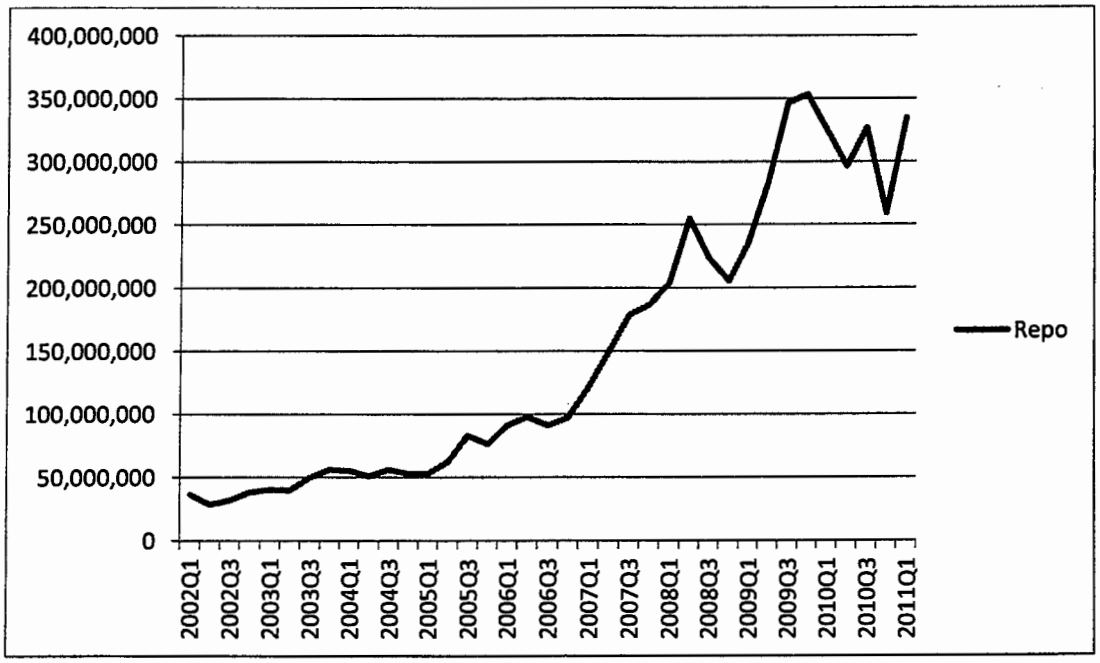
Brazilian banks devised new products to offer their clients in order to circumvent some of the reserve requirements set out by the government. One that grew in popularity with the large and medium sized banks was Repo Funding. The Repo Funding was used as a substitute for time deposits in order to circumvent the reserve requirements set upon time deposits (Robitaille 2011).

When discussing what a repo is we must remember that Brazilian banks are very often a conglomerate of different financial institutions. What would happen is one arm of the conglomerate; for instance, a leasing company would sell a medium or long term domestic bond to another arm of the bank conglomerate. The sale of this note or bond would be deposited into the issuing institution (the leasing arm) by the form of a certificate of inter-financial deposit or CDI (certificados de deposito interfinanceiro). This CDI then could be sold to outsiders and the income used to finance new loans (Robitaille 2011).

The repos were used because the government had no reserve requirements on them and the larger banks could then lower their reserve requirements by passing time deposits into repos. In short, the repos were used by larger and medium sized banks in order to avoid the 15% reserve requirement of government bonds that they were required to carry for time deposits. These repos were mainly for large institutional investors. They were very liquid and tended to pay a slightly higher rate than their time deposit counterparts. The use was so widespread that in combination with the changing reserve requirements and the effects of the 2008/2009 crisis, Robitaille (2011) notes that perhaps as few as nine banks were still required to meet the official reserve requirements for time deposits at the end of 2008.

The extent of the growth and use of Repos as financial instruments can be seen in Chart 2.7. The Repo market remained relatively calm during the 2002 to mid-2005 period with Repo quarterly sums ranging between approximately 40 to 50 million US dollars, only growing by a quarterly average of approximately 5%. The first major growth spurt in the use of Repos came in the second half of 2005 through 2006 where the average quarterly increase in the use of Repos rose to over 8.6%. The lead up to the 2008 financial crisis saw a mad dash in the use of Repos in Brazil as from Q1 2007 to Q2 2008 the average quarterly growth rate for Repos was nearly 18%, a growth of 97 million US dollars in Q4 2006 to 254 million US dollars in Q2 2008.

**Chart 2.7 The Growth of the Repo Market in Brazil 2002-2011**




Source: Central Bank of Brazil

The government eventually issued legislation in 2008 that required a 100% reserve requirement on new issues of repos and a gradual institution of 25% reserve requirement on

pre-2008 repos. CDIs also had the same reserve requirements as time deposits (Robitaille 2011).

This government action combined with the financial crisis seemed to put a damper on the attractiveness of Repos as for the Q3 and Q4 periods of 2008 where Repos actually declined on average over 10% per quarter. This set back in the use of Repos was short lived. By 2009 there was an average quarterly growth rate in Repos of nearly 15%; though negative growth was seen in 2010 as well in the growth of the use of Repos as financial instruments. Thus taken together the market has tapered off as of late for Repos, but they are still in use.

On the other side of the financial innovation debate we have the actions of the small and medium sized banks. Due to high reserve requirement cut offs the small, and many medium sized, banks were not included in the reserve requirements that were imposed on the larger banks. Thus they did not use as much of the repo funding as they did not need to circumvent the reserve requirements. However, they did face difficult financial times and when faced with liquidity strains a popular option was the sale of the bank's loan portfolios.

The loan portfolio sale would typically include a group of payroll and vehicle loans. These sales were almost exclusively between small and medium sized bank sellers and large bank buyers. This allowed more liquidity in the smaller banks when they were facing liquidity pressures. The government also loosened the rules governing these sales during the 2008/2009 financial crisis as is discussed further in the following section.

The combination of the growth of Repos within the medium and large banks and the growth of loan portfolio sales within the small banks show that Brazilian banks were actively trying

to circumvent the reserve requirements imposed by the Central Bank. We would also be able to state with the combination of the above financial innovations and the growth of online and automatic teller machine banking in Brazil that the Brazilian banking system is not conservative when it comes to financial innovation.

### 2.2.9 The Financial Crisis' Effects on Brazil

The effects of the world financial crisis of 2008 and beyond had a dramatic yet short lived effect on the Brazilian economy as well as its banking sector. When Lehman Brothers failed in 2008 it set off a domino effect throughout the world financial system. Where countries like the USA, UK and Iceland had a banking crisis; Brazil never faced a banking crisis like theirs.

The remnants of the Real Plan and lessons learned during the high inflation years had instituted a strict regulatory body to monitor the financial system which helped limit the possibilities of Brazilian banks collecting toxic assets (de Paula and Sobeira 2010). The Brazilian banking system faced more of a crisis of confidence than a true banking crisis. The main effects of the crisis in the banking sector came from capital flight by foreign investors and foreign banks in order to shore up their holdings in other countries or to improve their liquidity elsewhere or just in part to be less risk adverse in the bad economic environment.

This sudden reduction in foreign capital had a knock on effect within the banking sector as money dried up and borrowing cost rose sharply (Mello and Pisu 2009). To combat the lack of credit the Central Bank of Brazil relaxed its reserve requirements for banks in order to increase the money supply in the market. As smaller banks were more negatively affected by the worsening credit environment the government also made it easier for larger banks to buy the loan portfolios of smaller banks in order to promote stability. Furthermore, the Public

Banks were then encouraged to expand their loan portfolios in order to alleviate the burden placed on the market by the quick departure of foreign capital and to increase liquidity in the market place.

These actions by the Central Bank of Brazil helped taper the effects of the financial crisis in Brazil. Having begun in 2008 the crisis had already begun to subside in Brazil by early 2009, though the aftereffects would take longer to smooth out. However, the crisis did have a dramatic and yet short term shock to both the Real and the Bovespa. Charts 2.5 and 2.6 show the effects that the crisis had on both of them. The Real lost approximately 40% of its value from September 2008 to January 2009. Additionally, the Bovespa stock market with its heavily commodity based index fell nearly 50%. It speaks to the return of confidence in the Brazilian economy that both the currency and the stock market were approaching their pre-crisis levels within a year.

When looking at the overall picture of the banking market within Brazil we can see that the Real Plan, the PROES and PROER programs, the regulatory environment that they established and the opening up of the market led to an increase in concentration, stability and confidence in the Brazilian banking industry. Therefore the plans all accomplished what they set out to do, form a better healthier banking industry by eliminating many of the problems that had been associated with Brazilian banking before their implementation.

Those regulatory successes helped the Brazilian banking system through more challenges over the 2002-2011 period as it had to deal with the effects of economic crises around the world, and closer to home such as in Argentina in the early 2000s, and Brazil's own crisis at

around the same time, and not to mention the current global banking and financial crisis. These successes have all lead to a strong, stable and sound banking system.

## 2.3 Literature Review on Competition Measures

Conventional belief states that concentration and consolidation in an industry are often considered anti-competitive. This is thought of as fewer competitors in many peoples' minds means less competition and firms thus have a better ability to abuse their market power over customers in a more concentrated market.

While competition in any industry is seen as a positive phenomenon, including the banking industry. Following on that line of thinking throughout Latin America, including Brazil, many governments have been liberalizing their banking sectors in order to make them as competitive as possible and gain the benefits of perfect competition (Maudos and Guevara 2007).

This is due to the theory that bank managers with market power have less incentive to deal with their inefficiencies and the cost of these inefficiencies are passed on to the bank customers. This makes the banks less competitive and efficient thus the industry as a whole could be seen as less competitive and efficient. And banking customers suffer with higher costs and prices in order to cover for these inefficiencies. However, even if conventional belief states this, there is no strong theoretical evidence that consolidation leads to less competition or vice versa (Yeyati and Micco 2003). It would depend on the situation in which the consolidating is taking place. Given this one must study the particular market and its particular differences to know if the consolidation is affecting competition.

### 2.3.1 The Role of Banks in the Economy

Before focusing on the models used to determine competition in the banking industry we need to discuss assumptions in terms of the role that banks play in the economy. The two main approaches to bank activities are the Production Approach (PA) and the Intermediation Approach (IA). They are identical in their microeconomic view of the banking industry; however they differ in their ideas of a bank's true economic activity (Gutierrez de Rozas 2007).

The PA affirms that banks are in the business of producing services for their depositors, lenders, and borrowers by using their factor inputs of labor and physical capital. Additionally, the PA has banks producing multiple outputs, loans and deposits that are liquid, riskless, and easily divisible. This belief that firms can produce multiple outputs does not allow for the use of empirical competition models such as the Panzar Rosse H-Statistic.

On the other hand the IA has banks only producing a single output, loans, which follow along with the theory and empirical results of the Panzar Rosse model. The IA says that loans and deposits have different characteristics that give them different levels of risk, liquidity, and divisibility. This can be seen in that many banks do not have an equal amount of loans and deposits. The theory behind IA also states that banks produce their loans by using labor, physical capital, and deposits or financial capital as their factor inputs. Thus the banks act as intermediaries between depositors and borrowers in the IA, while banks produce both loans and deposits in the PA (Gutierrez de Rozas 2007).

Having determined that banks function as intermediaries (IA) one must determine in what manner to proceed. We see that research on bank competition has focused on two main areas,

the structural and non-structural approach. The structural approach is can be summarized by two examples. First there is the Structure-Conduct-Performance paradigm. This is the collusion hypothesis. Here the theory is that higher profits are brought about by collusion among the industry players. Therefore in this perspective the more concentrated a market becomes the easier it is to collude and gain extra profit from the collusion (Bain 1956). The main thrust being that more concentration weakens competition (Casu and Girardone 2006). Concentration ratios and other indices like the Herfindahl Index are used in order to show the changes in market structure over time and therefore give credence to a more concentrated thus less competitive market (see Chapter 5 below). The second is Demsetz Efficiency Hypothesis that is discussed below.

### 2.3.2 The Quiet Life Theory

"The best of all monopoly profits is a quiet life." – Hicks (1935, p. 8)

This quote from Hicks has been used constantly throughout economic literature to represent what some would say would be the worst part of monopoly action, and that would be inaction. The "quiet life" would occur when a company has more extreme market power and thus exhibit a lower effort by managers and directors to eliminate inefficiencies. This may come about in the form of pricing above marginal costs, thus relaxing the need to reign in these inefficiencies. Therefore there would be a negative correlation between market power and efficiency (Maudos and Guevara 2007, Berger and Hannan 1998, Casu and Girardone 2009).

Berger and Hannan (1998) tested the quiet life hypothesis in concentrated and non-concentrated banking sectors and their results came up with a few noteworthy observations.

In regards to marginal costs, managers may not have the same pressure to lower their costs and inefficiencies if they are in a position to use their market power. Additionally, the concentrated market may allow managers to follow non-profit maximizing goals. This could be in the form of pet projects or other non-core business activities.

Also, in concentrated markets or non-competitive markets, managers may spend their time and energies on maintaining the market power of the company at the expense of controlling inefficiencies. Finally, and maybe the worst effect of the quiet life, inefficient and incompetent managers are not held accountable for their incompetence since their weak performance is hidden by the artificial margins. Thus they are allowed to stay in their positions continually hurting the company's profitability, efficiency and clients.

### 2.3.3 Structural Approaches to Competition

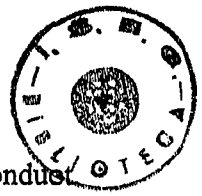
This would seem contradictory to the other structural approach best summed up by Demsetz' efficient structure hypothesis. Here the efficient banks and industries gain profits and market share due to their superior efficiencies. Thus the market consolidates as less efficient companies are forced out or lose market share to the efficiently superior companies (Demsetz 1973). Demsetz efficiency hypothesis follows along with Schumpeter's opinion that businesses and entrepreneurs that develop new and innovative products or production schemes will drive out less efficient or less competitive firms (Teixeira and Mollo 2006).

Demsetz Efficiency Hypothesis also states that market consolidation does not have to lead to the worst parts of monopolistic behavior, such as false scarcity and higher consumer prices. Demsetz' (1973) work is interesting because it shows that this mindset of how a competitive firm builds its mini-monopoly by being the best firm in their market rings true. The PROES

and PROER programs were developed in order to help force out less efficient and uncompetitive banks from the market. Thus there was a governmental push in consolidating the market and hoping that the more efficient and better run banks would survive and prosper. This could then give the appearance of a monopoly or oligopoly.

Demsetz (1973) looks at concentration of a market in terms of competitive pressures. These pressures are used by some firms to institute change and become more efficient and productive. They use these advantages to develop better and more affordable products and with that advantage the firm gains more market share. This in turn allows for the more efficient banks to take market share away from their less efficient rivals as well as force out the less competitive and efficient banks who have less efficient cost structures.

Demsetz states that an industry with few firms can come about only from superior production or marketing skills or the market is only able to sustain a few competitors. This would then indicate that few firm industries do not necessarily mean there is a monopoly or oligopoly structure per se, as in terms of the negatives of monopolies or oligopoly collusion. This suggests it may indeed be that the firm in control of the market has a more competitive performance and this may take the shape of goodwill or a good reputation in the community or in the form of higher productivity in the specific knowledge that employees of the firms have (Demsetz 1973). Demsetz feels that profit may not come about in such "monopoly" like situations due to artificially created scarcity in the market, but instead by uncertainty, a bit of luck and efficient use of resources. This theory is termed the efficient structure hypothesis (Maudos and Guevara 2007).



The other structural approach (as mentioned previously) is the Structure Conduct Performance Paradigm (SCP). The SCP assumes that concentration in the market means collusion and anti-competitive behavior, while the Efficient Structure Hypothesis assumes that the concentration in the market has come about by more efficient players gaining market share from less efficient players (Casu and Girardone 2006). The two structural approaches, SCP and Efficient Structure Hypothesis have one major drawback; they both assume the market is performing in a certain way before analyzing the data.

### 2.3.4 Non-Structural Models for Competition

On the other hand there are the non-structural models. These models postulate that more than market structure and concentration effect competition in an industry (Panzar and Rosse 1987). There are three main non-structural models that have been discussed in the literature. The Iwata Model (Iwata 1974), though rarely used for testing bank competition, requires us to look at banks supplying homogenous products to customers in an oligopoly setting. This requires extensive micro level data for the costs and production of said products. The extreme lack of use and micro-level data requirements of the Iwata model in scientific studies makes it of little use in analyzing competition in the banking sector.

The second non-structural model is the Bresnahan or Bresnahan-Lau model (Bresnahan 1982). The Bresnahan model has been used to a limited extent to analyze competition in banking in the US (Shaffer 1989), Canada (Shaffer 1993), Finland (Suominen 1994), Colombia (Barajas et al 1999), and of importance Brazil (Nakane 2001). The studies for South America found competitive markets were the norm. The model determines the market power of an average bank in the country and then compares it to simultaneous estimations of

the market supply and demand curves. If the average banks marginal revenues coincide with the industry's marginal revenues collusion is taking place (Bikker and Haaf 2002).

The third non-structural approach was developed by Panzar and Rosse (1987). In terms of statistical testing of market concentration, and by proxy competition, and in general for monopolies, the Panzar-Rosse H-Statistic (Panzar and Rosse 1987) has been used extensively throughout competition literature. While investigating newspapers Rosse noticed something interesting; newspapers tend to be local monopolies but the reduced form revenue equations kept showing coefficients that were not consistent to monopolies.

Therefore, Panzar and Rosse (1987) came up with a few ideas of how to test for monopolies on their own. They used comparative statistics in order to test theories against each other. In terms of monopolistic competition versus monopoly they tested individual companies and then tested the market equilibrium in order to compare them to each other. The comparisons would show them the differences between the two. This is due to the theory that each firm would act as a monopoly regardless if they were in a monopoly or in monopolistic competition.

### 2.3.4.1 The Panzar Rosse Model

Mkrtchyan (2005) used the Panzar-Rosse H statistic in his study of banking competition in emerging markets. He termed it that the PR test measures the competitive nature of a market and the market power of the firms within said market. Moreover, the predictive movement of price changes in reaction to a cost change is different depending on whether or not a firm has a monopoly. The H-Statistic is derived from a "reduced form revenue equation and measure of the sum of elasticities of total revenue of the bank with respect to bank input prices"

(Mkrtchyan 2005, p. 69). The H-Statistic ranges from one to negative infinity. When $H = 1$ the market is considered in perfect competition. When $0 < H < 1$ the market is termed in monopolistic competition. This is where most studies find banking markets to be. Then when $H \leq 0$ the market is found to be functioning in a monopoly setting.

**Table 2.3 Panzar Rosse H-Statistic Explanatory Values**

| H-Statistic Value | Market Structure Found |
|---|---|
| $H \leq 0$ | Monopoly or Oligopoly |
| $0 < H < 1$ | Monopolistic Competition |
| $H = 1$ | Perfect Competition |

The Panzar Rosse model has an advantage in that we can control for variables such as size and ownership as it uses bank specific data. Another advantage is that we must not specify the relevant market as banks within the market specify themselves by their activities, i.e. universal banks versus insurance based financial institutions.

Furthermore, the data allows us to observe bank revenues while output prices, output costs, and output quantities used in other models may not be readily available. Also, many other studies use the Panzar-Rosse H statistics in their studies on concentration and competition in the banking industry (Yeyati and Micco 2007, Belaisch 2003, Claessens and Leaven 2004, 2005, Halkos and Salamouris 2001 and 2004, Mkrtchyan 2005, Nakane and Weintraub 2005, Casu and Girardone 2006 and 2009, Gutierrez de Rozas 2007, Yildirim and Philippatos 2007, Bikker et al 2006, Bikker and Spierdijk 2008, Claessens 2009, Lucinda 2010). This allows us

to compare our results to previous studies in the sector and compare results to other countries' sectors.

The Panzar Rosse model does have a few assumptions and limitations. First off we must assume that the market is in long-run equilibrium. The H-statistic should equal zero in equilibrium and negative in the case of non-equilibrium. However Gutierrez de Rozas (2007) notes that with firms entering and exiting the market places doubt on an overall equilibrium in the market. Furthermore, Panzar Rosse tests only for single-output firms. Thus we must assume that the banks being analyzed are only producing intermediate services by means of their factor inputs, labor, capital, and funds thus using the intermediation approach of banking activities. Finally, Panzar Rosse assumes a homogeneous cost structure and price elasticity of demand greater than unity within the market being tested.

### 2.3.5 Competition Measures Empirical Literature Review

Casu and Girardone (2006) used the Panzar Rosse test in order to analyze the EU banking market for 1997 to 2003. They were testing to see if the deregulations throughout the European Union running up to the introduction of the Euro currency had brought about a more level playing field for EU banks. The deregulations tore down barriers between EU banking sectors that had kept cross country mergers and further banking integration from occurring; therefore developing more competitive EU banking markets.

The study analyzed concentration, efficiency and competition in order to find any relationships between them and to see where the EU market stood during the period. DEA scores are used as bank specific variables that represent bank managers' actions and abilities

as their actions could represent a switch in bank costs. They found that the EU-15 systems were to be in monopolistic competition during the period of the study.

Additionally, they found no evidence that more efficient banking systems are also more competitive, due to their results being that efficiency had a negative and significant effect on the H-Statistic (competition) for most countries in their study. However, the overall H-Statistic results remained the same. This would suggest that the most cost inefficient banks may be spending more on their inputs to achieve higher quality outputs, i.e. higher service on higher profit generating products. They go so far as to note that the most efficient banking sectors are the least competitive. Additionally, they concur with other studies that looked at the increased concentration of the EU banking sector stating that the concentration of a banking sector could not fully explain a country's competitiveness.

In their study Yildirim and Philippatos (2007) use a PR test in order to test for levels of competition and market concentration within Latin American countries' banking sectors. Their findings show that no countries in Latin America have monopolies or perfect competition. They state that according to their research results the banks in these countries earn their profits and revenues as if they are in monopolistic competition. Given this, they surmise that the highly concentrated banking markets in the region do not lead to anti-competitive conduct among the banks. Additionally, while following up on their original research they found that market concentration does not necessarily lead to a lower level of competition in the market or higher bank performances. Yet, focusing on domestic bank performance individually it was shown to be negatively affected by competition and foreign bank participation. This could be shown by the more competitive foreign banks luring clients away from their domestic competitors.

Yildirim and Philippatos (2007) broke the time period 1993-1999 into two groups (1993-1996 and 1997-1999) in order to study any variations in the concentration of the individual banking sectors over time. Their results for Brazil showed a decrease in competition over the two time periods from a PR H statistic of 0.80 to 0.71. This drop in the H Statistic would show that with the drop in the numbers of banks (Nakane and Weintraub 2005) there was a corresponding drop in competition.

The H-Statistic results throughout some Latin American countries also varied from 1993-1996 to 1997-1999. For example, Brazil, Chile and Venezuela showed marked decreases in their H-Statistics which would represent a decrease in competition in the banking market, while Argentina, Peru, Paraguay, and Uruguay showed marked increases in their H-Statistics over the same period thus a increasing of competition (Yildirim and Philippatos 2007). This helps to emphasize that though many of the Latin American countries' banking sectors are going through changes and reforms, the effects are different on a case by case basis and are worth examining closer.

Yeyati and Micco (2007) also studied Latin American banking and the affect of foreign activity in the sector and noted an accelerated concentration throughout the regions banking markets as well as an increased presence of foreign bank participation. They found that the increased concentration did not negatively affect competition throughout the region. The period of study (1994 to 2001) showed an increase in competition using the Panzar Rosse model. Their main belief was that the banking markets were overpopulated with inefficient and non-competitive banks, and that the more competitive rivals won out on the domestic

front and relatively more efficient and ever more present foreign banks bought up local banks.

Gelos and Roldos (2004) examined emerging market banking sectors across the globe including central Europe, Asia, and Latin America from 1994-2000. Their study found that most nations were facing a decrease in the overall number of banks in the market; however this decrease in bank numbers did not necessarily lead to an increase in the level of concentration in all the banking sectors as measured by the Herfindahl Index, with Brazil being one of the few exceptions. They note that the difference between consolidation in developed markets and emerging markets is that in developed markets consolidation was due mainly to the search for efficiency gains while in emerging markets it was due to the aftereffects of financial crises, the intervention of local governments and entry of foreign banks.

Furthermore Gelos and Roldos (2004) break the period into two parts and use panel data with fixed effects in order to achieve a comparison of competition levels between the two periods. They found that Brazil and most other emerging economies were found to be in monopolistic competition and did not have significant changes in their competition levels between the two periods. They also found that overall the increase in foreign bank participation had a positive correlation with competition and noted that the competition gains from the entry of foreign banks outweighed the negative competitive effects of market consolidation. And finally, the level of competition in Brazil and other Latin American countries as well as central European and Asian nations after the large scale concentrations of the markets showed that there was little or no decline in competition for the period of 1994-1999.

Belaisch (2003) also used the Panzar Rosse H-statistic for Brazil and found monopolistic competition for the period 1997-2002. Her paper focused on determining possible factors that may prohibit a strengthening of bank intermediation and further efficiency developments in Brazilian banks. She also stated that the Brazilian banking system was dominated by universal banks and that bank intermediation was rather low compared to other nations that is there were very little loans going out in proportion of GDP versus the United States, Euro area, or Japan or comparable Latin American countries such as Chile. She also points out that lower deposit levels and loan levels may be due to the historical instability of the Brazilian banking sector as discussed previously, and thus private sector savings are lower in comparison.

Furthermore she stressed the influence of international and macroeconomic effects on the Brazilian banking market and how they have led to less intermediation by banks. In addition, the high inefficient overheads that Brazilian banks kept during the period were significant in influencing the cost of funds for banks while personnel costs were insignificant to the cost of funds.

Neto et al (2005) analyzed the 1995-2003 period for competition and concentration in the Brazilian banking sector. Their study used a combination of concentration ratios, the Herfindahl Index, Hall-Tideman and Theil concentration statistics and the Panzar Rosse H-Statistic in order to test what effect concentration had on competition. Neto et al noted that the market for total assets, total deposits and total loans was concentrating over the period in the top 10 largest banks. From 1995 to 2003 the market share of the top ten banks in total assets increased from 69.5% to 78.1%, and market share of the top 10 banks in total deposits

also increased from 78.3% to 86%. However, the market share of total loans for the top ten banks remained stable changing from 77% in 1995 to only 78.8% in 2003.

The Herfindahl Index test for market power over the period showed a slight increase in market power in terms of total assets (0.08 in 1995 to 0.09 in 2003), yet there was a slight decrease in total loans (0.11 to 0.094) and total deposits (0.11 to 0.10) over the same period. Of important note was that they also found that Brazil was in monopolistic competition over the period and that by regressing the concentration statistics on the Panzar Rosse H-statistic they found concentration had a negatively significant effect on competition. Neto et al (2005) then analyzed the relationship between these concentration measures and competition and found that concentration had a negative effect on competition in the Brazilian banking sector.

A further study on Brazilian profitability was done by Barros (2008). The study delved into the effects of government financial policies and their effects on the profitability and spreads found in the Brazilian banking market in terms of bank ownership, whether public government owned banks or private banks. The author also noted the high profitability and spreads found in Brazil compared to other countries, especially those found in private Brazilian banks. The author analyzed how the social policies of government affected the high profitability and spreads. The research found that the high spreads found in Brazil could be harming local development as local customers could not afford the higher loan rates that come with such spread disparity.

Additionally, the cost pressure put onto public banks to help institute social policies added undo costs to public banks that were then passed on to local customers. This upward cost pressure then lead to higher prices for customers and allowed private banks, who do not have

to partake in government social policies, to raise their spreads as well without adding undo costs to their operations, contributing to the high profitability of private banks in the sector. This then is a sign of a loss of competition as public banks are unable to follow the best practices in terms of cost controls.

The ramifications of such government policies effecting cost and profit efficiencies are rather large. Brazilian public banks have a large share of the market and the cost inefficiencies that develop due to discrepancies in the government policy must be passed onto the clients. These inefficiencies are not necessarily due to managerial ineptness as they are in the disparity between the cost of social programs and the amount of federal funds made available to the banks in order to institute them. This then would affect competition as private banks would be able to charge lower rates due to their lower costs and take market share away from public banks.

Halkos and Salamouris' studies using the H-statistic (2001 and 2004) on the Greek banking sector saw an increase in competition after the liberalization of their banking rules. The allowance of other European Union banks to compete more freely in the Greek banking sector has led to increased competition in price and quality levels that had been a major boost to the Greek banking sector during the 1990's and early 2000's.

Having been used extensively with numerous different variables Bikker et al (2006) focus on possible misspecifications of the Panzar Rosse Model. They compare their own results to results from previous studies covering 101 countries with 18,000 banks over a 16 year period. They find that previous studies tended to overestimate competition in banking markets. They find that in the 28 studies they cover each has a problem of misspecification in the model.

Bikker et al (2006) find that although the previous studies find that monopoly action cannot be rejected in 28% of the countries studied, while the previous found that monopoly cannot be rejected in 0% of the markets.

Moreover they find that the previous studies underestimated the number of markets where perfect competition could not be rejected. Their two main reasons for the misspecification are as follows. Most studies use a scaled version of bank income as their dependent variable that is, revenues (interest income or total revenue) divided by total assets. This then changes the model from a revenue equation into a price equation, because by dividing by total assets the variable can be seen as the lending rate price. The second misspecification comes in terms of the selection of explanatory variables specifically, the scaling variable to account for size, Total Assets. They state that using Total Assets then transforms the revenue equation into a price equation as well and thus, fundamentally transforming the model.

Bikker and Spierdijk (2008) continue with a study on the changes in banking competition over time. They state that the actual change in competition from 1986 to 2004 was significant for many countries and regions. They state that Western and Eastern Europe, the United States, and Japan faced declining banking competition over the period. While developing nations banking systems became more competitive. They felt that this decline in the developed banking world was driven by increased concentration of market share from dominant players and a switch from intermediation as the main income driver for banks toward more importance of off-balance sheet activities, such as fees. These off-balance sheet activities are more difficult for consumers to price, which gives banks a better opportunity to use their market power to overcharge customers.

Finally, we look at other possible additions to the analysis of competition that may better explain the effects and produce better interpretive thoughts of the results. The Lerner index of competition is one of these. Maudos and Guevara (2007) point out that the Panzar Rosse and other concentration models may not be the best form of defining market competition and as a result a different method should be used. They stated that the Lerner index could be used as the researcher would be able to have market power be represented at a bank level as opposed to an industry level, thus giving more defined results. Berger et al (2009) used the Lerner Index as a proxy for competition and market power in a study on 23 developed nations. The Lerner index represents the mark-up of price over marginal costs. However, one of the drawbacks of the Lerner index is that price information is sometimes limited and one may need to estimate marginal costs.

Casu and Girardone (2009) used a Lerner index for competition in one of their studies on the link between competition and efficiency. They found that competition could be influenced by previous year competition levels. Also, in their study of five European banking nations from 2000 to 2005 banks were not becoming more cost inefficient while gaining market power. This leads them to state that Hick's "Quiet Life" scenario was not taking place in these markets at the time.

An additional noteworthy point that has come up in a few articles on banking competition and concentration point out that in developing markets like Brazil the large banks tend to function in more efficient and competitive ways, while smaller banks are seen to sometimes function in a more monopolistic way (Bos and Kolari 2005, Belaisch 2003). One possible explanation as to why they may have their own small mini monopoly is due to limited bank networks in less populated areas in some developing nations.

A recent empirical study on Brazilian banking was carried out by Lucinda (2010). Lucinda set out to test for the validity of the Panzar Rosse model by following various methods used in other Panzar Rosse studies. The author used various Panzar Rosse variables in order to run tests due to the high level of discrepancies between variables and values chosen to represent the model. The author notes that by taking out deposits as a variable the competition level increases, however the R square of the overall test falls. Overall regardless of variables used Lucinda found that H-Stat did not have a very explicative value. Still the market overall for the 2002-2008 period was found to be in monopolistic competition using various sets of variables though the article does not give an overall course of development of competition. Given the discrepancies in short and long term equilibrium the author does note that in short term equilibrium a simple positive H-Stat score indicates monopolistic competition and negative a monopoly. Therefore the author does not reject the possibility of perfect competition.

## 2.4 Literature Review for Efficiency Analysis

As discussed previously, competition is good for the development of any industry and with that competition comes innovation, international competitiveness, new product offerings and efficiency gains. In order to determine the performance efficiency of banks we must find some way to analyze the banks and determine which banks are performing well and those banks that are performing poorly. Frontier analysis, specifically in this research Data Envelopment Analysis, is a noteworthy tool that can be used in order to determine efficiency gains. The frontier function approach bases efficiency frontiers of companies or industries at a maximum realistic output that a bank or financial institution can achieve with their current

levels of input and technology (Shanmugam and Das 2004). In other words we are benchmarking the companies' performances.

### 2.4.1 Frontier Analysis

Frontier analysis in itself is basically a benchmarking technique where best-practice firms are considered the frontier of maximum efficiency, productivity or whichever criteria one chooses. The frontier that is created is then against other firms in the market to compare and determine their level of efficiency relative to the best-practice frontier setting firms. Frontier analysis also allows for ease of use as one does not need insider information or in depth knowledge of an industry in order to analyze it. Consequently there is no information asymmetry that can affect the analysis of the frontier as financial data is used. Additionally, if the frontier analysis is used by insiders they can then make better decisions on areas that need to be improved in the industry or the individual firms in terms of cost, profit, technical or allocative efficiencies. Though the information obtained by frontier analysis most likely will tell executives what they already know, it does give hard numbers with which to work in order to improve efficiency.

The drawback to frontier analysis is that it basically tells managers information they already know. Frontier analysis does give managers quantitative proof of what they have already observed and it can then lead them to make decisions that can correct those areas where they are behind in terms of the benchmark competitors (Berger and Humphrey 1997). Furthermore, the application of frontier analysis for government approval of mergers or acquisitions cannot be left out. By being able to show the different levels of efficiencies merging banks or enterprises have, they can forecast where they will be improving thus, validating their mergers or acquisitions.

The parametric models, Stochastic Frontier Analysis (SFA), Distribution Free Approach (DFA) and Thick Frontier Analysis (TFA) and non-parametric models, Data Envelopment Analysis (DEA) and Free Disposal Hull (FDH) are explained more in depth in the following pages and have some differences. These differences are mostly based on the assumptions that a researcher must put on the data in order to use each model. The main dividing assumptions are: 1. The restrictiveness of the functional form of the model, parametric models being much more restrictive than non-parametric models. 2. How the model deals with random error. Non-parametric models assume that there is no error in the system and that all variations come from inefficiencies and not, for example, from bad luck. Parametric models do use random error and inefficiency in their models and thus have different efficiency values than a similar non-parametric model. There are further differences within parametric methods by way of distribution of inefficiency and random error.

Their similarities are that each is a frontier efficiency or X-efficiency in some literature model. Here a decision making unit (DMU) is measured against a best-practice firm in terms of cost, production, profit, revenue. The score ranges between zero and one where zero is complete inefficiency and one is the best-practice firm's score, i.e. most efficient. The efficiency of the firm is divided between technical efficiency, which is a DMU's ability to maximize output with the inputs that they have, i.e. get the most out of their inputs, and allocative efficiency which is a DMU's ability to optimize their inputs in the best way possible, i.e. be able to put inputs to their best use. As a result taken together we have a measure of overall economic efficiency.

There is no consensus on what the best way to measure efficiency in banking is, therefore we analyze a few of the more commonly used frontier analysis methods of both parametric and non-parametric orientation in our literature review.

In terms of comparing parametric and nonparametric approaches Berger and Humphrey (1997) analyzed 130 studies on frontier efficiency analysis. They found that in general the nonparametric approach found less efficiency than the parametric approach. However, the dispersion of efficiency was greater in nonparametric than parametric frontier analysis. But, as we are more pessimistic about how efficient banks and companies in general are run, it would give us more reason to select a nonparametric approach in order to assess true efficiency in banks/companies.

Berger and Humphrey's 1997 study noticed that there were discrepancies between parametric and nonparametric frontier analyses of efficiency. Nonetheless, they noted that while using different parametric or nonparametric methods within their types of efficiency measures that group the efficiency scores correlated more closely, i.e. parametric measures SFA and Thick Frontier Approach gave similar efficiency results for the banks being studied.

With all of these discrepancies what can we take from the difference between parametric and nonparametric efficiency measures? In general, we can gain a rough idea of where efficiencies and inefficiencies lie within an industry. This does not take into account the possibility that an industry in general could be rather inefficient in some area. This would come about if the benchmark for the industry is set artificially low, due to the market's overall position, i.e. if all banks have too many employees it is hard to see as they all compare equally in terms of number of employees. This would then give us a false sense of

true efficiency. Also, since there are possible faults in bank by bank analysis it may be better in terms of government policy to look at the industry in general that is, the industry average for certain efficiencies as well as using multiple frontier techniques in order to gain a more robust explanation of efficiency.

### 2.4.2 Cost Efficiency Versus Profit Efficiency Versus Alternate Profit Efficiency

When looking at the definition of efficiency there are three main concepts of efficiency that are used throughout the literature. These were defined by Berger and Mester (1997) as Cost, Profit and Alternative Profit Efficiency which allow for researchers to measure efficiency while taking into account market prices and competition instead of solely technical efficiencies. Determining which concept a study will use is vital in deciphering the results of any efficiency analysis.

The first concept is cost efficiency. Cost efficiency gives a firm's relative cost efficiency against that of a best practice firm. Taking the output of the bank being analyzed, we would compare how much the most efficient bank's costs would be for that same level of output. The parametric analysis uses a cost function that splits inefficiencies into allocative and technical inefficiencies. Allocative inefficiencies are those that arise when a firm does not act efficiently with their input prices, thus they are not allocating their money in the right areas at the right times at the right prices in terms of their inputs. Technical inefficiencies come about when a firm uses too much of its inputs in the production of the product or service. Here a cost efficiency score of 80% would show that the bank under review is wasting 20% of their inputs.

The second efficiency concept is that of profit efficiency sometimes referred to as standard profit efficiency. Here the firm's profit efficiency is being compared to that of the most efficient profit making firm in the group, which is to say how close the bank is producing to the maximum profit frontier for the set of inputs they have. If a firm has a score of 80% it shows they are missing out on 20% of profits they could be earning if they were as efficient as the most efficient banks. Berger and Mester (1997) felt that the profit efficiency concept is preferable to the cost efficiency model for evaluating overall performance of firms. This is mostly due to the fact that banks are profit maximizers and hence their efficiency goals are geared toward making the most profit. This may be counteractive toward cost efficiency as better service or customer attention on certain products may indicate higher costs and thus be seen as cost inefficient when they actually increase a company's profit. Also, profit efficiency orientation takes into account errors in the input as cost efficiency orientation does, however it also takes into account output errors.

A further variation of profit efficiency is termed the alternative profit efficiency and is used when certain assumptions of the previous two orientations are not satisfied. Usually these relate to different levels of quality in banking services, though output is not fully variable, banks in the industry use their market power to affect competition, or output prices are difficult or incorrectly measured. As the Brazilian banking sector, although concentrated, does not show abuse of market power nor does it have a significant difference in service quality, we feel that the previous two orientations could be used for Brazil. Furthermore, the main difference from the standard profit efficiency orientation is that here one uses output levels as opposed to output prices.

### 2.4.3 Parametric Estimation Techniques

In order to study efficiency in a more structured way we can also use parametric efficiency measures. Here the researcher places specifications on the efficiency frontier. This allows for more structure and focused evaluation, with the benefit of allowing for errors in the measurements. However, if the original form of the model is specified incorrectly the measured efficiency will be inaccurate (Berger and Humphrey 1997).

### 2.4.3.1 Stochastic Frontier Approach

Stochastic Frontier Approach (SFA) is one parametric frontier efficiency measure that specifies a functional form for the relationship between inputs, outputs, and additional environmental factors as well as random error. Within SFA the inefficiency and random error terms are separate. This is done by making specific assumptions about the distribution of the two variables. The random error term ($v_i$) or white noise is given as two sided and normally distributed, while the inefficiency term ($u_i$) is deemed to be one-sided and half normally distributed. Observing it empirically we see:

$$C_i = C(y_i, w_i) + \varepsilon_i = C(y_i, w_i) + u_i + v_i$$

Berger and Mester (1997) point out that in previous studies when the error and efficiency terms are not restricted the terms seemed normally distributed, which would cancel out the assumed correctness of the SFA required assumptions. In like manner, SFA also assumes that most firms will be grouped near full efficiency when that may not be the case. Also when looking at the differences in banking in Brazil in terms of state banks, domestic private banks, and foreign banks, such a rigid structure seeing most banks being equal may not be the right type of tool to use.

### 2.4.3.2 Distribution Free Approach

Another parametric method is called the distribution free approach. DFA also uses a frontier in a functional form in order to analyze inefficiencies. DFA is slightly different than SFA due to the separation of inefficiencies and error terms. This difference is in that DFA assumes that inefficiencies/efficiencies are stable over time and random error averages out over time. In order to test for inefficiencies a bank is assumed to have a core or base cost efficiency that does not change over time thus, panel data must be available in order to test over time. Furthermore, DFA does not have the same restrictions in terms of distribution that SFA has, the terms can be distributed in almost any non-negative way (Berger Humphrey 1997). The model estimates the cost or profit inefficiency/efficiency for the banks by comparing the residuals of banks versus the best practice banks in the study.

This does not seem to be a logical choice for a study of the changes in efficiency over time for Brazil as there have been a number of changes in the market such as regulatory reform, market make up, and interest rate and exchange rate fluctuations. However, DFA does note that if efficiency is changing in the market due to environmental forces such as government intervention or technological changes, the change will be noted versus the best average practice frontier rather than a certain efficiency point in time (Berger and Humphrey 1997).

### 2.4.3.3 Thick Frontier Approach

Another parametric efficiency frontier technique is the Thick Frontier Approach. Here a functional form is specified and the derived results assume that the top and bottom performance quartiles represent random error while the interior quartiles represent inefficiencies. The nature of TFA's quartile divisions does not allow it to make specific

efficiency estimates however; it does give banks a general idea of overall efficiency in the banks and the sector.

### 2.4.3.4 Fourier Flexible Functional Form

One of the draw backs to parametric models is their restrictiveness. In order to add more flexibility into the parametric model some authors have used a Fourier Flexible Functional form (FF) which uses Fourier trigonometric terms to translog functions (Berger and Humphrey 1997, Altunbas et al 2001). The FF is used when it is difficult or impossible to discern the true functional form of the relationship between the variables. This is due to its ability to better fit any normally behaved multivariate function (Altunbas 2001).

## 2.4.4 Non-parametric Estimation Techniques

Non-parametric estimation techniques evaluate technical inefficiencies in terms of banks using too many inputs to produce their output, or are producing too little output for the amount of inputs they have. The non-parametric methods focus on technical inefficiencies accordingly they do not relate wholly to the cost/profit/alternative profit efficiencies that were discussed before. This is mainly due to their differences from the parametric models. The main differences can be summarized as follows: 1. They cannot account for allocative inefficiencies, 2. They cannot differentiate between levels of specialization or service provided by different banks that may influence perceived cost/profit inefficiencies, 3. With no value given for outputs it is impossible to establish if the output produced is optimal.

A further potential caveat in the non-parametric method is that it does not allow for random error or white noise in the models. This would take away the notion of chance or a bad day at the bank. Burger and Humphrey (1997) noted that parametric methods, on average, gave

higher efficiency scores than non-parametric methods which may be explained by the non-parametric methods inclusion of possible random error in their inefficiency calculations.

### 2.4.4.1 Data Envelopment Analysis

In terms of measuring efficiency and as such competition we have specific frontier analysis measures that need to be discussed. Data Envelope Analysis has been used to measure inefficiencies and efficiencies in different industries. Furthermore, DEA is a non-statistical method which relies on linear programming. It provides a linear piecewise frontier by enveloping the collected data points and thus giving a convex production possibilities frontier. It gives us a measure of relative efficiency of different decision making units (DMU) (Halkos and Salamouris 2001). Specifically nonparametric DEA focuses on the direct relationship between inputs and outputs of a business unit. This ability to deal with multiple inputs and outputs is one of DEA's main advantages versus parametric efficiency measures. Furthermore they are especially useful when dealing with group data, such as bank branches (Bos and Kolari 2005, Halkos and Salamouris 2004, Camanha and Dyson 2006).

When measuring efficiency a researcher must look at the orientation they wish to use. In efficiency analysis researchers should focus on one of two measures, either an input or output oriented measure. As discussed in Coelli (1996) input oriented measures focus on how much a firm could proportionally reduce their inputs and at the same time remain at their current level of production. The output oriented measure looks at how much a firm can proportionally increase their produced quantities while not altering the amount of input quantities they use.

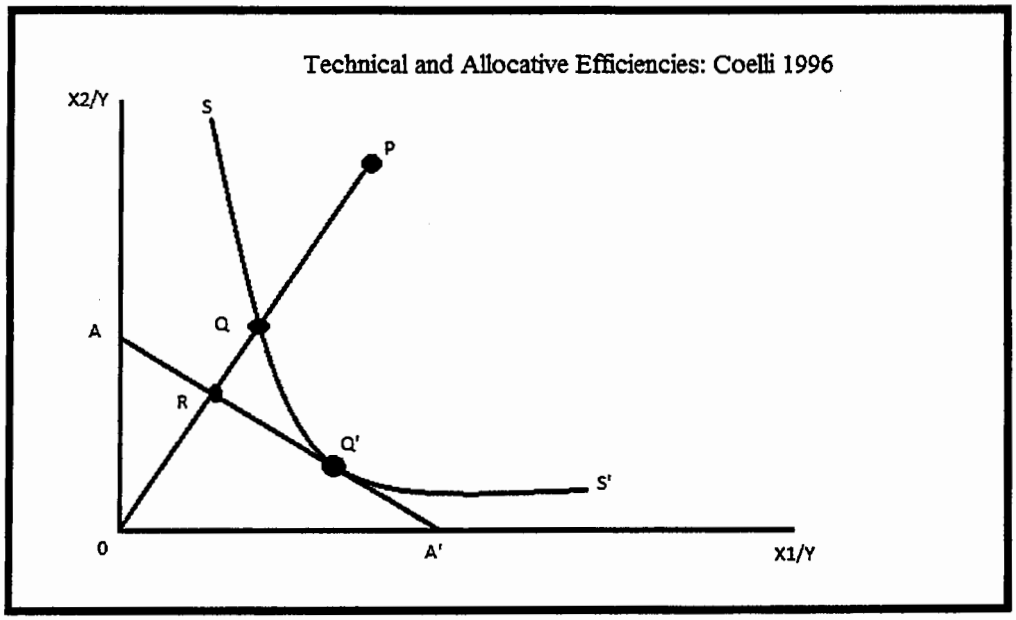
According to Farrell (1957) efficiency can be divided into two main components. The first component is Technical Efficiency (TE). TE shows a firm's ability to maximize output for a particular set of inputs. The second component is allocative efficiency (AE). AE shows the ability of a firm to use a set of inputs in an optimal proportion given the price that they were paid for. Total Economic Efficiency (EE) is thus a combination of both AE and TE.

The following Figure 2.1 (from Coelli 1996) uses an input oriented two input one output Constant Return to Scale (CRS) model and allows for a brief visual explanation of TE and AE. The line SS' is the fully efficient firm's production function determined by DEA. The point P represents the output of a single firm using the two inputs X1 and X2. The technical inefficiency for the firm is measured as the distance QP. This represents the proportional amount that inputs could be reduced in order to still achieve the same level of output. Technical efficiency is thus determined by the ratio TE = OQ/OP that is bounded by zero and one, thus a value of one represents a fully efficiency firm and any value less than one represents a non-fully efficient firm. The line AA' is the input price ratio and with this one is able to determine the Allocative Efficiency of the firm. Therefore AE = 0R/OQ. The line AA' allows for determining the allocative efficient point Q' as it shows how much a firm would produce if it were both allocatively and technically efficient. Therefore the total Economic Efficiency of the firm is shown as EE = OR/OP or also TE x AE = EE

DEA was formulated by Charnes, Cooper, and Rhode in 1978 as a way of measuring efficiency of units in a system (Charnes, Cooper and Rhode, 1978). This development allowed for a relative comparison of efficiency between different units. These DMUs transform inputs such as income or resources into outputs such as services or products.

Consequently, in DEA analysis we have to be able to collect data for the same inputs and outputs for the DMUs being studied in order to make a successful comparison.

**Figure 2.1: Technical and Allocative Efficiencies Shown on an Input Oriented Two Input One Output CRS Model**




Charnes, Cooper and Rhodes (1978) developed their DEA measure in terms of constant returns to scale (CRS) which is often referred to as the CCR model. While Banker, Charnes and Cooper (1984) proposed a DEA measure in terms of variable returns to scale (VRS) which is often referred to in the literature as the BCC model. The CRS model is appropriate when all DMUs are functioning on an optimal scale however, if there are factors in the market that may lead to non-optimal scale functioning such as imperfect competition, market shocks or other factors then a Variable Return to Scale (VRS) model is more appropriate. If not all of the DMUs are producing at an optimal level then the conditions can lead CRS models to confuse technical efficiencies and scale efficiencies. On the other hand, the VRS

model will allow for calculating technical efficiency without the problems of scale efficiencies as in the CRS model (Coelli 1996).

Also, DEA weighs separate efficiency factors differently. If we analyze the weights associated with each variable in our efficiency we can see if a firm is focusing on just one or two of the efficiency factors or in all of them. As a result we can see if a firm "specializes" in a certain area of efficiency. However, as they may be very strong in one or two areas this would give them an overall efficient score, whereas they are technically not efficient in other factors. So, we could still suggest improvements in banks that are deemed fully efficient (Halos and Salamouris 2001).

In terms of data collection it is often difficult if not impossible to obtain certain types of data from a bank or firm, thus we must use available data, hence nonparametric analyses rely on accounting data such as costs, outputs, inputs, revenues, profits and the like (Berger and Humphrey 1997). These variables are then used to determine the benchmark for the industry to which the banks being studied can be compared. In other words, a set of indices is created that can be used to compare a wide range of factors within multiple groups. This could then be used in order to compare different groups of banks within the Brazilian market, domestic versus public versus foreign bank efficiencies.

DEA is better than a simple ratio analysis in terms of judging overall efficiency. For one it gives a more robust evaluation of efficiency within an industry. With ratio analysis we use only one comparison measure, that is Return on Assets (ROA), Return on Equity (ROE), deposits, loans, investments or the efficiency ratio (Non-interest expense divided by total revenue less interest expense) and compare it to other firms, while in DEA we take a group of

inputs and outputs and develop a composite efficiency comparison measure, i.e. using ROA, deposits, loans, etc. together to form the composite. When we combine the different measures into the frontier we can then compare the individual bank efficiencies and determine their relative (technical) levels of efficiencies in terms of other banks as opposed to their actual levels of efficiency (Kirkwood and Nahm 2006).

These technical efficiencies ratios that DEA determine are equal to a weighted sum of outputs over a weighted sum of inputs. The weights are determined for each DMU by determining the efficiency frontier for the group as a whole using a maximization of the efficiency ratio so that every DMU is equal or less than one. DMUs that lie on the frontier are termed efficient and those that do not lie on the frontier are termed inefficient (Halkos and Salamouris 2001).

#### 2.4.4.1.1 Bank Activities and Approaches to Data Envelopment Analysis

Furthermore, it is important to note that there are two main approaches to DEA in terms of banks economic activities, the intermediation approach and the production approach similar to the thoughts in the competition section above. They are summarized as:

- Intermediation approach: this DEA approach sees banks as an intermediary between those wanting to invest their funds and entities that wish to use those funds. In terms of the use of inputs and outputs this approach considers the financial value of outputs related to deposits, loans, and securities, while when looking at inputs it focuses on the financial costs related to liabilities.

- Production approach: this DEA approach sees banks as the supplier of services for depositors. Therefore this approach sees outputs consisting of the number and value of transactions over a period of time, and inputs are focused on labor and capital.

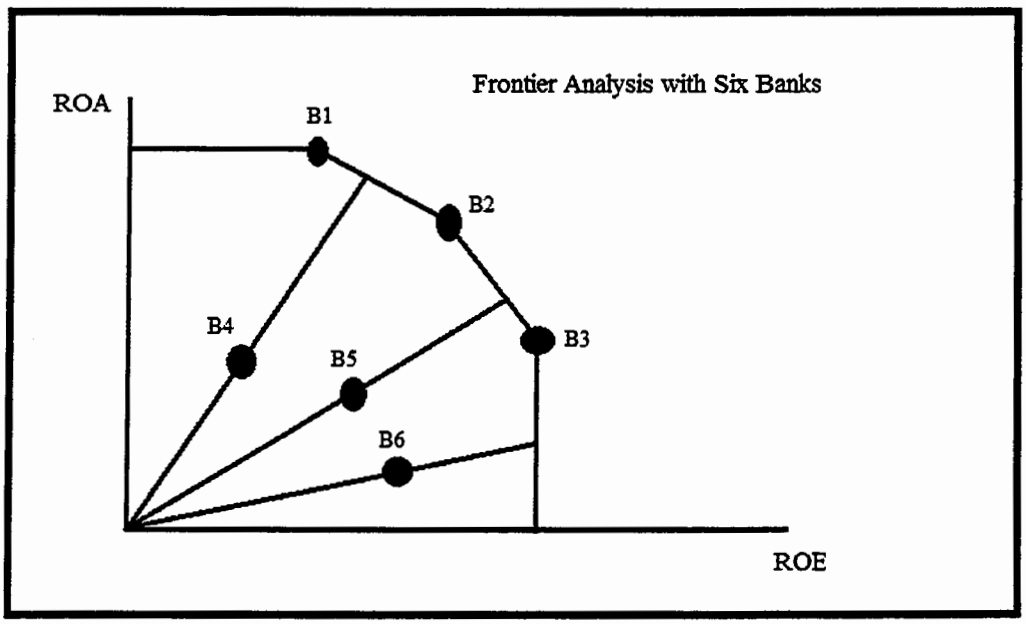
Focusing back on the technical side of DEA, DEA is basically a set of linear observations where the maximum efficiency frontier is created by the connecting of the benchmark (i.e. most efficient) variables/ratio. Thus, each variable has its own maximum represented by the most efficient bank's score in that benchmarked variable. Then all other banks' own variables are compared to the benchmarked best practice variable. Figure 2.2 below gives an example of a frontier analysis where we have a study of six banks, B1, B2, B3, B4, B5, and B6. Banks B1, B2, and B3 set the efficiency frontier which we have set up in terms of Return on Assets and Return on Equity. Banks B4, B5, and B6 are not lying on the efficiency frontier so they would be considered inefficient in terms of the best practice banks. We measure the amount of efficiency by the distance the banks value Bx lies from the efficiency frontier. Subsequently we would determine the efficiency or lack thereof, for B5 by looking at the ratio 0B5/0Bμ. Where 0B5 is the distance from the axis to point B5 divided by the distance from 0 to where the line that B5 is on touches the frontier Bμ, the efficiency frontier.

Moreover, it is important to reinforce that DEA gives us relevant and not absolute efficiency scores, thus the bank or DMU's efficiency score is directly affected by the efficiency of the sample of DMUs used (Halkos and Salamouris 2001). An important note is that maximum efficiency that DEA gives is the best efficiency among the firms being evaluated, and consequently being the "most efficient" does not necessarily mean they are fully efficient in relation to all banks in the world, it is limited to the set being evaluated.

DEA and nonparametric frontiers are useful and relatively easy to use, but they do have their drawbacks. The main problem with nonparametric studies is that they assume that there is no random error in the model. Given that for a more focused problem list for nonparametric

frontiers Berger and Humphrey (1997) assume there is no error in constructing the frontier, no lucky days that give a bank better performance from one observation to the next and there are no mistakes created by the accounting policies that measure input and output for said banks. If any of these errors were to occur they could affect the efficiency frontier and thus affect all of the measured efficiencies for all the banks.

**Figure 2.2 Frontier Analysis with Six Banks Example on a Two Axis Efficiency Frontier Based on Return on Assets as the Y axis and Return on Equity as the X axis and Variable Returns to Scale**




### 2.4.4.2 Free Disposal Hull Approach

A special case of DEA is the Free Disposal Hull (FDH) approach. Just like DEA the FDH permits changes in efficiency and does not have any prior assumptions placed on the model. It also has the same drawbacks as any DEA that were previously mentioned, such as

misrepresentation of error terms as inefficiency. The main difference between standard DEA analysis and FDH analysis is that instead of the convex relationships between inputs and outputs under DEA the FDH allows for free disposability of inputs and outputs. Additionally FDH usually produces larger estimates of efficiency compared to DEA (Delis et al 2009).

### 2.4.4.3 Malmquist Index

When panel data is available a Malmquist index can be used in order to determine productivity changes over time. These changes can be broken down into technical change and technical efficiency change. Hence by comparing the different time periods to each other researchers are able to calculate technical change and technical efficiency change over determined time periods in order to better follow the development of changes in the market (Coelli 1996). Due to the extensive number of calculations needed over our time period (over 5000 separate linear programs) as well as changes in bank reporting to the Central Bank of Brazil a Malmquist Index is beyond the scope of this research

## 2.4.5 Empirical Literature Review for Efficiency Measures

Berger and Humphrey (1997) reviewed 130 studies with various frontier efficiency analyses for twenty-one countries. Their study covered a multitude of facets and dimensions in which banks can be segmented, via size, ownership, market structure, bank type, economic environment, interest rates, regulation reform, privatization and much more in order to determine some of the common traits of efficient banks.

They found a rough equal division of parametric and non-parametric models being used within the 130 studies. They found that in general non-parametric methods gave lower efficiency scores; however, in general the two methods did give relatively consistent

efficiency scores. On the other hand, when it came to rankings, parametric and non-parametric methods were not consistent. While within each method the individual models tended to rank banks similarly when they were within the same group, i.e. SFA and TFA. Therefore for policy sake it was better to use the parametric and non-parametric efficiency scores rather than their rankings. Also of note, was the different efficiency scores by different methods have different levels of discernable information that can lead to different policy choices by executives. As a result the model used could predispose one set of efficiency scores. Therefore taken together overall efficiency scores are of more use to policy makers than the rankings.

Of further interest in this paper are their notes on efficiency and market structure. When looking at market power and cost efficiency Berger and Humphrey (1997) state that cost efficiency is more influential in profitability than market power. However, they do find that in higher concentrated markets where market power abuse could be taking place banks do not show higher cost efficiency as their managers seem to be taking the "quiet life" path as discussed by Hicks despite lower deposit rates and higher interest rates.

In their study on efficiencies in the US banking sector Berger and Mester (1997) used the parametric Distribution Free Approach for the period 1990-1995. While analyzing many other parametric and non-parametric approaches they focused on DFA in order to allow for the ability to have more lax restrictions on the distributions of the error term and inefficiencies. This allowed them to test for cost, profit and alternative profit efficiency. They found that alternative profit efficiency ratios were lower than standard profit efficiency ratios which could be derived from the ability to compare level of quality of inputs and outputs that the former allows.

In terms of significant influences on efficiencies there were a few important notes. They found regardless of size banks can control their cost efficiency rather uniformly, however they become less profit efficient as they grow larger as it may become harder for the larger banks to find new sources of efficient profit gains.

Also, in terms of ownership, publicly traded banks had higher cost and standard profit efficiency ratios. In terms of their loan portfolios they found that banks with higher loan to total asset ratios were found to have higher standard profit efficiency. Simultaneously, they found that in less competitive markets (lower Herfindahl Index markets) banks were able to exercise their market power by the negative relation to concentration and cost inefficiency, as well as the positive correlation between concentration and alternative profit efficiency. And in total they found that banks were wasting 20% of potential profits due to cost inefficiencies and almost half of potential profits due to profit inefficiencies.

Staub et al (2010) looked at efficiency developments in the Brazilian banking sector from 2000-2007. Using DEA analysis they were able to determine that Brazilian banks have lower cost efficiency than their European and U.S. counterparts. On the contrary, foreign banks in Brazil were the most inefficient in the market compared to domestic private and public banks. The authors added extra measures to DEA in order to account for cost as well as allocative and technical efficiencies. They also found that public banks were the most efficient in terms of cost, technical and allocative efficiency which would seem to go against popular theory that public banks have an agency problem. Furthermore, they found that cost efficiency in general for all bank types hovered around 0.44 efficiency over the study and allocative inefficiencies rose during the 2002-2007 period. Therefore their overall results did not show

improvement in efficiency in the Brazilian banking sector. Also, they found that non-performing loans are a key indicator of efficiency levels of banks.

They not only ran DEA analysis they analyzed the set up of the Brazilian banking sector in order to determine why the numbers may be so different than their foreign counterparts. One thing they noted was that as the corporate bond market is not developed in Brazil and firms are forced to use banks more for their financing. Consequently banks play a more important role in economic development private sector financing than in other countries.

An additional study on Brazil focused on the profitability and spreads of public banks versus private banks. Barros (2008) found some important notes for possible efficiency/inefficiency rankings of banks. The author noted that the public banks in Brazil are run as private institutions even though they are governmentally owned. This is due in part to the fact that public banks are also listed on the stock market and thus have pressure to remain profitable and competitive.

The article also points out that the Brazilian government uses the public banks in order to implement their social policies, i.e. unemployment benefits, micro-credit programs, retirement programs, public employee payments, etc. The funds made available to the public banks in order to cover these programs sometimes do not equal their actual costs and the public banks must pass on these incurred costs to their clients. This then leads to a lower efficiency rating even though it is not necessarily the management's failure to control costs that added these extraneous costs to their bottom lines. The author found government policies that add costs to public banks actually increase the profitability of the private banks in the sector, because these increased prices to public bank customers allowed for private banks to

raise their prices, increasing their spreads and profitability as they did not have the increased cost burden.

Another DEA study on the Brazilian banking sector was done by Pires Goncalvez (2008) over the 1995-2006 period. The study used DEA efficiency scores as a proxy for management quality within the CAMEL (Capital adequacy, Asset quality, Management quality, Earnings ability and Liquidity position) bank rating system. The results showed that there were differences between efficiency scores that could help indicate at risk banks with quality control issues. The study analyzed the top 50 banks in Brazil and found that over the period public banks were more efficient than their private bank counterparts. Also noted was the overall increase in efficiency scores from 0.74 in 1995 to 0.87 in 2005.

Casu, Girardone and Molyneux (2004) studied multiple European banks from 1994 to 2003. In their study they used DEA to model banking efficiency over the period. They were able to point out cost efficiency gains in numerous countries' banking industries over the period studied until 2000. The increased inefficiency or wastage after 2001 could be attributed to increased competition and the influence of further deregulation and the preparation for the introduction of the Euro.

Casu et al then used their DEA results as bank specific variables in a study on competition in the European banking sector over the time period and found that there is little evidence that more efficient banking systems are more competitive than their inefficient counterparts. The efficiency scores were negative in their competitive Panzar Rosse H-statistic regression showing the most efficient banks were generating the lowest total revenues per assets. This

would fit in with the idea that more profitable products may incur higher costs thus coming out in the regression as inefficiencies.

A study on European banking done by Altunbas et al (2001) focused on the period 1989-1997. They used SFA analysis with a flexible Fourier function in order to estimate scale economies, efficiencies, and technical changes. They found that the largest banks, in general, have diseconomies of scale while the smallest banks were found to have scale economies. They also note that there is little evidence to suggest that larger banks are more efficient than their smaller counterparts, yet technical progress was shown to lower costs for all banks and increased with bank size. Furthermore the authors point out that X-efficiencies are more important than scale economies within the European banking market. Subsequently banks would be better served controlling their efficiencies whether technological or managerial than going for larger economies of scale.

In a comparative study of stochastic frontier analysis and programming frontier efficiency on the US banking industry from 1986-1991 Eisenbeis et al (1999) discerned the informativeness of each method of efficiency testing. The authors found that based on size both models had lower levels of variance in efficiency scores as the banks became larger. Furthermore, regardless of size, banks in the study were becoming more efficient over the period. The efficiency rankings of the two models were strongly correlated allowing us to say that they are giving roughly the same results.

Their stochastic analysis showed that higher risk taking banks had higher inefficiencies; higher variance in their stock returns and had lower capitalization. Additionally, the SFA inefficiency scores found strong relationships between their scores and bank managerial

practices. These links were weaker in the programming frontier analysis. Their results found that both analyses did produce efficiency scores that were informative to the researcher; though they felt that the stochastic frontier approaches should be held in higher regard than the programming frontier efficiency models as it was more informative, but both measures should be used in order to produce a more robust analysis of the efficiency situation.

Kirkwood and Nahm (2006) viewed banks as intermediaries and used two separate DEA models based on cost efficiencies in order to analyze the Australian banking market for 1995-2002. The two models were used in order to test for banking service efficiency and profit efficiency. Their study showed that the large/major banks had increased their banking service, profit and revenue efficiencies over the period while medium sized banks maintained the same levels of banking service efficiency and suffered a decline in profit efficiency and revenue efficiency. They also noted that these increased efficiencies were rewarded with higher stock valuations.

Hahn (2007) focused on the Austrian banking market and analyzed the efficiency developments from 1996-2002. His technique was to use a slack-based DEA model as well as a bootstrap estimator in order to deal with the inherent dependency problem of DEA. They also note that most Austrian banks are regional and that there are very few banks with international reach. Accordingly they determined that it would be of importance to factor in environmental factors into the DEA model. This controlling for external environmental factors within the geographical areas improves the efficiency scores for the banks. However, over the period Austrian banks decreased in their efficiency.

Camanha and Dyson (2006) used DEA and a Malmquist Index in order to analyze the internal inefficiencies within a group of banks. They focused on the Portuguese market and divided banks by region. This then allowed them to test by regional market in order to find branch level inefficiencies. Using a modified Malmquist Index they were able to separate branch performance. Their analysis showed that the northern region of the country had the lowest productivity/efficiency ratings while the Lisbon region was found to be the most productive/efficient. The country region south of Lisbon scored closely to the Lisbon region; however it had a greater range of productivity/efficiency measures which shows a wide range of productivity/efficiency.

In his country specific study on efficiency in the Italian banking sector Resti (1997) analyzed the sector and found that Italian banks' efficiency remained unchanged over the time period. Furthermore, the study noted that Italy's banking system can be broken into Northern and Southern regions in terms of efficiency and that deposits are the highest cost-intensive products on offer. The study also found that both parametric and non-parametric models give relatively the same results and the slight variations in the efficiency scores can be traced back to the models themselves.

In Halkos and Salamouris' study (2004) on the Greek banking sector for 1997-1999 using a combination of ratio analysis and DEA, they saw an increase in competition and efficiency after the liberalization of Greek banking rules. The allowance of other European Union banks to compete more freely in the Greek banking sector has led to increased competition in price and quality levels that have been a major boost to the Greek banking sector. The major difference in their study versus the majority of DEA studies is that they use ratios instead of banks inputs and outputs. They note that using ratio analysis and DEA together as

complements in order to better analyze DMUs' efficiencies. They note that larger banks in terms of assets have larger efficiency scores, while smaller banks were being driven out of the market while efficiency scores rose; this was caused mostly by mergers and acquisitions.

A larger Greek study from 1993-2005 by Delis et al (2009) was used in order to compare SFA cost and profit efficiencies to DEA. The period was marked by financial reforms, economic crises and joining the Euro. With their SFA analysis they found that Greek banks were significantly better in terms of cost efficiency versus profit efficiency. Additionally, large banks were found to be slightly more cost efficient than their smaller counterparts. While in terms of profit efficiency the medium and small banks had greater profit efficiency then their larger counterparts, which may be explained by smaller banks taking greater risks in their loan portfolios. Furthermore their SFA analysis found that private banks had superior profit and efficiencies and had improved their cost efficiencies over the period to approximately the superior cost efficiency level of the public banks.

Using the same variable set their DEA analysis gave significantly lower efficiency scores than SFA. They also found that efficiency improved over the entire period using DEA while efficiency increased with SFA until 2002 when it began to decrease. They further note that the DEA and SFA do give weakly consistent rankings over the period for cost efficiency. However, both did reach the same conclusion in that bank size has a positive relationship with cost efficiency, yet they conflicted on the relationship between ownership (private versus public) and cost efficiency.

Bos and Kolari (2005) set out to analyze the economic motivations for geographic expansion by US and European banks. Their study uses both stochastic frontier approaches for cost and

profit in order to test for economies of scale and scope for the period 1995-1999. They found that in general the large US and European banks have increasing profit returns to scale and similar increasing profit returns to scope. Therefore they are driven to increase their size in order to take advantage of their returns to scale and scope. Also, they find that large US banks are more profit efficient than their large European counterparts. And in general they found that small banks (regardless of region) have higher cost efficiencies while lower profit efficiencies in comparison to the larger banks.

Also in a similar study, Schure, Wagenvoort and O'Brien (2004) used DEA to analyze solely the European banking sector from 1993 to 1997. Their study found that larger commercial banks were more productive and efficient than their smaller European counterparts over the entire time period.

Matousek and Taci (2004) used the distribution free approach (DFA) of DEA in order to analyze the Czech banking system during its transition period, 1993-1998. Their study focused on the transitions government's need to privatize their banks early in the transition process in order to allow for better bank efficiencies and a smoother transition to the new system. They found that foreign banks were more efficient than their Czech counterparts and stated that the government should have allowed for more foreign presence earlier in order for the Czech banking system to be more competitive and efficient sooner. They also found that large Czech banks were less efficient than their smaller competitors during the beginning of the study, but equaled out near the end. This again could be contributed to the influx of foreign competition in the market, which were the large banks main competitors, leading to the large Czech banks instituting internal bank reforms in order to better compete. Even

though the local banks were less competitive, all banks, regardless of size or ownership, showed an increase in efficiency over the period.

Espiria-Escuer et al (2004) used SFA in order to model European Union countries' banking systems' efficiencies. Their study focused on the pre-Euro period, 1988-1999 and allowed for the showing of the different starting points for each individual banking market. Whether they were public bank dominated as in France, regional bank dominated in Germany, or society dominated as in Italy and Spain. They set out to show the changes in efficiency that came about by the different countries preparing to join the Euro zone. For this reason they used SFA in order to test for technical efficiencies that can be compared to show if any countries had an advantage in any certain area. Thus they would be able to determine the different factors that led to differences in efficiencies.

Over the period all banking systems in the European Union showed improvements in their efficiency scores. The countries that started at the lowest level of efficiency showed the greatest improvement in their scores, e.g. Spain and Portugal improved over 50%. Of further interest when Espiria-Escuer et al (2004) factored in for country, they found that there is a country effect in terms of bank efficiency. However, when they tried to find an explanatory variable for all banking systems they found that there only significant explanatory variable overall was inhabitants per branch, which showed that the fewer inhabitants per branch the more efficient the banks were, i.e. more focus on each individual customer.

In their study of 15 Organization of Economic Co-operation and Development (OECD)[9] countries Lozano-Vivas and Pastor (2006) focused on macro-economic efficiency as well as financial efficiency developments from 1980-1997. Using DEA analysis they developed both a world-wide macro-economic efficiency and a financial efficiency frontier. They did this by determining inter- and intra-country efficiency, as well as testing for productivity changes, and then analyzing any relationship or associations between the three. The countries showed a convergence of macro-economic and financial efficiencies over the time period with nearly all countries showing an increase in efficiencies.

Maudos et al (2007) analyzed the relationship between market power and efficiency within the EU-15 countries from 1993-2002 covering 75% of all banks. They measured market power for loans and deposits separately with the Lerner's Index in order to measure them at bank level, which Panzar Rosse does not allow. They then analyzed the cost efficiency of each market by SFA. They found that market power increased in the loan market, but decreased in the deposit market. They also found that there was a positive relationship between efficiency and market power and thus Hick's "Quiet Life" scenario did not hold for the EU-15 banking market. Furthermore the authors used inefficiency as a proxy for social loss and determined that the welfare loss due to market power was 0.54% of the EU-15 GDP, which was worse than the welfare loss due to bank inefficiency.

In order to better analyze banking efficiency while taking into account bank specialization Pastor and Serrano (2006) looked back at EU banking from 1992 to 1998 in order to see if there were intra-specialization differences in efficiencies, as certain types of banking have inherently different cost structures, i.e. retail banking with the need for large number of

[9] Austria, Belgium, Canada, Denmark, Finland, Germany, Italy, Japan, Netherlands, Norway, Spain, Sweden, the U.K. and the U.S.

observations over the period, not just yearly. Thus they were able to note any trend in efficiency gains or losses. They found that competition and efficiency are positively related, while the introduction of foreign banks into the market decreased efficiencies. As with Shanmugam and Das (2004) study on Indian banking reforms, they find that all banks increased efficiency over the period and that private domestic Indian banks were the least efficient types of banks and that public and foreign banks were significantly more efficient in comparison.

A later analysis of the Indian banking sector performed by Debnath and Shankar (2008) focused on 2004-2005. Their findings were interesting as they were one of the few papers to show a negative relationship with bank size and efficiency. Their DEA analysis of the period showed that medium sized banks were the least efficient in comparison to large or small banks. They also found that no banks were facing increasing returns to scale regardless of size or ownership and that any mergers in order to eliminate inefficient banks would be counterproductive if they were looking to gain efficiencies.

Park and Weber (2006) focused on the relationship between efficiency and productivity in the Korean banking market for the period 1992-2002. This period was marked by a pan-Asian financial crisis, concentration in the Korean banking market, as well as the liberalization and deregulation of the Korean banking market. They also note that the Korean government wanted to develop Korea as a financial hub for the region, which can influence bank decision making and thus their efficiency developments. Due to non-performing loans being written off by many Korean banks the authors used the directional technology distance function to estimate the productivity growth, a version of DEA. This function allows for desirable and un-desirable outputs to be separated and measured within the model. The directional vectors

are then determined and measured giving a comparative measure of efficiency and productivity.

Their results show that the Korean bank sector inefficiency doubled from 1992 to 1995, then doubled again in the run up to the 1997/1998 pan-Asian financial crisis. This inefficiency problem was most likely compounded by the government's non-allowance of mergers during the reform period. After the financial crisis the governments allowed mergers and from 1998 through 2000 and efficiency levels rose, as inefficient banks were now able to be purchased out of the market by their more efficient rivals. Unfortunately, the inefficiency levels began to rise again during the last two years of the study. However, the change in bank product offerings over the time period and the technical progress that came along with them helped the sector become even more productive while becoming less efficient over the time of the study.

Analyzing transition economies, Bonin et al (2005), tried to determine how ownership affected banking efficiency in eleven countries[10] in Eastern Europe from 1996 to 2000. Using SFA they found that private domestic ownership and state ownership of banks did not have a significantly different level of cost or profit efficiencies. Also, having any sort of international investor led to improved profit efficiency. However, they also found that foreign owned banks are better at increasing cost efficiencies versus improving profit efficiencies. Additionally, the analysis has shown that inefficiency increases with bank size, which would follow Hick's "Quiet Life" scenario for these transition countries.

[10] Bulgaria, Croatia, Czech Republic, Estonia, Hungry, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia.

El-Gamal and Inanoglu (2005) analyzed efficiencies in the Turkish banking market from 1990 to 2000 focusing on the differences between ownership types. They used the SFA cost function approach as well as a labor efficiency cost-function analysis. They found that foreign banks were the most efficient followed by state run banks. They also noted that special financial houses, i.e. Islamic banks were no less efficient than their private domestic banking competitors.

# Chapter 3: Research Questions

The research questions for this dissertation have been divided into two separate groupings. The first grouping, the principal research questions, allows for the discovery of the true nature and background of the Brazilian banking industry. They allow us to characterize the banking system in order to delve deeper in the second level of research questions. The second level of research questions or the fundamental research questions allow for the deeper understanding of the issues, effects and causal relationships discussed in the literature review and the principal research questions.

## 3.1 The Principal Research Questions

### 3.1.1 Research Question 1: Has the Brazilian banking sector continued to consolidate over the period of the study?

Yeyati and Micco (2007) Neto (2005), and Yildirim and Philippatos (2007) all note that the Brazilian banking sector had been consolidating since the institution of the Real Plan in the early 1990's to the mid 2000s. As consolidation has been the norm throughout the past 20 years in Brazilian banking the research needs to continue in order to analyze the developments in concentration in the Brazilian banking sector in terms of Total Assets, Total Deposits and Total Loans. The most common measures have been concentration ratios and the Herfindahl Index for testing market power. Analyzing the market with these tools will then allow us to better judge the level of concentration development and by proxy competition in the sector.

### 3.1.2 Research Question 2: Has the Brazilian banking sector become concentrated to the point that the government should take action?

The end of 2000's and beginning of 2010's have seen a continued increase in mergers and acquisitions in the Brazilian banking sector as well as the concentration mentioned by previous authors (Yeyati and Micco (2007), Neto (2005), Belaisch (2003), Pires Goncalves 2008) in the previous decades may lead to an overly concentrated banking market which could have a negative effects on competition as well as on the customer service, financial package offerings and banking choices for the final bank customer. Therefore governments should know if the market is over-concentrated in case there could be a social loss from the increased competition and if they should be more vigilant in merger and acquisition approvals.

### 3.1.3 Research Question 3: What is the level of competition in the Brazilian banking sector?

Monopolistic competition has been the prevailing ranking for competition in the Brazilian banking sector in previous studies (Belaisch 2003, Yildirim and Philippatos 2007, Lucinda 2010) ranging from 1995 to 2008. The major differences between the studies have been in regards to discrepancies in the variables to use in order to test for competition. In order to have a more robust analysis of competition in Brazil it is important to expand the tests in order to better understand the current competitive climate in Brazil data. Additionally, by analyzing the sector up through 2011 the effects of the financial climate on competition may better be analyzed.

### 3.1.4 Research Question 4: How efficient is the Brazilian banking sector?

Previous studies have stated that efficiency in the Brazilian banking sector has stagnated over time (Staub et al 2010) while others have stated that there was an improvement in efficiency (Pires Goncalves 2007). Efficiency is not only a measure of the best use of input prices and outputs, but it also can work as a proxy for management quality and thus could give information that would better understand the internal managerial workings of banks. Therefore it is important to calculate more efficiency estimates in order to improve the amount of data available for comparison. Also, by researching over a time frame we are able to track changes or lack of changes in the sector's efficiency as well as make notes on possible effects of macroeconomic factors.

## 3.2 Fundamental Research Questions

### 3.2.1 Research Question 5: Has the concentration of the sector had a negative effect on competition?

Yildirim and Philippatos (2007) noted that the concentration in the Brazilian banking sector had a negative effect on competition in the 1990s while Belaisch (2003) alluded to the same. Although other studies (Casu and Girardone 2006) have stated that an increase in concentration does not necessarily relate to a decrease in competition. Furthermore, Yeyati and Micco (2007) note that there is little evidence to suggest that an increase in concentration leads to a decrease in competition. With such mixed results throughout the literature it would be of interest to further analyze the relationship between concentration levels and competition levels to see what the current standing is of the relationship between concentration and competition within the Brazilian banking sector.

### 3.2.2 Research Question 6: How has the current financial crisis affected the concentration in the Brazilian banking sector?

Macroeconomic effects can have great impacts on markets. The current financial crisis has had wide spread effects throughout many industries including the world banking market and this has lead to mergers, acquisitions, exits from respective markets and reevaluations of banks positions in their non-core markets. Though the Brazilian economy, Real, stock market have all returned to their Pre-Financial Crisis levels the after effects of the crisis may have influenced the market structure of the banking industry and therefore consequently, it is important to analyze the possible changes brought about by the financial crisis to concentration in the Brazilian banking sector.

### 3.2.3 Research Question 7: Has the current financial crisis affected competition in the Brazilian banking sector?

The financial crisis brought with it numerous effects on the Brazilian economy and banking sector specifically. With the sharp downturn and quick rebound of the Real to the dollar and the Bovespa stock exchange as well as the effects of the historically low SELIC overnight rate after the financial crisis it is important to analyze how these may have played out in the level of competition in the Brazilian banking sector. The key component of the competition analysis of this thesis deals with specifically measuring the possible changes in competition before and after the financial crisis. This will allow us to note if the crisis has been positive or negative for competition.

### 3.2.4 Research Question 8: Does ownership type have any relation to efficiency in the Brazilian banking sector?

Previous studies have noted that Brazilian Public Banks, owned by the federal or state governments are more efficient than their Domestic Private Banks or Foreign Banks. This seems to be in contrast to popular belief that government institutions are less efficient than their private sector counterparts. Also, as efficiency has been used as a proxy for management quality (Pires Goncalves 2007) we may be able to determine on average which type of banks by ownership are better at managing their input prices and outputs than their competitors. Therefore it would be of interest to study further the developments of efficiency scores by ownership to see if there are any possible management policy connotations.

### 3.2.5 Research Question 9: Did the current financial crisis have any effect on efficiency in the Brazilian banking sector?

The financial crisis has been felt throughout the business world with job losses, plant closures and increased pressure to cut costs where ever possible. These pressures have been felt within the banking industry as well as there has been an before unseen amount of pressure for banks to control their costs to manage the financial storm that has been wrecking havoc throughout the financial world over the past few years. These increased cost pressures brought about by the financial crisis need to be analyzed in order to better understand whether they have had any effect on the overall efficiency in the Brazilian banking sector. This also would help to note whether or not any different management quality issues between banking subgroups, i.e. ownership or bank size, may have led to different effects in quality levels during or after the crisis.

### 3.2.6 Research Question 10: Does the level of efficiency affect competition in the Brazilian banking sector?

Casu and Girardone (2006 and 2009) promote the need for more research on the link between efficiency in banking markets and competition in banking markets. Their studies showed that increased competition led EU banks to be more efficient; however increased efficiency did not result in an overall more competitive banking system. Hence it is of interest to see how efficiency may or may not affect competition in the Brazilian banking industry and vice versa.

### 3.2.7 Research Question 11: Is Bigger Better? Does Bank Size have any relation to efficiency in the Brazilian Banking Sector?

In order to prove that "Bigger Is Better" in terms of banking efficiency and the size of a bank, we need to prove that as Brazilian banks have become larger in market share, loans, deposits, etc they have become more efficient at the same time. This would then allow for the further consolidation of banks via mergers and acquisitions as they could state that by becoming larger the banks are becoming more efficient and can thus pass on those efficiency savings onto their end customers.

### 3.2.8 Research Question 12: Is the Quiet Life in effect in the Brazilian banking sector?

From Hicks' (1935) to Berger and Hannan (1998) and Maudos and Guevara (2008) the idea of the worst effects of a concentrated market where companies act in inefficient and self-serving manners is known as the Quiet Life. Demsetz' Efficiency Hypothesis allows for the possibility of market concentration being due to more efficient firms beating out their

inefficient rivals for customers. By testing for efficiency and its relationship with bank size we should be able to tell if the Brazilian banking sector is enjoying the "Quiet Life" of inefficiency with their increased concentration or if they are partaking in the mindset of Demsetz Efficiency Hypothesis.

# Chapter 4: Data and Methodology

## 4.1 The Data

Our data set is taken from the Banco Central do Brasil's (Brazilian Central Bank) statistics on the Top 50 universal banks in Brazil. We have focused on the 37 quarterly reports from the first quarter 2002 to the first quarter 2011 for these Top 50 banks which gives us 1850 possible total bank quarter observations. We must note that data pre-second quarter 2009, does include development banks, automaker financial banks due to the Central Bank of Brazil's change in reporting criteria. Prior to Q1 2009 these banks were divided into different subgroups and not included in the Top 50 universal banks. After Q1 2009 the excluded institutions are included in the consolidated banking list of all financial institutions.

The statistics cover only the Top 50 banks individually in Brazil; though we do have the statistics for all institutions combined as well which we use to form our market shares seen in Table 5.1 above. We feel that these Top 50 banks represent a significant part of the market, never dipping below 82% of total financial banking system Total Assets market share, 90% of Total Deposits or 78% of Total Loans thus, can be used as a proxy for Brazilian banking market as a whole. Also, the banks in the Top 50 change each quarter and many banks are not found consistently throughout the period 2002-2011 due to mergers, acquisitions and some banks falling out and entering into the Top 50 that the Central Bank of Brazil reports.

We have divided our data in terms of bank size based on Total Assets and ownership type set forth by the Central Bank of Brazil. Public banks are banks that are owned by the federal or individual Brazilian state governments, Private Domestic Banks, and Foreign Banks[11] in order to better gauge whether or not these factors have influence over competition and or efficiency scores.

## 4.2 Methodology

There are two empirical models utilized and discussed in this chapter. The first is the Panzar Rosse Model for measuring competition and the second is the Data Envelopment Analysis model used to measure efficiency.

### 4.2.1 The Panzar Rosse Model

Brazilian banks are seen as intermediaries and as such the intermediation approach is used in order to evaluate the competition in the loan market in Brazil. As discussed previously the Panzar Rosse H-Statistic assumes that the market is in long term equilibrium, thus in perfect competition an increase in any input's price will create a rise in marginal costs and decrease in total revenue of the same degree. However, if the market is in monopoly then the increase will lead to a corresponding decrease in the monopolist's revenue due to the monopoly existing in the elastic part of the demand curve. Consequently, the H-statistic will let us know the amount of competition in a market by the effect that a cost increase has on the total revenue of the bank or company being analyzed.

[11] Foreign controlled banks as well banks with foreign participation.

Throughout the literature researchers have used a variety of variables to best represent their market. This has led to some difficulty in comparison of one Panzar Rosse study data to another. Therefore our H-Statistic data will be different than previous studies on Brazil (Belaisch 2003, Yeyati and Micco 2003, Neto et al 2005, Yildirim and Philippatos 2007, Lucinda 2010). We are focusing on a certain period within a single market with a standardized government data set; we feel that this will allow us to be able to show the developments in Brazilian banking competition over the time period, specifically showing the effects of the current financial crisis on the Brazilian banking sector's level of competition.

The model assumes that banks are profit maximizers thus:

$$R_i'(P_i, n, BSF_{i,rev}) = C_i'(P_i, F_i, BSF_{i,cost})$$

Where R is revenue, C is cost, P is output, n is the number of banks surveyed, BSF are bank specific factors affecting revenues and costs, F is the factor input prices. The Panzar Rosse model assumes that the market is in equilibrium, thus null profit should come about at market level. Therefore Panzar and Rosse H-Statistic shows the sum of the elasticities of the reduced form revenue function with respect to factor prices, represented as:

$$H \equiv \sum_j \frac{\partial R_i}{\partial F_{j,i}} \frac{\partial F_{j,i}}{\partial R_i}$$

This explains why when H is equal to 1 the market is in perfect competition[12], while if H equals 0 or negative the market is in monopoly. Also, if the H-Statistic falls between zero and 1 the market is found to be in monopolistic competition.

[12] In short run equilibrium H may be greater than 1 (Lucinda 2010).

The Panzar Rosse H-Statistic model that we use can be shown as (derived from Claessens and Laeven 2004, Casu and Girardone 2006, Gutierrez de Rozas 2007, and Bikker and Spierdijk 2008. Lucinda 2010):

$$\ln(P_{it}) = a_i + B_1 \ln(F_{1,it}) + B_2 \ln(F_{2,it}) + B_3 ln(F_{3,it}) + \sum_{j=1}^{J} \Theta_j \ln(C_{j,it})$$

$$+ \sum_{k=1}^{K} \delta_k D_k + \xi_{it}$$

Where:

Dependent Variables:

$(P_{it})$ = TR, Total Revenue from Banking and non-Banking Activities. This includes Interest Revenue, Service Charges, Bank Charges, non-operational income, and other operational income. Total Revenue can be used as banks compete on more than just their loan portfolios and with the importance of bank fees and service charges to Brazilian banks the total revenue that a bank earns better represents the effects of competition.

$(P_{it})$ = TRTA, Total Revenue from Banking and non-Banking activities over Total Assets. The normalization of Total Revenues by Total Assets is used in order to compare the results with both the Total Revenue as the dependent variable model with the more commonly used in the literature Total Revenue over Total Assets model.

$(P_{it})$ = IR, Interest Revenue. Earlier studies focused on interest revenue as they were testing for competition in the loan market. We use both Interest Revenue and Total Revenue in our study to give a more robust set of statistics.

$(P_{it})$ = IRTA, Interest Revenue over Total Assets. The normalization of Interest Revenue by Total Assets is used to compare the results with the Interest Revenue model as well as the more commonly normalized models in the literature.

Explanatory Variables

Factor Input Prices

$(F_{1,it})$ = PFUNDS, Price of Loanable Funds: Ratio of Interest Expense to Total Deposits and Total Liabilities.

$(F_{2,it})$ = PLABOR, Price of Labor: Ratio Personnel Expenses to Total Employees. Using total employees is seldom used in the research as employee numbers are often not reported, but it is seen as a better measure of the Price of Labor (Bikker et al 2006) and the employee numbers are made available by the Central Bank of Brazil.

$(F_{3,it})$ = PCAPITAL, Price of Capital: This is calculated by taking Overhead Expenses over the combination of Leased Assets and Fixed Assets. This allows us to see the price paid by banks for covering, maintaining and developing their fixed and leased assets.

$(C_{j,it})$ = Represents a series of bank specific variables.

$(C_{1,it})$ = RISK, Ratio of Total Loans to Total Deposits and Liabilities from Borrowing. This is used a proxy for a bank's propensity to take on intermediation risk, as well as showing the liquidity of the bank and the weight of its loan portfolio.

$(C_{2,it})$ = DEPOSITS, Total Deposits, which is used as a proxy for demand for the firm by customers as well as a way to measure or control for size.

$(C_{3,it})$ = TOO BIG, Ratio of number of branches to the total number of branches. This is an additional relation to the idea of testing for size. However, it principally allows for us to analyze the geographical dispersion of banks throughout the country as larger branch networks would represent larger TOO BIG ratios.

$(C_{3,it})$ = EFF, Data Envelopment Analysis Efficiency Score. This allows us to test whether efficiency plays a role in competition and total revenue of the banks. Casu and Girardone (2006) note the lack of research of efficiency on competition.

$(D_k)$ = Dummy variables.

$(D_{POB})$ = PUBLIC, Variable for Public ownership, in order to test if ownership has an effect on the Total Revenue of a bank as well as its possible influence on competition.

$(D_{FOB})$ = FOREIGN, Variable for Foreign bank ownership or participation, in order to test if ownership has an effect on Total Revenue of a bank as well as its possible influence on competition.

And we state that: $H = B_1 + B_2 + B_3$, is the sum of the factor price elasticities in regard to the reduced revenue function.

In order to determine long run equilibrium as is required for the Panzar Rosse H-Statistic to function we assume that if all variables are taken in terms of Total Assets the elasticities should equal zero ($E = B_1 + B_2 + B_3 = 0$) as in equilibrium Total Revenue to Total Assets should not be affected by factor prices.

We use three separate models in order to compare results and give more robustness to our analysis. The first model, Model X, is similar to models used throughout the literature. Here we use Total Revenue as the dependent variable as non-interest income has become more important to banking balance sheets over the past decade.

Model X[13]:

$$\ln(TR_{it}) = a_i + B_1 \ln(PFUNDS_{1,it}) + B_2 \ln(PLABOR_{2,it}) + B_3 ln(PCAPITAL_{3,it}) + \Theta_j \ln(DEPOSITS_{j,it}) + \Theta_j \ln(RISK_{j,it}) + \Theta_j \ln(TOOBIG_{j,it}) + \xi_{it}$$

The second model we use, Model B, includes the variables for Efficiency and Bank Ownership. As Casu and Girardone (2006) stressed there has not been a great deal of research in the relationship between efficiency and competition. Hence we include efficiency in this model. The dummy variables for ownership also allow us to test the effect of ownership on competition.

Model B[14]:

$$\ln(TR_{it}) = a_i + B_1 \ln(PFUNDS_{1,it}) + B_2 \ln(PLABOR_{2,it}) + B_3 ln(PCAPITAL_{3,it}) + \Theta_j \ln(DEPOSITS_{j,it}) + \Theta_j \ln(RISK_{j,it}) + \Theta_j \ln(TOOBIG_{j,it}) + \Theta_j \ln(EFF_{j,it}) + \Theta_j \ln(PUBLIC_{j,it}) + \Theta_j \ln(FOREIGN_{j,it}) + \xi_{it}$$

[13] A further Model X is used with Total Revenue over Total Assets as the dependent variable.
[14] A further Model B is used with Total Revenue over Total Assets as the dependent variable.

The third model, Model IR, changes the dependent variable to Interest Revenue. In the past this was more prevalently used than total revenue. As Lucinda (2010) noted there is great discrepancy in which variables are best suited for Panzar Rosse tests. Therefore we use Interest Revenue in order to see whether there are any major differences in the level of Panzar Rosse H-statistic depending on the dependent variable.

Model IR[15]:

$$\ln(IR_{it}) = a_i + B_1 \ln(PFUNDS_{1,it}) + B_2 \ln(PLABOR_{2,it}) + B_3 ln(PCAPITAL_{3,it}) + \Theta_j \ln(DEPOSITS_{j,it}) + \Theta_j \ln(RISK_{j,it}) + \Theta_j \ln(TOOBIG_{j,it}) + \Theta_j \ln(EFF_{j,it}) + \Theta_j \ln(PUBLIC_{j,it}) + \Theta_j \ln(FOREIGN_{j,it}) + \xi_{it}$$

## 4.3 The Data Envelopment Analysis Model

The literature has extensively used both SFA and DEA in efficiency studies for banks. We use the DEA approach as it gives us one value that we can use within the Panzar Rosse Model. The studies have shown that both SFA and DEA show relatively consistent results in rankings and efficiency, though DEA shows higher levels of inefficiencies than SFA mostly due to DEA not separating the error term from efficiency. DEA is easy to use multiple outputs and allows us to infer cost, technical and scale efficiencies without direct knowledge of the factor input prices (Staub et al 2010). This as well as its acceptance and universal use throughout the literature and coupled with its giving a single value of efficiency, we use the DEA measure of efficiency in order to test for efficiency in the Brazilian banking sector.

[15] A further Model IR is used with Interest Revenue over Total Assets as the dependent variable.

In terms of inputs versus outputs oriented DEA we have decided to use an input oriented DEA model focusing on cost efficiency. This is designed to better show managerial effectiveness for controlling costs that come about with more intense concentration in the market. It allows us to test for possible market power as the efficiency scores will help us determine if bank managers are running a more efficient bank. Additionally, in input oriented models technical inefficiency is shown as a proportional reduction in input utilization. This allows us to use the DEA score as a proxy for effects of competition on managerial efficiency. We also note that we see banks as intermediaries and thus use the intermediation approach to analyze banks.

Within the literature there is discussion of returns to scale and their affect on DEA analysis. The constant return to scale model functions only when all DMU are functioning at an optimal scale. This would not seem to hold true for a study of Brazilian banking as factors such as imperfect competition, financial constraints, government social programs pressed upon public banks would all affect a bank's ability to operate at an optimal scale. The variable return to scale approach has been more widely used throughout the literature and would seem to fit better within our analysis.

Detailing the outline of the methodology of DEA.

$\Theta^* = \min \Theta$

Subject to:

$$\sum_{j=1}^{n} \lambda_j x_{ij} \leq \theta x_{ij} \qquad i = 1, 2, \ldots, m$$

$$\sum_{j=1}^{n} \lambda_i y_{rj} \geq y_{r0} \qquad r = 1, 2, \ldots, s$$

$\sum_{j=1}^{n} \lambda_j = 1$

$\lambda_j \geq 0 \qquad j = 1, 2, \ldots, n$

Where:

$Bank_0$ represents one of the n banks being analyzed.

$\lambda$ represents the weight given to each bank that forms the efficiency frontier.

$\Theta^*$ is the input oriented efficiency measure for $Bank_0$.

$x_i$ are the i-th inputs for $Bank_0$.

$y_r$ are the r-th outputs for $Bank_0$.

If we have $\Theta^* = 1$, $Bank_0$ would be considered to be on the efficient frontier and be a best-practices bank in terms of cost efficiency. When we measure the banks and it receives an efficiency score of $\Theta^* = 1$, this means that $Bank_0$ is on the efficiency frontier. If the $\Theta^*$ of a bank's DMU is less than 1 than it is considered inefficient in terms of the best-practice efficient banks. Therefore if $\Theta^* = 0.75$ we would say that $Bank_0$ is inefficient with 75% cost efficiency in terms of the best-practice banks that form the frontier. In other words they are 25% less efficient then the fully efficient banks.

In terms of the inputs and outputs used for our study we have inputs of: Interest Expenses to show the cost of interest baring products, Operating Expenses net Personnel Expenses to show the cost of running the bank minus the personnel costs, and Personnel Expenses to

show the amount spent on the labor force in order to produce bank outputs. These characterize the inputs needed in order for banks to perform their actions as intermediaries between depositors and borrowers. The outputs used are Investments, Total Loans & Leases net of provision for loan losses to show the output of loans and leases that banks have produced, and Total Deposits as this also is considered an output as the desirability or demand for a bank's services can be derived from their total deposits.

Then for explanatory purposes we use Total Assets for scaling the banks in order to allow us to see whether bank size demonstrates differences in efficiency in the market. We analyze the results additionally by controlling for ownership type noted by Foreign Owned banks, Public Banks that are controlled by the federal or individual state governments, and Domestic Private Brazilian banks.

In this thesis the DEAMax software developed by Cheng Gang of Peking University and Qian Zhenhua of the University of Science and Technology of Beijing, China (Cheng and Qian 2011), is used in order to conduct Data Envelopment Analysis. The software offers three main analysis options: 1. analysis of standard CRS and VRS models which focus on determining technical and scale efficiencies, 2. analysis of CRS and VRS models that take into account cost and allocative efficiencies, 3. applying a Malmquist DEA method to panel data which is used to determine total factor productivity, technological change, technical efficiency changes and scale efficiency changes.

DEAMax also allows for three ways to deal with slacks; the one-stage, two-stage and multi-stage DEA model. The multi-stage model is the most robust; however as slacks can be seen as allocative inefficiencies and can easily be overstated Coelli (1996) recommends that a one-stage DEA can show the technical efficiency that we are searching for.

Consequently, in this analysis we use a one-stage DEA model with VRS in order to analyze input-oriented cost efficiencies in the Brazilian banking industry. The Malmquist and multi-stage options, while good, are beyond the scope of this research.

# Chapter 5: Developments in the Market Structure of the Brazilian Banking System

## 5.1 Concentration Ratio and Market Share

The evolution of the structure of the Brazilian banking sector over the past twenty years has been astounding. From a country of rampant inflation in the early 1990's to a world power by the end of the 20th Century, Brazil has seen a wide range of reforms and structural changes to its banking sector in the recent past.

The Brazilian banking sector is marked by high profitability and high bank spreads (Barros 2008). Since the mid 1990's the Brazilian banking sector has been consolidating; whether through government action, forcing out inefficient or unsafe banks or in through mergers and acquisitions. The Brazilian banking sector we see today is dominated by the top five banks in the market. Looking at the concentration ratios over the 2002-2011 period from Table 5.1[16] we see that the evolution of large bank dominance continued throughout the period in terms of Total Assets (TA) and Total Loans (TL) with a lesser increase in Total Deposits (TD).

[16] For full Concentration Ratio tables on all quarters see Appendices 1, 2, 3, and 4.

## Table 5.1 Concentration Ratios and Herfindahl Index for Brazilian Banks, Q1 2002, Q1 2006, Q1 2009 and Q1 2011[17]

| Concentration Ratios | 2002Q1 | 2006Q1 | 2009Q1 | 2 011Q1 |
|---|---|---|---|---|
| CR3 Total Assets | 34.3% | 35.7% | 48.3% | 47.1% |
| CR5 Total Assets | 46.4% | 50.4% | 67.8% | 68.1% |
| CR10 Total Assets | 61.6% | 68.7% | 77.7% | 84.9% |
| CR50 Total Assets | 82.6% | 84.6% | 86.25% | 95.6% |
| CR 3 Total Deposits[18] | 49.9% | 46.6% | 54.1% | 52.8% |
| CR 5 Total Deposits | 60.1% | 58.4% | 77.2% | 69.1% |
| CR10 Total Deposits | 74.6% | 79.9% | 87.0% | 85.4% |
| CR50 Total Deposits | 90.9% | 92.1% | 93.3% | 95.4% |
| CR 3 Total Loans[19] | 32.7% | 35.9% | 47.6% | 46.4% |
| CR 5 Total Loans | 43.4% | 48.8% | 65.8% | 67.8% |
| CR10 Total Loans | 59.2% | 69.5% | 75.1% | 84.7% |
| CR 50 Total Loans | 79.8% | 80.5% | 83.0% | 95.1% |
| Herfindahl Index | 2002Q1 | 2006Q1 | 2009Q1 | 2011Q1 |
| HI for Top 50 Banks, Total Assets | 0.056 | 0.064 | 0.101 | 0.107 |
| HI for Top 50 Banks, Total Deposits | 0.100 | 0.097 | 0.134 | 0.133 |
| HI for Top 50 Banks, Total Loans | 0.055 | 0.067 | 0.096 | 0.108 |

Source: Banco Central do Brasil and author calculations. Top 50 based on Total Assets.

In Q1 2002 the top five banks accounted for 46.4% of Total Assets, 43.4% of Total Loans and 60.1% of Total Deposits which progressed in Q1 2006 to 50.4% in TA, 48.8% in TL and a slight decrease to 58.4% in TD. This was followed by significant increase in Q1 2009 to

[17] We use the k-firm concentration ratio ($CR_k$) and the Herfindahl Index in order to test for concentration, as they have been widely used and accepted throughout the literature and by governments testing mergers and acquisitions (Yeyati and Micco 2003, Gutierrez de Rozas 2007).
[18] Deposits held by top ten banks according to Total Assets, not top ten banks according to Deposits.
[19] Loans held by top ten banks according to Total Assets, not top ten banks according to Loans.

67.8% in TA, 65.8% in TL, and 77.2% in TD. This continuing increase in concentration was tapered some by the financial crisis at the end of the 2000's which in Q1 2011 left the concentration of the top five banks at 68.1% of TA, 67.8% of TL, with a dip to 69.1% of TD[20].

To give an idea of how the largest banks are winning out in comparison to even the next largest banks we compare the top five banks to the banks ranked six through ten in terms of Total Assets. The development in terms of average bank size, the progression of consolidation within the top five banks has led to the average size for a top five to grow in relation to banks ranks six through ten and as well as in relation to the even smaller banks[21]. For example the top five banks have had on average three times more Total Assets, 2.75 times more Total Loans and 4.4 times more Total Deposits in Q1 2002 than banks six through ten which held steady through Q1 2006. This gave the five largest banks 2.75 times more Total Assets, 2.35 more Total Loans, though a dip to 2.7 times Total Deposits than banks six through ten in Q1 2006.

Afterward the industry started to consolidate more and in Q1 2009 the differences between the top five and banks six through ten grew larger. Q1 2009 showed the top five banks to have 6.8 times more average Total Assets, 7.1 times more Total Loans and 7.1 times more Total Deposits than banks six through ten. This held for two of the groups, in Q1 2011 average Total Assets was 6.9 times, Total Loans 7.8 times, while Total Deposits dipped to 4.6 times that of the next five banks. Overall this showed that the biggest banks were in fact growing larger in relation to even the other large banks in the country giving the country five

[20] Of note the Brazilian Central Bank reclassified how banks are classified in Q2 2009, leading to slight variances in data post Q2 2009.
[21] For Descriptive Characteristics and Averages see Appendix 5.

dominant banks by the end of the study[22]. Therefore, one should take note of the dominant position that the largest banks have in the Brazilian banking industry.

However, this has not always been the case or at least not to this extent. Looking at the Concentration Ratios (CR) for Brazil from 2002 to 2011 we see that there has been a slow and steady gain of market share for the top banks at the expense of their smaller competitors. The top five banks or CR5 in Table 5.1 show that over time they have increased their market share of Total Assets over 21%, Total Loans by 24% and Total Deposits by 9% in the sector, while the overall top 50 banks representation of the Total Assets have stayed relatively level during that period, 82.6% in Q1 2002, 84.6% in Q1 2006, and 86.25% for Q1 2009 and 95.6% for Q1 2011[23]. Therefore it can be said the big banks are getting bigger and the small banks are getting smaller.

If we switch our gaze to the Top 10 Banks (CR10), in Q1 2002 the top ten banks accounted for roughly 61% of Total Assets, 77% in Q1 2009 to a further increase of 85% in Q1 2011. Total Deposits also saw more consolidation. They have gone from 74.6% in Q1 2002 to an astounding 87% in Q1 2009 while having tapered off to 85% of the market in Q1 2011. Additionally, CR10 for Total Loans follows more closely the path that Total Assets has made, growing from 59.2% of Total Loans in Brazil in Q1 2002 to 77% in Q1 2009 then a further increase to 85% of the market by Q1 2011. These numbers hammer home the point that big Brazilian banks are getting bigger and the smaller banks are the ones losing out. Further on in this chapter we talk about the breakdown of the growth by bank type, public, private domestic, and foreign owned.

[22] A development bank is left out of the top five comparison in Q1 2011 in order to keep the data homogenous for all four observation.
[23] The Brazilian Central Bank changed bank characteristics in Q2 2009 and that leads to part of the increase for Q1 2011.

## 5.2 The Herfindahl Index Test for Market Power

With such high concentration ratios it leads to the question, "Is the market too concentrated?" and, if so, what does that mean for competition? Are the banks becoming more or less competitive as the market becomes more concentrated? This is the core of our study. One indicator in order to test for market power in addition to the concentration ratio is the Herfindahl Index (HI), sometimes referred to as the Herfindahl-Hirschmann Index, where the concentration ratio sums up the market share of k number of banks, the Herfindahl Index sums the square of the market shares ($s_i$) for the banks in question.

$$HI = \sum_{i=1}^{N} s_i^2$$

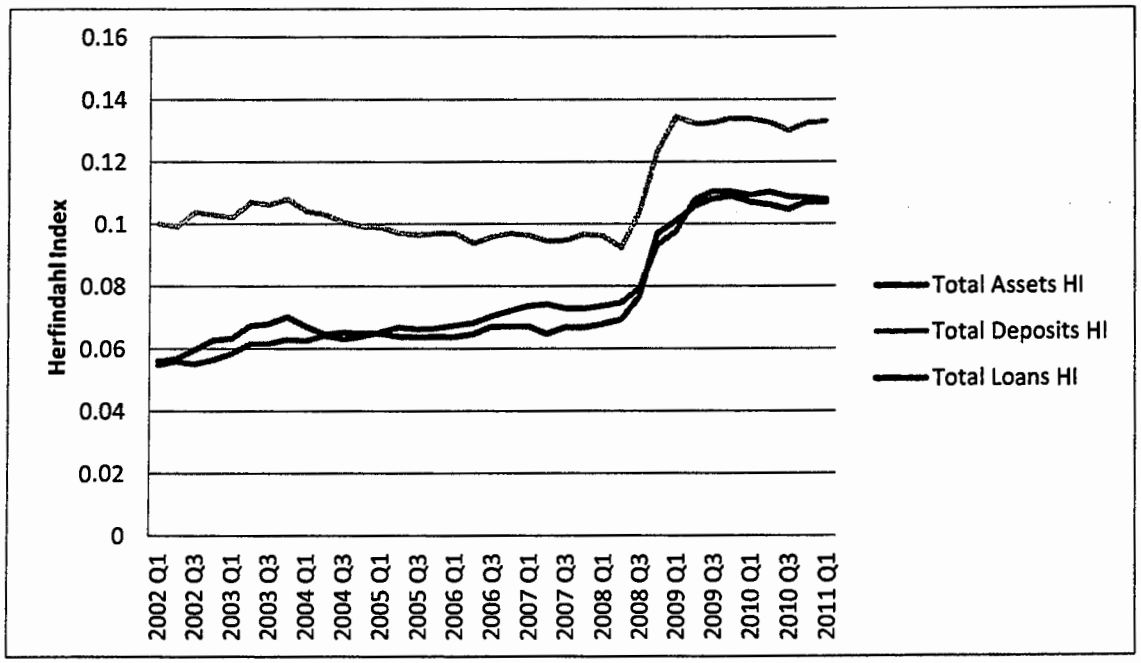
The index can take into account a large number of firms or a single monopoly. Theoretically an increase in the Herfindahl Index (HI) generally indicates an increase in market power and thus a decrease in competition and vice versa. The United States' Justice Department and Federal Trade Commission determine that an HI score between 0.100 and 0.180 shows a moderately concentrated market while scores over 0.180 are considered concentrated[24].

Over the 2002 to 2008 period the HI, in terms of Total Assets for the top 50 Brazilian banks, remained relatively stable. From Q1 2003 through Q2 2008 the HI ranged from 0.063 to 0.070 with a quarterly average of 0.066. It is only since the second half of 2008 to 2011 that we have seen a significant increase in the HI. The first jump is related to the purchase of

[24] http://www.justice.gov/atr/public/testimony/hhi.htm

Unibanco by ITAU Bank both top 10 banks at the time of the acquisition[25]. And has continued to rise due to increased merger and acquisition activities in the sector as some Foreign Banks reevaluate their strategy for Brazil. As of Q1 2011 the HI for Total Assets was still a normal concentrated market HI score of 0.107.

**Chart 5.1 Herfindahl Index Test for Market Power for Total Assets, Total Deposits and Total Loans in Brazilian Banking by Quarter, Q1 2002-Q1 2011**




Source: Brazilian Central Bank and Author Calculation.

Even though this is a significant increase in the movement of the HI it still shows that Brazil has only just entered into a "moderately concentrated" market according to United States Government standards. It is important to note that governmental agencies use HI in order to gauge the effect of potential mergers on competition. Therefore mergers may be denied due

[25] The Central Bank of Brazil reclassified their Top 50 Banks from Q2 2009 thus skewing the HI slightly higher.

to their subsequent effects[26]. Therefore if a potential merger would go beyond the pre-set limit or change the market structure too much it may cause the regulatory agencies to raise concerns. Chart 5.1 contains the Herfindahl Index for the top 50 Brazilian banks from Q1 2002 until Q1 2011, for all Herfindahl Index Quarterly Scores see Appendix 6.

## 5.3 The Effects of Concentration on Competition

Now that we have the concentration ratios and Herfindahl Index we can evaluate their effects on competition with Neto et al (2005) as a rough guide. Using the H Statistics (discussed in Chapter 6) as our proxy for competition we regress the effects of the concentration measures (CR3, CR5, CR10 and HI) on the H-Statistic for the thirty seven quarters of the study from Q1 2002 to Q1 2011. We use the number of branches to control for the growth of the industry, the average DEA quarterly efficiency ratings, and a time variable in order to take into account for the pre and post crisis period. The results of the regressions are found in Tables 5.2, 5.3, and 5.4, the descriptive statistics are in Appendix 11, and the Correlation Matrices are found in Appendices 12, 34, 35, and 36.

$$H = \alpha_0 + \alpha_1(Concentration\ Measure) + \alpha_2(Total\ Branches) + \alpha_3 DEA + \alpha_4 Pre - Crisis\ Time\ Dummy + \varepsilon$$

Table 5.2 shows that all concentration measures for Total Assets except for CR5 have a significantly negative effect on competition, especially in relation to the concentration of the top 3 banks (CR3) and in relation to the Herfindahl Index. This would imply that concentration in the Total Assets in the industry leads to lower competition.

[26] Anti-trust concerns are brought up in concentrated markets where mergers change the HI score by 0.01.

## Table 5.2 Relationship Between Competition[27] and Total Asset Concentration (CR3, CR5, CR10 and HI)

| | CR3 | CR5 | CR10 | HI |
|---|---|---|---|---|
| Branches | -.00017<br>(.0002) | -.0001542<br>(.00021) | .00024<br>(.0002) | -.000025<br>(.00021) |
| Concentration Measure | -10.384***<br>( 3.23398) | -4.755848<br>(5.215) | -9.083***<br>(3.758) | -34.333***<br>(10.005) |
| DEA | -3.6720<br>2.159189 | -4.6054***<br>(1.8142) | -4.064*<br>( 2.029061) | -3.597<br>(1.9721) |
| PreCrisis | -.26812<br>(.4598) | .14703<br>(.70592) | .1821<br>(.4658) | -.2915<br>(.4248) |
| Constant | 11.40**<br>(5.2695) | 10.149*<br>(5.076) | 6.373<br>(4.827) | 7.251<br>(4.8714) |
| R-Square | .3388 | .2867 | .3302 | .3303 |
| F-Stat | F(4,32) =<br>4.21*** | F(4,32) =<br>3.66*** | F(4,32) =<br>5.22*** | F(4,32) =<br>4.97*** |
| # Observations | 37 | 37 | 37 | 37 |

Note: t-stat in parentheses, P-Value < 0.05***, P-Value < 0.1**, P-Value <0.15*

## Table 5.3 Relationship Between Competition[28] and Total Deposits Concentration (CR3, CR5, CR10 and HI)

| Deposits TR | CR3 | CR5 | CR10 | HI |
|---|---|---|---|---|
| Branches | -.00045<br>(.00018) | -.00025<br>(.00026) | -.00018<br>(.00019) | -.00027<br>(.0002) |
| Concentration Measure | -6.042***<br>(2.189) | 1.5968<br>(5.228) | -8.8499*<br>(4.724) | -23.665***<br>(9.757) |
| DEA | -3.269<br>(2.313) | -5.3173***<br>(1.863) | -4.8800***<br>(2.037) | -3.519<br>( 2.20126) |
| PreCrisis | -.1403<br>(.4650) | .9391<br>(.7736) | .2116<br>(.5352) | -.17697<br>(.37798) |
| Constant | 15.035***<br>(4.212) | 8.356<br>(8.607) | 15.447***<br>( 6.7109) | 11.597***<br>( 4.542) |
| R-Square | .3353 | .2755 | .3379 | .3084 |
| F-Stat | F( 4,32) =<br>5.69*** | F(4,32) =<br>4.54*** | F(4,32) =<br>4.20*** | F(4,32) =<br>5.77*** |
| # Observations | 37 | 37 | 37 | 37 |

Note: t-stat in parentheses, P-Value < 0.05***, P-Value < 0.1**, P-Value <0.15*

[27] H-Stat determined by using total revenue as the dependent variable. For the regression table for the regression with total revenue over total assets as the dependent variable see Appendix 37.

[28] H-Stat determined by using total revenue as the dependent variable. For the regression table for the regression with total revenue over total assets as the dependent variable see Appendix 38.

Table 5.3 focuses on the relationship between the concentration of Total Deposits and competition. In the table we see that as with Total Assets the concentration ratios all have negative signs and are significant (except for CR5). This would lead us to point out that concentration in Total Deposits in the top banks also lead to less competition in the market.

## Table 5.4 Relationship Between Competition[29] and Total Loans Concentration (CR3, CR5, CR10 and HI)

| Loans TR | CR3 | CR5 | CR10 | HI |
|---|---|---|---|---|
| Branches | -.00017<br>(.00020) | -.00021<br>(.00026) | .00017<br>(.00034) | .00011<br>(.00027) |
| Concentration Measure | -4.0608<br>(5.037) | -1.5859<br>(6.013) | -5.6781<br>(3.781) | -30.741**<br>(15.006) |
| DEA | -5.459***<br>(2.095) | -5.184***<br>(1.839) | -5.006***<br>(1.962) | -4.682***<br>(1.969) |
| PreCrisis | .5110<br>(.5164) | .5854<br>(.7178) | .7002<br>(.4005) | . 2083<br>(.4542) |
| Constant | 9.959**<br>(4.987) | 9.694**<br>(4.5258) | 5.6087<br>(5.500) | 5.0778<br>(5.2205) |
| R-Square | .2837 | .2746 | .3080 | .3123 |
| F-Stat | F(4,32) =<br>4.65*** | F(4,32) =<br>3.69*** | F(4,32) =<br>4.77*** | F(4,32) =<br>4.38*** |
| # Observations | 37 | 37 | 37 | 37 |

Note: t-stat in parentheses, P-Value < 0.05***, P-Value < 0.1**, P-Value <0.15*

Table 5.4 shows the relationship between concentration in the Total Loans market and competition. Here we see that the signs are all negative for concentration in Total Loans, however here not all concentration ratios have significance. Also, note that none of the measures reach a 95% confidence interval as in Total Assets (CR3) or Total Deposits (HI). Therefore we can say that concentration in the Total Loan market may be harmful to

[29] H-Stat determined by using total revenue as the dependent variable. For the regression table for the regression with total revenue over total assets as the dependent variable see Appendix 39.

competition, but not as harmful or significant as the concentration in Total Assets or Total Deposits[30].

## 5.4 Foreign Participation and Competition

As discussed above foreign participation has fluctuated in the Brazilian banking sector. The effects of foreign participation can be both positive and negative for consumers as well as the banking sector as foreign banks' focus may not always be on the host market they have moved into.

### Table 5.5 Correlation Matrix of Quarterly H-Statistics and Foreign Participation

| 37 Observations | HStatTRTA | HStatTR | Foreign TA | Foreign TD | Foreign TL | DEA |
|---|---|---|---|---|---|---|
| H-Stat Total Revenue over Total Assets | 1.0000 | | | | | |
| H-Stat Total Revenue | 0.5585 | 1.0000 | | | | |
| Foreign Total Assets | 0.1948 | 0.4951 | 1.0000 | | | |
| Foreign Total Deposits | 0.4106 | 0.4802 | 0.7198 | 1.0000 | | |
| Foreign Total Loans | 0.0757 | 0.4362 | 0.9491 | 0.6913 | 1.0000 | |
| DEA | -0.0375 | 0.2309 | 0.4909 | 0.4701 | 0.6249 | 1.0000 |

Overall when comparing quarterly H-Statistic scores from Q1 2002 to Q1 2011 we see a positive correlation between foreign participation and competition in the Brazilian banking sector. Table 5.5 shows the correlations between both a H-Statistic where Total Revenue over

[30] When using total revenue over total assets as the dependent variable for the H-Statistic measure the values of the concentration coefficients vary from those in the total revenue model, however they are not significant at any of the three significance levels. The signs also are mixed, but relatively similar.

Total Assets was used as a dependent variable and a H-Statistic where just Total Revenue was used as the dependent variable. Both measures do have positive correlations to foreign participation in the loan market, the deposit market and in the overall total assets. This shows the relative positive importance that foreign banks do play in the competition levels in Brazilian banking.

# Chapter 6 Empirical Results

## 6.1 Empirical Results for the Panzar Rosse H-Statistic

The analysis of competition in the Brazilian banking sector has been divided into three periods in order to: 1. evaluate the overall level of competition in the sector from 2002 to 2011, 2. to evaluate the level of competition found in the sector before the current financial crisis, 2002-2008 and 3. Evaluate the effects of the financial crisis on the level of competition for the 2009-2011 period.

Similar to Gelos and Roldos (2004) we use panel data instead of cross-sectional data in order to test for changes in the level of competition. We use fixed effects and robust standard errors which allow for differing methods of controlling the coefficients' changes over time. This allows us to control for heterogeneity as well as allowing us to use the fixed effects to encompass bank specific non time varying attributes that are not directly stated in the regression.

Additionally, the use of panel data does not allow for us to track the effects of banks that have merged with other banks as only the larger bank is kept in the Central Bank database after the date of the merger. Also, Central Bank data only covered the Top 50 banks for the 2002-2008 period while all Brazilian banks were covered from Q2 2009. Thus some of the smaller banks that were on the fringe of the Top 50 may have been in existence for the entire 2002-2011 period, but the data was not made available by the Central Bank. Therefore of the

original Top 50 Brazilian banks in the first quarter of 2002 only 23 of the original 50 banks rank in the Top 50 for all 37 quarters of the study.

### 6.1.1 Overall Competition Measure for 2002-2011

Beginning with an analysis of the complete 2002-2011 period we find with all three models with both sets of dependent variables that the Brazilian banking sector is in monopolistic competition. Table 6.1.1 shows the regression results with fixed effects and robust standard errors as well as the results from the Hausman, Breusch and Pagan Lagrange Multiplier, Wald and F-Tests for the models using Total Revenue and Interest Revenue as their dependent variables, while Table 6.1.2 has the corresponding results and tests for the models using Total Revenue over Total Assets and Interest Revenue over Total Assets as their dependent variables.

The three models give us slightly varying H-Statistic values however, all find the Brazilian banking sector to be in Monopolistic competition over the 2002-2011 period. In terms of Total Revenue as the dependent variable we find that the fixed effects and robust standard error models give strikingly similar scores with Model X and Model B. Model X's scores were 0.7602 for the robust standard error model and 0.7571 for the fixed effects model. Model B's corresponding scores with Efficiency and Bank Ownership factored in for the entire period were 0.7581 and 0.7565. Both models' Hausman tests showed that there were no significant differences in using the fixed effects or robust standard error model. When looking at Interest Revenue as the dependent variable the Brazilian banking sector appears slightly more competitive with robust standard error H-Statistics of 0.8088 and 0.8076 for the fixed effects model.

When the dependent variable is normalized by taking the Total Revenue or Interest Revenue by Total Assets (as seen in Table 6.1.2) the results show a slight numerical change, though continual classification. Model X's H-Statistics are now 0.7017 for the robust standard error model and 0.7085 for the fixed effects model. Model B's are 0.7137 and 0.7149 respectively. The IR Model also sees a decrease from the non-normalized model, where the robust standard error H-Statistic is 0.7657 and fixed effects value of 0.7699.

The sum of the factor input prices (Price of Funds + Price of Labor + Price of Capital) is significantly larger than zero in all cases and consequently we can reject the position that the market is working as a monopoly/oligopoly. Furthermore the sum of the factor input prices for all models is significantly less than one and so we can rule out perfect competition in the Brazilian banking sector over the life of the study. Table 6.1.1 and 6.1.2 show the regression results as well as the H-statistics and tests for all three models[31].

Looking at the costs that Brazilian banks face, all three factor input prices are significant at a 95% confidence interval for Models X and B when Total Revenue is used as the dependent variable. Thus the banks total revenues are affected by the factor input prices that they face in the market. The coefficient results are similar to the findings of Belaisch (2003), Neto et al (2005), and Lucinda (2010). When using Interest Revenue as the dependent variable the Price of Capital in the robust standard error model loses its significance over the entire 2002-2011 combined period. Additionally, when using the normalized Total Revenues to Total Assets and Interest Revenue to Total Assets the Price of Capital becomes insignificant in all models. Belaisch's and Neto's results showed the price of labor to be insignificant over the 1993-2001 period, therefore not having significant factor input prices is not unheard of. This

[31] Correlation Matrix for the Panzar Rosse model regression for the periods: 2002-2011, Pre-Financial Crisis, and Post-Financial Crisis are found in Appendices 19-33.

contradictory result may be in part due to the factoring out bank size via the normalization of the significant effects that larger banks feel in managing their branch networks. Therefore the price of capital no longer holds as much sway in revenue generation or loss when size is not factored in.

Other coefficient estimates allow us to see that the Too Big to Fail measure of number of branches to total branches (geographic dispersion) is significant in all models (except for the fixed effect models with interest revenue involved) and has a positive sign. We also see that Total Deposits are positively significant in all models with Total Revenue as the dependent variable while significant in half of the scaled models, thus it may be sufficient as a proxy for demand. This shows us that, all else staying the same, as the banks grow in terms of number of branches/geographic dispersion or total deposits their total revenue and interest revenue increase. This also allows us to assume that the expanded bank networks that Brazilian banks have developed are beneficial to their total revenue. Taken with Total Deposits we can say that bigger was better in terms of a bank's Total Revenue over the 2002-2011 period.

The idea that bigger is better follows with the idea of scale economies in the sector and therefore the larger banks are able to reduce their costs at a greater pace than their smaller competitors. The Risk coefficient in the non-normalized models (total revenue and interest revenue) is positive and significant showing us that banks that intermediate more have more total revenue. Thus, Risk taking was beneficial to the Total Revenue as banks could extend themselves to more potential customers therefore increasing their market share and revenue. Another note on Risk is that it has a significant negative slight correlation to Foreign Bank ownership. This allows us to say that Foreign Banks are more selective in their clientele and do not over extend themselves in the market.

## Table 6.1.1 Regression Results for Panzar Rosse for 2002-2011 with Total Revenue and Interest Revenue as the dependent variables

| | X Robust All TR | X FE All TR | B Robust All TR | B FE All TR | IR Robust All TR | IR FE All TR |
|---|---|---|---|---|---|---|
| Pfunds | .4278*** (.0617) | .4266*** (.0612) | .4286*** (.0624) | .4269*** (.0614) | .5442*** (.0785) | .5365*** (.0768) |
| Plabor | .3217*** (.0738) | .3194*** (.0779) | .3186*** (.0753) | .3184*** .0787 | .2562*** (.0656) | .2622*** (.0695) |
| Pcapital | .0107*** (.0039) | .0111*** (.0037) | .0109*** (.0038) | .0112*** .0037 | .0084, .0043 | .0089* (.0040) |
| Deposits | .4591*** (.0502) | .4507*** (.0511) | .4590*** (.0500) | .4504*** .0509 | .4870*** (.0541) | .4679*** (.0546) |
| Risk | .2618*** (.0576) | .3165*** (.0605) | .2635*** (.0595) | .3125*** .0615 | .2554*** (.0695) | .3255*** (.0702) |
| Too Big | .2072*** (.0422) | .1499*** (.0458) | .2126***, .04368 | .1496*** .0462 | .1696*** (.0457) | .0435 (.0568) |
| Efficiency | | | -.0107 (.0630) | -.0188 (.0633) | .0398 (.0658) | .0212 (.0641) |
| Public | | | -.1024 (.1737) | Dropped | -.1275 (.1580) | dropped |
| Foreign | | | .0810 (.1215) | .0521 (.1467) | .0252, .0984 | .0081 (.1042) |
| Constant | 8.5739 .6970 | 8.4063, .6722 | 8.6206, .7196 | 8.3882, .6773 | 8.2010 (.7799) | 7.7224 (.7421) |
| Wald Test & Significance | chi2(6) = 686.37, 0.0000 | | chi2(9) = 755.76, 0.0000 | | chi2(9) = 731.93, 0.0000 | |
| F-Test & Significance | | F(6,819) = 125.43 (0.0000) | | F(8,817) = 94.69, 0.0000 | | F(8,801) = 85.51, 0.0000 |
| R Square | 0.8389 | 0.8212 | 0.8442 | 0.8236 | 0.8572 | 0.7973 |
| Hausman | 0.7735 | 0.7735 | 0.3837 | 0.3837 | | Does not meet Hausman assumptions |
| LM | chi2(1) = 2361.83 (0.000) | | chi2(1) = 2120.29, 0.0000 | | chi2(1) = 1262.33, 0.0000 | |
| # Observations | 848 | 848 | 848 | 848 | 832 | 832 |
| # Banks | 23 | 23 | 23 | 23 | 23 | 23 |
| Hstat | 0.7602 | 0.7571 | 0.7581 | 0.7565 | 0.8088 | 0.8076 |
| $H \leq 0$ | Reject | Reject | Reject | Reject | Reject | Reject |
| $H = 1$ | Reject | Reject | Reject | Reject | Reject | Reject |

Note: t-stat in parentheses, P-Value < 0.01***, P-Value < 0.05**, P-Value <0.1*

**Table 6.1.2 Regression Results for Panzar Rosse for 2002-2011 with Total Revenue over Total Assets and Interest Revenue over Total Assets as the dependent variables**

| | X Robust All TRTA | X FE All TRTA | B Robust All TRTA | B FE All TRTA | IR Robust All TRTA | IR FE All TRTA |
|---|---|---|---|---|---|---|
| Pfunds | .5781*** (.0593) | .5790*** (.0630) | .5801*** (.0600) | .5800*** (.0630) | .6818*** (.0761) | .6768*** (.0789) |
| Plabor | .1218*** (.0335) | .1287*** (.0383) | .1325*** (.0366) | .1341*** (.0399) | .0844** (.0341) | .0937** (.0377) |
| Pcapital | .0018 (.0054) | .0008 (.0051) | .0011 (.0053) | .0008 (.0051) | -.0005 (.0041) | -.0006 (.0041) |
| Deposits | -.0618*** (.0258) | -.0595* (.0291) | -.0579* (.0268) | -.0560 (.0297) | -.0540 (.0276) | -.0605 (.0312) |
| Risk | .0056 (.0392) | -.0135 (.0449) | .0300 (.0419) | .0100 (.0460) | .0294 (.0639) | .1354 (.0595) |
| Too Big | .1360*** (.0264) | .1364*** (.0301) | .1166*** (.0275) | .1410*** (.0305) | .0761** (.0326) | .0452 (.0433) |
| Efficiency | | | .1168** (.0509) | .1173** (.0493) | .1681*** (.0561) | .1526** (.0558) |
| Public | | | .2709** (.1101) | dropped | .2590* (.1276) | dropped |
| Foreign | | | -.0141 (.1002) | .0072 (.1353) | -.0899) (.0909) | -.0247 (.1079) |
| Constant | 0.8025 (.3506) | .7418 (.3714) | .5707 (.3760) | .7390 (.3889) | .4349 (.3555) | .3630 (.3883) |
| Wald Test & Significance | chi2(6) = 352.38 0.0000 | | chi2(9) = 356.15 0.0000 | | chi2(9) = 431.07 0.0000 | |
| F-Test & Significance | | F(6, 819) = 41.39 0.0000 | | F(8,817) = 31.20 0.0000 | | F(8,801) = 41.47 0.0000 |
| R Square | 0.5082 | 0.5011 | 0.5576 | 0.5046 | 0.5579 | 0.4310 |
| Hausman | 0.9945 | 0.9945 | Does not meet Hausman assumptions | Does not meet Hausman assumptions | Does not meet Hausman assumptions | Does not meet Hausman assumptions |
| LM[32] | chi2(1) = 947.08 (0.0000) | | chi2(1) = 566.71, 0.0000 | | chi2(1) = 828.36, 0.0000 | |
| # Observations | 848 | 848 | 848 | 848 | 832 | 832 |
| # Banks | 23 | 23 | 23 | 23 | 23 | 23 |
| Hstat | 0.7017 | 0.7085 | 0.7137 | 0.7149 | 0.7657 | 0.7699 |
| $H \leq 0$ | Reject | Reject | Reject | Reject | Reject | Reject |
| $H = 1$ | Reject | Reject | Reject | Reject | Reject | Reject |

[32] The Breusch and Pagan Lagrange Multiplier test shows that there are panel effects within the data. However, as we have a limited number of observations and the adding of more variables to control for the effects may cause more noise in the results than improved observation.

Note: t-stat in parentheses, P-Value < 0.01***, P-Value < 0.05**, P-Value <0.1*

Efficiency is negative though not significant when regressed upon Total Revenue. However it is positive and not significant if we use Interest Revenue as our dependent variable. In the normalized models the coefficient sign for efficiency is positive and it is significant in all models and we can relate that the more efficient a bank is the higher the total revenue would be. Consequently it would not be in their favor to go the "Quiet Life" route if they are looking to expand Total Revenue as customers may shy away from perceived in-efficient banks.

The dummy variables for foreign banks and public banks are both positive and negative in certain models. Yet they are not significant in the non-normalized regressions. Hence in general they gain more total revenue or interest revenue than their private domestic bank counterparts. However the Public Bank coefficient is significantly different than zero in a positive manner in the normalized case. This positively significant coefficient value shows that on an even playing field public banks are able to return greater revenue than their domestic and foreign counterparts.

Looking at our correlation matrices (see Appendix 19, 20, 21, 28, and 29) Foreign Ownership and Total Revenue to Total Assets and Total Revenue have a small negative correlation. Of more interest is the correlation between ownership and pay. Though the correlations are not necessarily strikingly high their signs give some insight. Foreign banks have a positive correlation with the Price of Labor over the 2002-2011 period while public banks had a negative correlation (.441 versus -.414 for the panel banks), thus for workers it was more profitable to work for a foreign bank than their domestic counterparts. This however could be

influenced by Foreign Banks paying ex-patriots higher salaries in order to move them from their home markets to Brazil.

If we look at Efficiency the correlation tables show a relationship with a few other variables. Though not strong correlations their signs help give us a better idea of the functionality of the market. Foreign banks had a negative correlation with efficiency while public banks had a positive correlation with efficiency. This would lead us to surmise that the foreign banks are less efficient than their Brazilian counterparts. This also shows that public banks are slightly more efficient than their private domestic counterparts.

Furthermore there is a positive correlation between the Too Big to Fail variable and Efficiency as well as a positive correlation between Deposits and Efficiency. This would lead us to surmise that the larger banks that are geographically dispersed are slightly more efficient than their smaller counterparts. Correlating with bigger is better in terms of efficiency. The efficiency scores by ownership and bank size are discussed more in the Data Envelopment Analysis Results found in chapter 6.2. Also of note is the positive correlation of efficiency to interest revenue to total assets and the slight negative correlation to total revenue to total assets. This slight difference in signs may allude to banks using less than efficient means in order to attract non-interest revenue generation banking activities.

### 6.1.2 The Financial Crisis and Its Effect on Competition

This thesis set out to test not only the overall level of competition in the Brazilian banking sector, but also to discover if the recent world financial crisis has had an effect on competition in the Brazilian banking sector. We have divided the 2002-2011 period into two periods the pre-financial crisis period of 2002-2008 (Table 6.2.1 and 6.2.2) and the post-

financial crisis period of 2009-2011 (Table 6.3.1 and 6.3.2). The separation of periods is used in order to achieve an idea of the changes and developments in competition between the periods in particular to note any effects on competition due to the financial crisis (Yildirim and Philippatos 2007).

Looking at the H-Statistics in Table 6.2.1 and 6.2.2 we see that the level of competition in Brazil in the Pre-Financial Crisis period is marked by monopolistic competition in the normalized models and possible perfect competition in the non-normalized models (6.2.1). The normalized models in 6.2.2 show H-Statistics of 0.8483 (robust standard errors) and 0.8561 (fixed effects) for Model X, 0.8587 and 0.8598 respectively for Model B and 0.9347 and 0.9391 for Model IR) which are similar to the scores found by Lucinda (2010). We find that the sum of the Factor Input Prices are significantly greater than zero hence, eliminating the monopoly option. Additionally H-Statistic is significantly less than one and we are able to eliminate perfect competition in the normalized model.

If we focus on the Post-Financial Crisis H-Statistics found in Table 6.3.1 and 6.3.2 we see that the Brazilian banking sector is still considered to be in Monopolistic Competition. However the period is noted by a drastic downturn in all H-statistic measures regardless of model or dependent variable. Of note is the differences between robust standard error H-Statistics and fixed effects H-Statistics. Part of this would be due to the shorter time period analyzed in the post-crisis period, only nine quarters. These discrepancies however do not take away from the staggering drop in competition between the pre and post crisis periods.

**Table 6.2.1 Regression Results for Panzar Rosse Pre-Financial Crisis Period 2002-2008 with Total Revenue and Interest Revenue as the dependent variables**

| | X Robust Pre TR | X FE Pre TR | B Robust Pre TR | B FE Pre TR | IR Robust Pre TR | IR FE Pre TR |
|---|---|---|---|---|---|---|
| Pfunds | .5206*** (.0454) | .5209*** (.0441) | .5043*** (.0449) | .5026*** (.0439) | .6864*** (.0500) | .6830*** (.0482) |
| Plabor | .4940*** (.0526) | .4949*** (.0530) | .4934*** (.0532) | .4984*** (.0530) | .3749*** (.0546) | .3847*** (.0515) |
| Pcapital | .0169*** (.0038) | .0178*** (.0038) | .0154*** (.0039) | .0162*** (.0039) | .0190*** (.0043) | .0204*** (.0043) |
| Deposits | .3783*** (.0454) | .3696*** (.0448) | .3787*** (.0467) | .3691*** (.0462) | .4201*** (.0550) | .4050*** (.0538) |
| Risk | .2690*** (.0658) | .3123*** (.0646) | .2434*** (.0688) | .2790*** (.0671) | .2081*** (.0558) | .2516*** (.0578) |
| Too Big | .2818*** (.0383) | .1970*** (.0487) | .2825*** (.0388) | .1882*** (.0487) | .2107*** (.0526) | .0602 (.0984) |
| Efficiency | | | -.2604** (.0967) | -.2754*** .0971 | -.2075** (.0891) | -.2317** (.0884) |
| Public | | | -.0145 (.1550) | dropped | -.0819 (.1536) | dropped |
| Foreign | | | .0442 (.2532) | dropped | -.0978 (.2445) | dropped |
| Constant | 9.9902 (.6317) | 9.6532, .6165 | 9.868 (.6777) | 9.474, .6532 | 9.510 (.8050) | 8.7931 (.8546) |
| Wald Test & Significance | chi2(7) = 41149.06 0.000 | | chi2(10) = 46781.82 0.0000 | | chi2(9) = 1702.43 0.0000 | |
| F-Test & Significance | | F(6,615) = 198.08 0.0000 | | F(7,614) = 174.80 0.0000 | | F(7,604) = 221.86 0.0000 |
| R Square | 0.8421 | 0.8169 | 0.8453 | 0.8131 | 0.8591 | 0.7603 |
| Hausman | 0.2333 | 0.2333 | 0.4013 | 0.4013 | 0.0142 | 0.0142 |
| LM | Chi2(1) = 2101.70 0.0000 | | chi2(1) = 2004.36 0.0000 | | chi2(1) = 1673.96 0.0000 | |
| # Observations | 644 | 644 | 644 | 644 | 634 | 634 |
| # Banks | 23 | 23 | 23 | 23 | 23 | 23 |
| Hstat | 1.0315 | 1.0336 | 1.0131 | 1.0172 | 1.0803 | 1.0881 |
| $H \leq 0$ | Reject | Reject | Reject | Reject | Reject | Reject |
| $H = 1$ | Do Not Reject | Do Not Reject | Do Not Reject | Do Not Reject | Do Not Reject | Do Not Reject |

Note: t-stat in parentheses, P-Value < 0.01***, P-Value < 0.05**, P-Value <0.1*

The non-normalized models show drops to, 0.5655 and 0.7465 for Model X (robust and fixed effects), 0.6059 and 0.7497 for Model B and 0.4890 and 0.6991 for the IR model. The effects are equally dramatic when looking at the normalized results. Model X shows 0.5294 and 0.7647 for its robust standard error and fixed effects normalized results, Model B, 0.5563 and 0.7689 respectively and 0.5162 and 0.7165 for the normalized IR model. Given this we are able to eliminate monopoly and perfect competition for the post crisis period.

The H-Statistic for the pre-financial crisis period is higher than both the H-Statistic for the whole 2002-2011 period as well as the Post-Financial crisis period 2009-2011. Consequently, we can surmise that the financial crisis has had a negative effect on competition in the Brazilian banking sector.

If we look at the differences in the coefficients between the two periods we can note a few changes and similarities between the periods. The first difference is the lack of significance of the Price of Capital in the normalized Pre-Financial Crisis results. This would suggest that controls on Overhead were not as high on the priority list of the banks before the crisis. On the other hand, Post-Financial Crisis the coefficient for the Price of Capital (a proxy for controls on Overhead and Capital expenditures) became significant in the normalized model.

Moving to the Factor Input Price of Labor we can see that in the Pre-Crisis period Labor costs in the non-normalized models with coefficients of 0.494 for Model X, 0.493 for Model B, and 0.374 for Model IR. However, the increase in cost pressures due to the financial crisis saw the Price of Labor coefficient drop to 0.132 for Model X, 0.125 for Model B and 0.133 for Model IR. This shows the diminishing effect that the Price of Labor between the periods.

**Table 6.2.2 Regression Results for Panzar Rosse Pre-Financial Crisis Period 2002-2008 with Total Revenue over Total Assets and Interest Revenue over Total Assets as the dependent variables**

| | X Robust Pre TRTA | X FE Pre TRTA | B Robust Pre TRTA | B FE Pre TRTA | IR Robust Pre TRTA | IR FE Pre TRTA |
|---|---|---|---|---|---|---|
| Pfunds | .7127*** (.0299) | .7162*** (.0296) | .7195*** (.0294) | .7202*** (.0292) | .8995*** (.0329) | .9000*** (.0332) |
| Plabor | .1388*** (.0332) | .1441*** (.0339) | .1426*** (.0337) | .1434*** (.0339) | .0340 (.0280) | .0378 (.0280) |
| Pcapital | -.0032 (.0048) | -.0042, (.0048) | -.0034 (.0047) | -.0038 (.0048) | .0012 (.0034) | .0013 (.0037) |
| Deposits | -.0287 (.0298) | -.0234 (.0310) | -.0265 (.0303) | -.0233 (.0315) | -.0032 (.0248) | -.0043 (.0263) |
| Risk | .0339 (.0466) | .0358 (.0502) | .0482 (.0471) | .0431 (.0505) | .0215 (.0341) | .0225 (.0372) |
| Too Big | .1151*** (.0248) | .1026*** (.0404) | .0911*** (.0258) | .1045** (.0409) | .0200 (.0369) | -.0214 (.0772) |
| Efficiency | | | .0623 (.0754) | .0604 (.0775) | .1057 (.0559) | .0959 (.0572) |
| Public | | | .3812*** (.0934) | Dropped | .3219*** (.1051) | Dropped |
| Foreign | | | .0189 (.1306) | Dropped | -.1551 (.1720) | Dropped |
| Constant | .6602 (.4305) | .5096 (.4702) | .3989 (.4624) | .5488 (.4912) | .2837 (.3855) | .1037 (.5135) |
| Wald Test & Significance | chi2(7) = 3883.16 0.0000 | | chi2(10) = 5350.99 0.0000 | | chi2(9) = 2341.88 0.0000 | |
| F-Test & Significance | | F(6,615) = 216.70 0.0000 | | F(7,614) = 186.94 0.0000 | | F(7,604) = 279.91 0.0000 |
| R Square | 0.5901 | 0.5805 | 0.6639 | 0.5836 | 0.6979 | 0.5082 |
| Hausman | 0.9999 | 0.9999 | 0.9994 | 0.9994 | 0.9996 | 0.9996 |
| LM | chi2(1) = 1351.47 0.0000 | | chi2(1) = 895.66 0.0000 | | chi2(1) = 1730.39 0.0000 | |
| # Observations | 644 | 644 | 644 | 644 | 634 | 634 |
| # Banks | 23 | 23 | 23 | 23 | 23 | 23 |
| Hstat | 0.8483 | 0.8561 | 0.8587 | 0.8598 | 0.9347 | 0.9391 |
| $H \leq 0$ | Reject | Reject | Reject | Reject | Reject | Reject |
| $H = 1$ | Reject | Reject | Reject | Reject | Reject | Reject |

Note: t-stat in parentheses, P-Value < 0.01***, P-Value < 0.05**, P-Value <0.1*

A further interesting note on Price of Labor in relation to Ownership is shown in the correlation matrices in Appendices 22 through 27 and 30 through 33. Here we see the changes in the correlation of pay to by ownership group. The correlation between Price of Labor and Foreign Ownership dropped from a significantly positive 0.3525 for all banks and 0.5274 for the panel set of banks to an insignificant 0.0374 for all banks and a lower 0.3264 for the panel set.

While the corresponding Public Banks correlation improved from a significant negative 0.408 for all banks and negative 0.464 for the panel set of banks to also negatively significant -0.163 for all banks and -0.3663 for the panel set. Thus we can say in the Pre-Financial Crisis era it was to the benefit financially for Brazilian bank employees to work at foreign banks versus their domestic counterpart banks.

Since the financial crisis however this gap has closed greatly. The exodus of foreign participation in the banking sector since the during the financial crisis that was discussed in Chapter 5 may have something to do with the drop, as well as Foreign banks replacing their ex-patriot home country employees with local Brazilian employees that do not receive extra benefits for living abroad as they are in their home country, however that analysis is beyond the scope of this thesis.

**Table 6.3.1 Regression Results for Panzar Rosse Post-Financial Crisis Period 2009-2011 with Total Revenue and Total Interest Revenue as dependent variables**

| | X Robust Post TR | X FE Post TR | B Robust Post TR | B FE Post TR | IR Robust Post TR | IR FE Post TR |
|---|---|---|---|---|---|---|
| Pfunds | .1341<br>(.0697) | .0864<br>(.0499) | .1142<br>(.0613) | .0840<br>(.0476) | .1105<br>(.0781) | .0571<br>(.0630) |
| Plabor | .1328***<br>(.0464) | .0841**<br>(.0378) | .1256**<br>(.0469) | .0865**<br>(.0381) | .1330***<br>(.0428) | .0661**<br>(.0263) |
| Pcapital | .2986***<br>(.0454) | .5760***<br>(.0620) | .3661***<br>(.0510) | .5792***<br>(.0622) | .2455***<br>(.0501) | .5759***<br>(.0629) |
| Deposits | .7228***<br>(.0769) | .4799***<br>(.0972) | .6581***<br>(.0825) | .4686***<br>(.0989) | .7907***<br>(.0879) | .6892***<br>(.1081) |
| Risk | -.0802<br>(.1404) | .0243<br>(.2185) | -.0653<br>(.1458) | .0310<br>(.1957) | .0696<br>(.2457) | .3985<br>(.2820) |
| Too Big | .1397*<br>(.0691) | .5140***<br>(.1593) | .2489***<br>(.0776) | .5695***<br>(.1868) | .1554*<br>(.0765) | .1999<br>(.3103) |
| Efficiency | | | .0447<br>(.0893) | .0524<br>(.0941) | .0944<br>(.0795) | .0800<br>(.0756) |
| Public | | | -.9383***<br>(.2180) | Dropped | -.7549***<br>(.1589) | Dropped |
| Foreign | | | -.1041<br>(.1219) | -.0745<br>(.1487) | -.1724*<br>(.0869) | -.0860<br>(.0806) |
| Constant | 4.0137<br>(1.4873) | 10.3164<br>(1.951) | 6.0209<br>(1.6499) | 10.8317<br>(2.1604) | 2.7788<br>(1.706) | 5.0205<br>(2.7703) |
| Wald Test & Significance | chi2(6) = 592.65<br>0.0000 | | chi2(9) = 820.00<br>0.0000 | | chi2(9) = 977.87<br>0.0000 | |
| F-Test & Significance | | F(6,175) = 53.90<br>0.0000 | | F(8,173) = 41.06,<br>0.0000 | | F(8,167) = 29.32<br>0.0000 |
| R Square | 0.8351 | 0.6364 | 0.857 | 0.638 | 0.8948 | 0.6681 |
| Hausman | 0.0003 | 0.0003 | 0.0047 | 0.0047 | 0.0003 | 0.0003 |
| LM | chi2(1) = 108.38<br>0.0000 | | chi2(1) = 103.07<br>0.0000 | | chi2(1) = 29.36<br>0.0000 | |
| # Observations | 204 | 204 | 204 | 204 | 198 | 198 |
| # Banks | 23 | 23 | 23 | 23 | 23 | 23 |
| Hstat | 0.5655 | 0.7465 | 0.6059 | 0.7497 | 0.489 | 0.6991 |
| $H \leq 0$ | Reject | Reject | Reject | Reject | Reject | Reject |
| $H = 1$ | Reject | Reject | Reject | Reject | Reject | Reject |

Note: t-stat in parentheses, P-Value < 0.01***, P-Value < 0.05**, P-Value <0.1*

Focusing on Efficiency in the market we see that the effects of efficiency on Total Revenue were slightly negative in the Pre-Financial Crisis period. This would lead us to note that banks may have been able to improve their Total Revenue better by taking on less than efficient management policies. However, with the increased cost pressures of the financial crisis efficiency's sign changed to the positive and is now beneficial to the Total Revenue of banks in the sector. In terms of Interest Revenues to Total Assets it is important to note that Efficiency has become a lot more positively correlated to IR to TA than TR to TA.

Furthermore, with the positive correlation between Deposits and the Too Big to Fail with Efficiency we see that the larger banks were efficient in both of the periods. This allows surmising that the larger banks with more branches and geographic dispersion were able to achieve some form of scale economies to improve their efficiency. Subsequently taken together we can see that management decisions that would lead to less efficiency would be harmful to Total Revenue and would lead banks to stay away from the "Quiet Life."

We see a further difference in the two periods in relation to the effects of Risk. In the non-normalized Pre-Crisis period the Risk coefficient was significant for all models with positive coefficients of 0.2690 for Model X (robust standard errors) and 0.2434 for Model B (robust standard error). Therefore we can say that the banks that took a higher amount of risk were rewarded with higher Total Revenues.

However, during the Post-Financial Crisis period the effect of Risk taking by banks changed. In terms of Total Revenues, Risk was no longer significantly different than zero and the coefficients fell to a negative 0.0802 for Model X and a negative 0.0653 for Model B (both

robust standard error model). Thus we can say that the benefits of taking on Risk that occurred in the Pre-Financial crisis days no longer exist, which coincides with pressures faced on banks to better control for risk in their portfolios.

Moreover when looking at the correlation between ownership and Risk the Foreign Banks are negatively correlated to risk in the market in the Pre-Financial crisis which then increases negatively during the Post-Financial Crisis period. Therefore we can surmise that Foreign banks were becoming even more selective with their clients in terms of their risk allowance. On the other hand the correlation of Risk with Public Banks changed very little between pre and post crisis. This may be due to the increase in customers looking for loans who were now denied by the Foreign Banks with their more strict abstention from Risk.

In terms of demand and size we have the Total Deposits coefficients to analyze. Here we see that both remained significantly positive in both periods however all explanatory value of Total Deposits increased in all three unscaled models from Pre- to Post-Financial Crisis. Therefore we can surmise that the increase in uncertainty that a financial crisis has was beneficial to the more demanded larger banks based.

Our other term for size and geographic reach Too Big to Fail also remained positive and significant in both periods (non-normalized), however the values fell in each of the models. These results lead us to surmise that the over branching of banks, though still having a positive effect on Total Revenue and Interest Revenue had lost some of the benefits that were seen in previous periods. However, taken with Total Deposits we feel we can say that the larger banks are in a better position to benefit with higher Total Revenue and Interest

Revenue than their smaller counterparts. Therefore, bigger would be better in both the Pre-Financial Crisis and Post-Financial Crisis Periods.

### 6.1.3 Similarities of the Two Separate Dependent Variables' H-Statistics Results

The use of two separate dependent variables is a direct result of the misspecification of Panzar Rosse variables discussed by Bikker et al (2006). In order to compare and increase the robustness of our overall results both the unscaled dependent variable Total Revenue (or Interest Revenue in the IR model's situation) and the scaled or normalized Total Revenue (or Interest Revenue) over Total Assets were used[34]. Bikker et al (2006) noted that some studies ruled out either monopoly or perfect competition in various occasions due to their selection of the normalized or scaled dependent variable Total Revenue over Total Assets.

Our results also show a slight difference in their results depending on the dependent variable. The most notable difference is that when the unscaled Total Revenue variable is used in the Pre-Crisis period we are not able to reject the possibility of Perfect Competition. While the scaled Total Revenue to Total Assets models do reject Perfect Competition.

This difference in market classification as well as the slight numerical differences in the H-Statistic scores does not however affect the overall descriptive nature of the changes in the Brazilian banking sector over the period. Table 6.3.3 shows the H-Statistics for the overall, pre- and post-crisis periods.

[34] See Appendix 40 and 41 for comparisons of Model X quarterly H-Statistics for total revenue over total assets versus total revenue with robust standard errors.

**Table 6.3.3 Summary of Robust Standard Error H-Statistic Measures for Overall, Pre-Crisis and Post-Crisis periods by Model and Dependent Variable**

| | Model X TR | Model X TRTA | Model B TR | Model B TRTA | Model IR IR | Model IR IRTA |
|---|---|---|---|---|---|---|
| Overall | 0.7602 | 0.7017 | 0.7581 | 0.7137 | 0.8088 | 0.7657 |
| Pre-Crisis | 1.0315 | 0.8483 | 1.0131 | 0.8587 | 1.0803 | 0.9347 |
| Post-Crisis | 0.5655 | 0.5294 | 0.6059 | 0.5563 | 0.489 | 0.5162 |

As can be seen in each case there is a dramatic drop in the H-Statistic and thus a drop in competition across the board regardless of model or dependent variable. This allows us to state that the financial crisis did indeed have a negative effect on competition in the Brazilian banking sector.

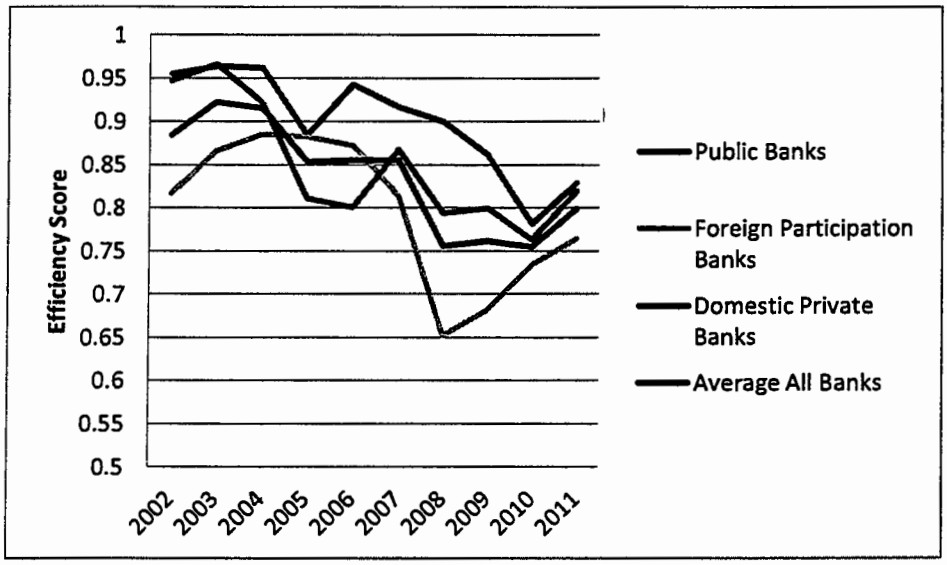
## 6.2 Empirical Results for Data Envelopment Analysis Efficiency Scores

### 6.2.1 Overall Efficiency Scores

Our quarterly results based on multiple criteria for the input-oriented VRS DEA Efficiency Scores from Q1 2002 to Q1 2011 for the top 50 largest banks in terms of Total Assets are found in Appendices 13-18. The quarterly results derived from the Data Envelopment Analysis show that over the period 2002-2011 the overall average relative efficiency of banks in Brazil had a slightly negative path. Table 6.4 and Chart 6.1 both show the overall yearly average DEA efficiency scores for the industry. We have divided our analysis into two parts. One is based on ownership type and the other on the size of the banks where we have divided the banks into groups of the Top 5, Top 10, Banks 6-10, Banks 10-50, Banks 11-25, Banks 26-50 and an all bank average. The scores are divided between bank average and weighted average DEA Efficiency Scores average where Total Assets are used as the weight.

It is important to note that DEA efficiency scores are relative measures of efficiency; here they only compare efficiency for the quarter that is under analysis. Therefore it is best to say that the efficiencies scores are in relation to the most efficient banks in that period. However, it can be used to compare overall relative efficiency in the market over time to gauge if certain groups are becoming less or more efficient relative to their peers, which follows with the notes from Pires Goncalves (2008) study over 1995-2006 and Staub et al (2010) study over 2000-2007.

## Chart 6.1 Average Yearly DEA Efficiency Scores by Ownership Type 2002-2011[35]

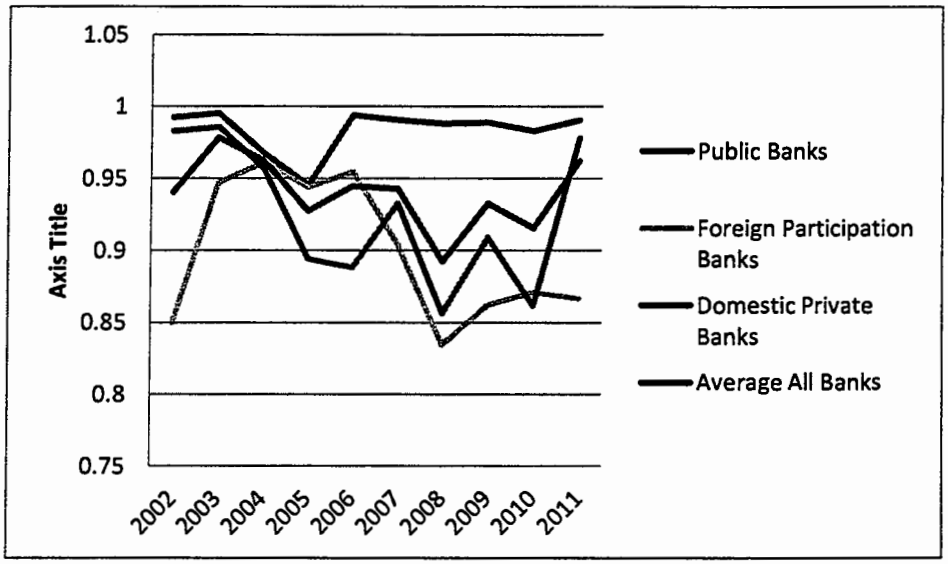



Earlier studies by Staub et al (2010) and Pires Goncalves (2008) found an increase in efficiency scores from 1995-2006, and our study does find an increase in efficiency at the beginning of our study 2002-2005, but post 2005 there is a decrease in efficiency in the sector. The empirical results show the average bank's Efficiency Score for 2002 was 88%, then an increase to 91.5% in 2004 followed by a decrease to 85% by 2006 with a further

[35] Year 2011 is represented by Q1 2011 only.

decrease to 76% for 2009 and an upturn to 80% for the first quarter 2011 and an overall DEA Efficiency Score of 84% for the 2002-2011 period. This downward trend is lessened when we take size of the banks into the equation. By using weighted averages we end up with a 2002 score of 93.9%, 94.4% for 2006, 93.2% for 2009, and 96.2% for Q1 2011 with an overall weighted average DEA Efficiency Score for the sector at 94%. This would give weight to the idea that the efficiency in the market was more stable than declining if we focus on the larger banks. However, we discuss Bank Size and efficiency later in this chapter. Charts 6.1 and 6.2 and Tables 6.4 and 6.5 give the yearly Average and Weighted Average DEA Efficiency Scores.

## Chart 6.2: Weighted Average Yearly DEA Efficiency Scores by Ownership Type 2002-2011[36]




One can note the influence of the financial crisis of the late 2000s on the efficiency scores as the average efficiency scores drops 10% from 2007 to 2008 or the beginning of the crisis

[36] Year 2011 is represented by Q1 2011 only.

while the efficiency scores maintain their 2008 levels for 2009 and start to recover in 2010. A more in depth discussion of the financial crisis and efficiency is found in chapter 6.2.4 below.

Also of note, as in Pires Goncalves (2008) study from 1995-2006 it was found that most quarters have approximately half of the banks with an efficiency score of 1 or fully efficient. This is consistent with the DEA efficiency scores that our study obtained. This nearly 50% ratio of fully efficient banks continued for the each quarter of our study as well from 2002-2011. The fully efficient banks were found throughout the top 50 banks, however they generally were found more often in the higher rankings in the top 50.

### 6.2.2 Efficiency Scores by Ownership Type

Focusing on ownership type and DEA efficiency scores there are numerous important results that we perceive. First, Public Banks consistently ranked more efficient than their Foreign Owned, approximately 10% and Private Domestic, approximately 5% counterparts over the life of the study. In only one quarter in the 2002-2011 period did Public Banks not have the highest efficiency score. This goes against the popular belief that Public Institutions such as banks are inherently less efficient as well as the criticism leveled against Brazilian Public Banks in Brazil during the time of the study (Pires Goncalves 2008).

However, the results show throughout the study that Public Banks ranked higher on average and in terms of a weighted average than all other banks. This is shown by the fact that over the period Public Banks' weighted average DEA efficiency score is almost 1. This higher efficiency in Public Banks was also found in earlier studies for 1995-2006 by Staub et al (2010) and Pires Goncalves (2008). Tables 6.4 and 6.5 and Charts 6.1 and 6.2 visualize the yearly DEA efficiency scores by ownership type.

We surmise that this phenomenon has something to do with managers in the Public banks being able to have financial support and backing from the federal or state budgets and thus not being as pressured by market pressures. Then the fact that the Public Banks act and function in almost a private banking manner since many of the Public Banks actually have shares available they are run with a more focused efficient approach than a "typical" public enterprise. The combination of these two phenomenon allow for managers to weather down turns better than their private counterparts as they do not need to incur inefficient costs in order to survive in turbulent economic times, such as the current financial crisis.

## Table 6.4: Average Yearly DEA Efficiency Scores by Ownership Type 2002-2011[37]

| | Public Banks | Foreign Participation Banks | Domestic Private Banks | Average All Banks |
|---|---|---|---|---|
| **2002** | 0.955163219 | 0.816672849 | 0.946593693 | 0.883983165 |
| **2003** | 0.963798739 | 0.865968276 | 0.966492633 | 0.922564895 |
| **2004** | 0.962090575 | 0.885009022 | 0.921523162 | 0.915272465 |
| **2005** | 0.8840269 | 0.882237939 | 0.81055259 | 0.85351427 |
| **2006** | 0.942929536 | 0.872142497 | 0.800975865 | 0.85522726 |
| **2007** | 0.916728889 | 0.813446514 | 0.867381963 | 0.85482863 |
| **2008** | 0.899710917 | 0.652060398 | 0.793334892 | 0.755723095 |
| **2009** | 0.861735583 | 0.682091329 | 0.799797532 | 0.761445325 |
| **2010** | 0.78111975 | 0.733967388 | 0.763114726 | 0.754696695 |
| **2011** | 0.829238889 | 0.7641946 | 0.819354238 | 0.79906962 |
| **Average** | **0.8996543** | **0.796779081** | **0.848912129** | **0.835632542** |

[37] Year 2011 is represented by Q1 2011 only.

A further note on ownership and efficiency is how Foreign Banks consistently rank as the least efficient banks on average over the period. The average Foreign Bank scored a 79.7% over the 2002-2011 period which is 10% less than public banks and 5% less than Private Domestic Brazilian banks.

The low efficiency average is greatly affected by the severe drop in Foreign Bank efficiency scores during the last half of the study. Though previous studies did note that foreign banks were the least efficient banks in the Brazilian banking sector (Pires Goncalves 2008 and Staub et al 2010). The large drop corresponds to the world financial crisis which saw many foreign banks decrease their participation outside of their core home markets, for example Foreign Bank participation in Brazil fell in terms of Total Assets, Total Deposits and Total Loans over the life of the study.

From 2007 to 2008 Foreign Bank efficiency dropped over 15% which corresponded to the decline in overall market share and participation in the whole sector as discussed earlier. While taking into account the Pre-Financial crisis period the Foreign Banks were actually on average more efficient than their Private Domestic competition. The 2004-2007 average scores of 88% efficiency for foreign banks and 84% efficiency for Private Domestic banks which they then switched positions for the 2008-2011 period with Foreign banks having a 70% efficiency score while Domestic Private banks dropped to a 79% efficiency score.

There are many factors that may influence these overall numbers. To begin, foreign banks may be using inefficient paying schemes with their workers. This may come about from the need for higher ex-patriot pay packages to lure executives away from their home country.

This would be supported by the strongly positive correlation between the Price of Labor and Foreign Bank variables in our Panzar Rosse competition research.

Additionally, factors in the home markets of foreign banks may have led them to reevaluate their positions abroad and focus their attention on their home markets and thus relaxing their managerial controls in foreign markets. As the foreign banks are private as well they do not have the backing of the federal government and thus cannot weather the financial storms as well as their Public Bank counterparts. This may lead to the selection of less than optimal input pricing due to volatility in the market.

## Table 6.5 Weighted Average Yearly DEA Efficiency Scores by Ownership Type 2002-2011[38]

| | Public Banks | Foreign Participation Banks | Domestic Private Banks | Average All Banks |
|---|---|---|---|---|
| **2002** | 0.992644186 | 0.849832179 | 0.982858976 | 0.939973191 |
| **2003** | 0.995523475 | 0.946747308 | 0.985759312 | 0.978479729 |
| **2004** | 0.967544244 | 0.961091815 | 0.956635461 | 0.962223853 |
| **2005** | 0.944829059 | 0.943550451 | 0.894264249 | 0.927071418 |
| **2006** | 0.993901233 | 0.954448974 | 0.888301628 | 0.944684766 |
| **2007** | 0.990776782 | 0.904032842 | 0.932705383 | 0.943011233 |
| **2008** | 0.988364117 | 0.834377726 | 0.856223358 | 0.892175381 |
| **2009** | 0.988851795 | 0.862065817 | 0.908620312 | 0.932665628 |
| **2010** | 0.982891028 | 0.870859452 | 0.861184223 | 0.915222307 |
| **2011** | 0.990241579 | 0.866525578 | 0.97779427 | 0.962118075 |
| **Average** | **0.98355675** | **0.899353214** | **0.924434717** | **0.939762558** |

[38] Year 2011 is represented by Q1 2011 only.

Furthermore, as we can see by the weighted averages the larger foreign banks were more efficient than their smaller counterparts; this may have something to do with their market selection. They may be targeting particular customer segments that though may be inefficient do bring a better return. This can be seen in the significant positive coefficient score of the Foreign Bank variable in our competition regression on Total Revenue. Thus they may be selecting less than optimal efficient inputs, but their financial return seems to be quite positive regardless of the inefficiency.

The changes in the weighted average scores would lead us also to surmise that it is not only the Foreign banks that have separate management goals. The gaps between average and weighted average efficiency scores shows us that it is not only the type of bank that may determine their input and managerial selections, but their size as well.

Switching our focus to the size of banks and their efficiency scores shows us other interesting points especially in consideration of the "Quiet Life" scenario discussed earlier. The results show that over the period of the study the larger banks better maintained their efficiency scores than their smaller counterparts.

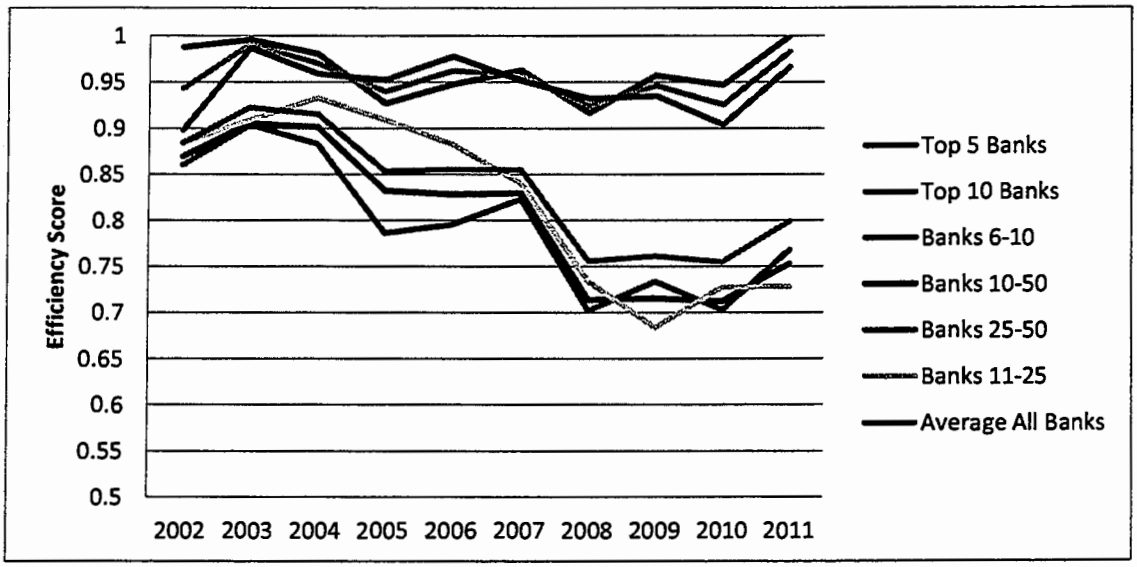
### 6.2.3 Efficiency Scores by Bank Size

Similar to the common conception that public banks would be less efficient due to their nature and oversight, larger banks would seem to be less efficient as they would typically have more levels of bureaucracy, overhead costs and less direct oversight as managers would have larger groups of employees to watch. Nevertheless, just as in the Public Banks, the larger banks in Brazil are consistently the most efficient. Looking at Charts 6.3 and 6.4 and Tables 6.6 and 6.7 we can see that the Top 10 banks in Brazil over the period of have

lengthened the gap between themselves and Banks 11-50. In 2002 the difference between the Top 10 Banks in Brazil and the rest of the Top 50 was 0.073 or approximately the bottom 40 banks were 7% less efficient than the Top 10 banks. By 2006 it had reached 13% and by 2010 the gap had expanded even further to where the smaller banks were nearly a quarter less efficient than their larger competitors.

Furthermore if we look at the smallest banks, Banks 26-50 we see that they have the lowest efficiency scores of all indeterminate of average or weighted average. There were only two years, 2009 and 2011,[39] where they ranked higher than their other smaller bank competitors in Banks 11-25. This consistently lower efficiency score coincides with smaller banks inabilities to achieve scale economies due to their limited size.

**Chart 6.3 Average Yearly DEA Efficiency Scores by Bank Size 2002-2011[40]**




[39] Year 2011 is represented by Q1 2011 only.
[40] Year 2011 is represented by Q1 2011 only.

If we focus solely on the Top 10 Banks we can see that they have maintained their overall average efficiency remarkably well. They have maintained mid to high 90% efficiency ratings without fail throughout the study. Additionally as mentioned previously in Chapter 5 the concentration ratios for the top banks in Brazil have risen over the period of study while at the same time we see that they have maintained their relative efficiency levels. This would lead us to surmise that the managers of the larger banks have been better able to weather the economic climate of Brazil and leverage their size into help maintain competitive and efficient cost management policies. These efficiencies in theory could then be passed onto their clients which would then make their services more attractive and thus bring in more clients, hence the increase in the CR10 throughout the study.

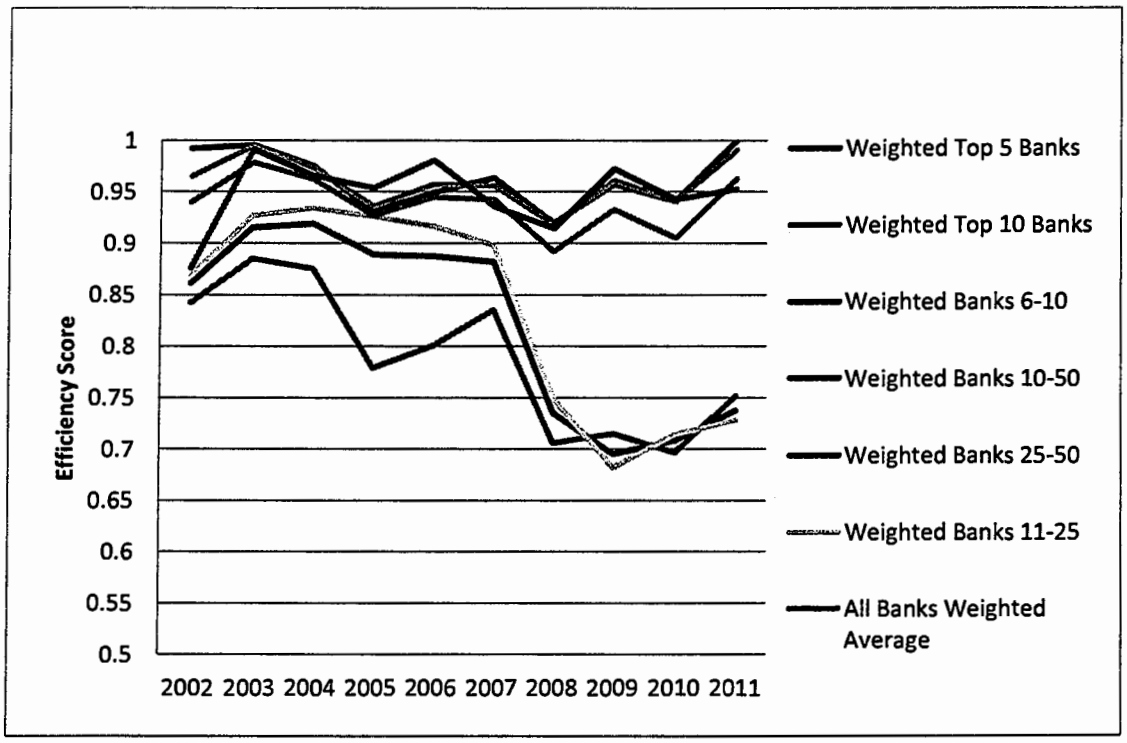
## Table 6.6: Average Yearly DEA Efficiency Scores by Bank Size 2002-2011[41]

| | **Top 5 Banks** | **Top 10 Banks** | **Banks 6-10** | **Banks 10-50** | **Banks 26-50** | **Banks 11-25** | **Average All Banks** |
|---|---|---|---|---|---|---|---|
| **2002** | 0.98804 | 0.94271 | 0.89738 | 0.86930 | 0.85989 | 0.88497 | 0.88398 |
| **2003** | 0.99576 | 0.99128 | 0.98680 | 0.90538 | 0.90347 | 0.90857 | 0.92256 |
| **2004** | 0.98081 | 0.96984 | 0.95886 | 0.90162 | 0.88294 | 0.93276 | 0.91527 |
| **2005** | 0.92674 | 0.93949 | 0.95224 | 0.83201 | 0.78619 | 0.90839 | 0.85351 |
| **2006** | 0.94745 | 0.96259 | 0.97773 | 0.82838 | 0.79576 | 0.88275 | 0.85522 |
| **2007** | 0.96282 | 0.95709 | 0.95136 | 0.82926 | 0.82282 | 0.83998 | 0.85482 |
| **2008** | 0.91637 | 0.92439 | 0.93240 | 0.71355 | 0.70146 | 0.73371 | 0.75572 |
| **2009** | 0.95745 | 0.94640 | 0.93535 | 0.71520 | 0.73387 | 0.68408 | 0.76144 |
| **2010** | 0.94673 | 0.92526 | 0.90379 | 0.71205 | 0.70280 | 0.72747 | 0.75469 |
| **2011** | 1 | 0.98341 | 0.96683 | 0.75298 | 0.76799 | 0.72795 | 0.79906 |
| **Average** | **0.96222** | **0.95425** | **0.94627** | **0.80597** | **0.79572** | **0.82306** | **0.83563** |

[41] Year 2011 is represented by Q1 2011 only.

The dominance of the larger banks in terms of DEA efficiency scores is best represented when comparing the average efficiency scores (Chart 6.3 and Table 6.6) versus the weighted average efficiency scores (Chart 6.4 and Table 6.7) for all banks. We can see that when taking into account total assets as a proxy for bank size we find that the overall efficiency score is markedly higher, for example 2002 88.3% to 94%, 2004 91.5% to 96.2%, 2006 85.5% to 94.4%, 2008 75.5% to 89.2%, 2010 75.5% to 90.5%, this just further stresses the dominating efficiency of the very large banks.

## Chart 6.4: Weighted Average Yearly DEA Efficiency Scores by Bank Size 2002-2011[42]




[42] Year 2011 is represented by Q1 2011 only.

## Table 6.7 Weighted Average Yearly DEA Efficiency Scores by Bank Size 2002-2011[43]

| | Weighted Top 5 Banks | Weighted Top 10 Banks | Weighted Banks 6-10 | Weighted Banks 10-50 | Weighted Banks 26-50 | Weighted Banks 11-25 | All Banks Weighted Average |
|---|---|---|---|---|---|---|---|
| **2002** | 0.9918 | 0.9645 | 0.8760 | 0.8614 | 0.8422 | 0.8680 | 0.9399 |
| **2003** | 0.9956 | 0.9947 | 0.9912 | 0.9153 | 0.8850 | 0.9269 | 0.9784 |
| **2004** | 0.9752 | 0.9729 | 0.9655 | 0.9189 | 0.8757 | 0.9341 | 0.9622 |
| **2005** | 0.9306 | 0.9358 | 0.9535 | 0.8889 | 0.7787 | 0.9256 | 0.9270 |
| **2006** | 0.9492 | 0.9573 | 0.9803 | 0.8873 | 0.8007 | 0.9163 | 0.9446 |
| **2007** | 0.9637 | 0.9564 | 0.9355 | 0.8819 | 0.8354 | 0.8981 | 0.9430 |
| **2008** | 0.9196 | 0.9181 | 0.9142 | 0.7351 | 0.7060 | 0.7491 | 0.8921 |
| **2009** | 0.9572 | 0.9612 | 0.9719 | 0.6952 | 0.7150 | 0.6819 | 0.9326 |
| **2010** | 0.9410 | 0.9414 | 0.9428 | 0.7080 | 0.6965 | 0.7142 | 0.9051 |
| **2011** | 1 | 0.9906 | 0.9527 | 0.7375 | 0.7514 | 0.7279 | 0.9621 |
| **Average** | **0.9624** | **0.9593** | **0.9484** | **0.8230** | **0.7887** | **0.8342** | **0.9387** |

If we look at the after effects on efficiency of the recent financial crisis we see that in 2008 overall the efficiency scores across the board suffered. The Top 5 banks' efficiency scores dropped on average 4.5% in 2008. The drop was even more pronounced when looking at the smaller banks 15% for Banks 11-25 and 13% for Banks 26-50 and their subsequent difficulties in returning to pre-2008 relative efficiency. Since the main drop in 2008 overall efficiency has stagnated for the smaller banks in 2009 and 2010, though through Q1 2011 the efficiency scores have improved slightly. This leads us to believe that the smaller banks were unable to deal with the after effects of the crisis and that their managerial limitations due to their small size has made it more difficult for them to keep up with their larger counterparts in terms of efficiency. While on the other hand the larger banks were in a better position to

[43] Year 2011 is represented by Q1 2011 only.

weather the financial crisis as we see that by 2009 the relative efficiency of the Top 5 banks was back to its pre-crisis levels. So in terms of relative efficiency bigger is better.

The counter intuitive thinking that large banks are actually more efficient than their smaller more "nimble" counterparts holds true in Brazil. Focusing on the combination of continuous concentration in the market as well as the larger banks consistently achieving higher efficiency scores, the growing gap between the large and small banks, and the feeling that bigger is better in terms of efficiency we feel that the Brazilian banking sector is certainly not taking the "Quiet Life." The Top 10 Banks are consistently efficient and growing their businesses thus doing the exact opposite of what the Quiet Life theory would suggest they would.

### 6.2.4 The Effects of the Financial Crisis on Banking Efficiency

As mentioned above the current crisis facing the world financial system has had an effect on the levels of efficiency and competition in the Brazilian banking sector. Tables 6.8 and 6.9 show the average DEA Efficiency scores for our subgroups by Ownership Type and Bank Size. Of note is that the effects of the financial crisis were noted sooner in the efficiency scores than in the competition scores. The drop in efficiency began in the beginning of 2008 while competition was negatively affected from the beginning of 2009. The overall average bank efficiency score fell from 0.88 to 0.76.

#### 6.2.4.1 The Financial Crisis and Banking Efficiency by Ownership Type

As briefly discussed in the Panzar Rosse Results as well as previously in this section we can see that the financial crisis has had an effect on all banking ownership types. In Table 6.8 we can see that the all bank average DEA efficiency score from the Pre-Financial Crisis to Post-

Financial Crisis period dropped approximately 12%. This allows us to note that overall sector efficiency did suffer.

Also of interest is that all Ownership Types saw a large down turn in their average efficiency scores. Public Banks were the most efficient in both periods with a Pre-Financial Crisis average efficiency score of 0.937 while Post-Financial Crisis the average had dropped to 0.842. The 9.5% drop in average relative efficiency for Public Banks was similar to the 9.3% drop in efficiency by their Domestic Private Bank competitors.

## Table 6.8 Pre-Financial Crisis (2002-2007) and Post-Financial Crisis (2008-2011) Efficiency Scores Based on Ownership Type

| | Public Banks | Foreign Banks | Domestic Private Banks | All Bank Average |
|---|---|---|---|---|
| 2002-2007 | 0.937456 | 0.855913 | 0.885587 | 0.880898 |
| 2008-2011 | 0.842214 | 0.69584 | 0.788227 | 0.760502 |
| Average | 0.903993 | 0.799671 | 0.851379 | 0.838597 |

The most effected ownership group was the Foreign Banks group. Their overall relative efficiency fell 16% from Pre-Crisis levels. As touched on previously the larger fall in Foreign Bank efficiency may have also something to do with conditions outside the Brazilian market such as economic factors in the Foreign Banks' home markets that may have needed their attention and thus efficiency in their Brazilian branches suffered or perhaps a more risk adverse portfolio position. This may be inferred by the decrease in participation of Foreign Banks in the sector during the Crisis period, a drop in market share of 9% in Total Assets, 8% in Total Deposits and 8% in Total Loans from the second quarter of 2008 to the first quarter of 2011. However this is just a conjecture as the additional research into foreign banks' home markets influence on their foreign branches efficiency is beyond the scope of this thesis.

### 6.2.4.2 The Financial Crisis and Banking Efficiency by Bank Size

While bank ownership did show distinct and severe drops in efficiency scores across the board, the effects of the financial crisis on bank efficiency was not as universal when the size of the bank was factored into the equation.

Looking at the results in terms of bank size we can see that the Top 10 Banks maintained an extremely high overall average efficiency score in both periods .961 and .935 respectively. And if we look at the biggest banks the Top 5 Banks we see that they suffered the smallest drop off in efficiency scores of all the groups. While the industry saw an 8% drop in efficiency the Top 5 Banks' average efficiency scores fell a mere 2.2% while Banks 6-10's average efficiency scores fell only 2.7% when comparing Pre-Financial and Post-Financial Crisis levels.

**Table 6.9 Pre-Financial Crisis (2002-2007) and Post-Financial Crisis (2008-2011) Efficiency Scores Based on Bank Size**

| | Top 5 Banks | Top 10 Banks | Banks 6-10 | Banks 11-50 | Banks 26-50 | Banks 11-25 | All Bank Average |
|---|---|---|---|---|---|---|---|
| 2002-2007 | 0.966941 | 0.960504 | 0.954066 | 0.860997 | 0.841851 | 0.892907 | 0.880898 |
| 2008-2011 | 0.944792 | 0.935975 | 0.927159 | 0.716634 | 0.716967 | 0.71608 | 0.760502 |
| Average | 0.959159 | 0.951886 | 0.944612 | 0.810275 | 0.797973 | 0.830778 | 0.838597 |

While on the other hand, the smallest banks, Banks 26-50 had a much more difficult time adjusting to the new efficiency pressures put upon them by the financial crisis as their average efficiency score fell 12.5%. The largest efficiency loser with the advent of the financial crisis was the middle sized banks, those ranked between 11-25 in terms of Total

Assets. They lost approximately 17.7% of their relative efficiency. Also, the smallest banks (banks ranking 26-50) lost slightly less efficiency than the Banks 11-25 group. This may be due to their small niche markets that they were better able to adapt to the changes that were brought about during the crisis.

Though both groups did fall to approximately 76% efficiency when compared to the best banks in the market. The precipitous fall in relative efficiency may be a combination of their lack of resources due to their small sizes to adjust to the new competitive environment that the crisis left them and that the larger banks did a better job at maintaining their efficiencies through the crisis. This would then lead to a lower relative efficiency mark for the smaller banks as they were unable to match the cost and efficiency savings that the larger banks were able to do.

The juxtaposition of all bank ownership types losing on average a minimum of 10% efficiency due to the financial crisis while the Top 5 and Top 10 banks efficiency scores even moved further builds my belief that not only is bigger better in terms of efficiency in the sector, but that the large Brazilian banks are not sitting back and letting the financial crisis hurt their efficiency levels, therefore they are not falling into the "Quiet Life." These results lead us to surmise that larger banks are better suited to adjust to the changes in pressures put upon them from the financial crisis.

# Chapter 7: Conclusions, Contribution to Scientific Knowledge and Further Research

## 7.1 Conclusions

The Brazilian banking sector has a strong regulatory environment which has developed through the past two decades with the implementation of the PROES and PROER programs as well as the Real Plan in order to stabilize the currency, put an end to hyperinflation and develop a sound and stable banking environment. These stabilization measures have helped to create one of the fastest growing economies in the world. However, it has not eliminated shocks or crises completely from the banking landscape. The 2008 financial crisis did affect Brazil due to the knock-on effects of foreign capital flight from the Brazilian banking market. This in turn, led to a sharp increase in the cost of borrowing throughout the sector. The knock-on effect was a brief loss of confidence in the system and a subsequent drop in the currency and the stock market.

The regulatory agencies instituted the following measures in order to help stabilize the banking market. They made it easier for larger banks to buy their smaller competitors. They lowered the reserve requirements on banks. And they encouraged the Public Banks to

increase their loan portfolios to make up for the loss of foreign credit. These measures helped to shorten the currency and market crises in Brazil.

This thesis analyzes the Brazilian banking sector for the 2002-2011 period using detailed financial statement data. During this time Brazil has changed from a regional leader to a global power. The Brazilian banking sector is structurally sound however; there have been changes in regulation, market structure, efficiency and competition during the period as well as the most significant global financial crisis in 80 years. Consequently, this study set out to analyze the developments in concentration, competition and efficiency over the period in order to expand the knowledge base to include possible residual effects of the recent crisis.

In order to test for concentration and market power in the Brazilian banking market we used two measures, concentration ratios and the Herfindahl Index for market power. In our analysis of concentration ratios over the 2002-2011 period in the Brazilian banking sector we found that the sector was increasingly consolidating within the Top 3Banks, the Top 5 Banks and Top 10 Banks in terms of Total Assets, Total Deposits and Total Loans from Q1 2002 to Q1 2011. In terms of Assets, Total Deposits and Total Loans the top three banks moved from a market share of 34.4% to 47.1% in Total Assets, 49.9% to 52.8% in Total Deposits and 32.7% to 46.4% Total Loans respectively. The Top 5 banks concentrated from 46.4% to 68.1% in Total Assets, 60.1% to 69.1% in Total Deposits and from 43.4% to 67.8% in Total Loans. The Top 10 banks' consolidated from 61.6% to 84.9% of Total Assets, 74.6% to 85.4% of Total Deposits and 59.2% to 84.7% of Total Loans. Given this information we can state that the Brazilian banking sector has continued to consolidate over the 2002-2011 period and that the market is dominated by the Top 5 Banks. In like manner, the Herfindahl Index consistently increased over the period signifying a further consolidation in the market as well.

This continued consolidation follows along with Yildirim and Philippatos (2007) and Yeyati and Micco's (2003) studies that noted that the Brazilian banking system had been consolidating in previous years.

Furthermore, using the Herfindahl Index to test for market power we found that the continued concentration in the three sectors (assets, deposits and loans) has raised the Herfindahl Index score in all three areas. That said, the industry is only moderately concentrated and government officials would have no problems with even slightly more consolidation. Though the Brazilian banking sector is continually consolidating according to governmental statistic measures it has not become overly concentrated to the point that the authorities should take action against future consolidation and in fact in order to promote stability in the sector the regulatory authorities were prompting the facilitation of even more consolidation of smaller banks into larger banks during the financial crisis. However, the Herfindahl Index did not increase much for any of the groups after the initial financial crisis consolidation period. Though when running a regression with multiple concentration measures on competition we did find that concentration has a negative effect on competition.

The financial crisis did have an extreme effect on market structure as there was a large exodus of foreign bank participation from 2008 to 2011. Their participation fell from 26.8% to 18.0% in Total Assets, from 23.1% to 16.4% Total Deposits and 23.5% to 15.1% in Total Loans from Q1 2008 to Q1 2011, which would reflect the capital exodus during the financial crisis. The Public Banks were the beneficiary of this change raising their participation levels respectively from 28% to 40.9% in Total Assets, 41.9% to 44.1% in Total Deposits and from 27% to an astounding 44% in Total Loans. This would reflect the increased pressure that the government put on Public Banks to increase their loan portfolios to make up for the foreign

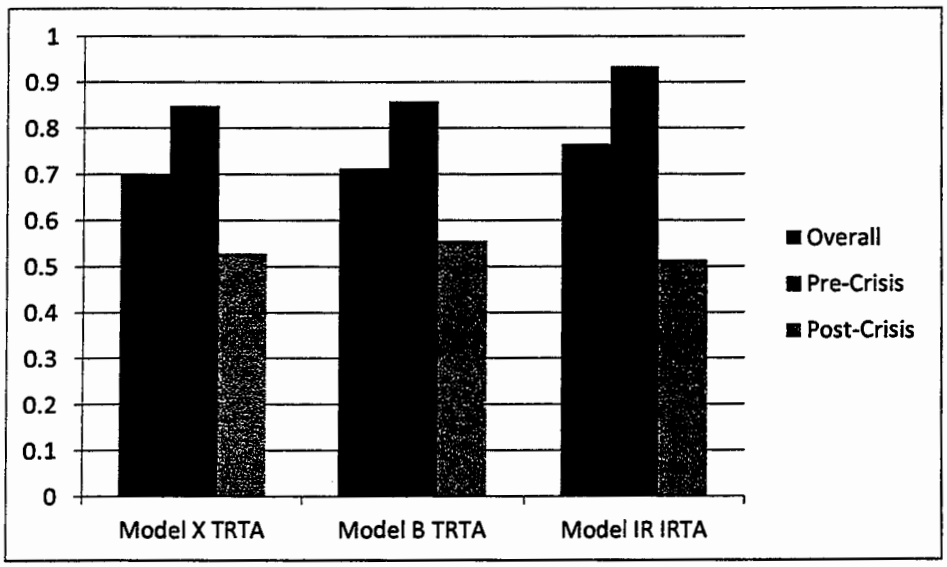
capital flight of the financial crisis. Which may help explain the dip in competition over the end of the study as foreign bank participation is positively correlated to competition.

Though concentration can be a proxy for competition there are disagreements in the literature if it is the best way to test for competition. Therefore we use a non-structural approach to competition measure. We use three separate Panzar Rosse models in order to test for competition in the Brazilian banking sector, two models with Total Revenue and Total Revenue over Total Assets as their dependent variables with one having an efficiency and ownership variables, and a third model with Interest Revenue and Interest Revenue over Total Assets as the dependent variables and with efficiency and ownership variables. For the entire 2002-2011 time period all three models found that the Brazilian banking sector is in monopolistic competition which is consistent with studies from previous time periods. Their scores derived with robust standard errors are relatively consistent with scores of 0.7602 for the non-efficiency, non-ownership, total revenue model, 0.7581 for the TR model with efficiency and ownership factored in and 0.8088 for the interest revenue model. Their fixed effects comparison models are all within 0.003 of the robust standard models. These three tests show us that Brazil is in a relatively competitive environment.

When dividing the 2002-2011 period into two separate periods, one Pre-Financial crisis and one Post-Financial crisis we see that the crisis has had a strong negative effect on competition. Table 7.1 shows the overall, pre- and post-financial crisis H-Statistic scores with normalized returns. The Model X score drops from 0.8483 to 0.5294 while the second total revenue over total asset model, Model B sees an equal large drop in competition from a pre-crisis H-Statistic of 0.8587 to 0.5563. The interest revenue based model, Model IR also saw a drop from a highly competitive 0.9347 to 0.5162. These scores find Brazil to be in

monopolistic competition in all three models, however the final crisis period is marked by a definite lower level of competition. This drop would seem logical given the fair amount of competition that left the market as the Foreign Banks exited in order to deal with possible liquidity issues in their home markets. Moreover, considering the government was pushing Public Banks to open their loan portfolios to more customers this may have had an anti-competitive effect on the H-Statistic as Public Banks may have been forced to take on loans that they would not have previously.

## Chart 7.1 Overall, Pre- and Post-Crisis H-Statistic Scores with Robust Standard Errors




The coefficients and correlations within the regressions have some interesting relationships. In comparing correlations between the Price of Labor and Ownership we see that Foreign Banks have a significantly positive correlation in the Pre-Crisis period while Public Banks have a negative relationship. Then in the Post-Crisis period the gap between the two shrinks. This would lead us to believe that the pay is higher at the Foreign Banks, which leads to some

indication as to why they are less efficient. Also perhaps the drop in the correlation may mean that Foreign Banks are moving their more expensive employees back to the home market in order to deal with issues there or they could be hiring more local workers who do not have the ex-patriot pay packages.

Furthermore, Foreign Banks correlate negatively to Efficiency in all three periods, while Public Banks have a positive correlation (though weak) even in the Post-Crisis period where cost pressures in a hard market would seem to lead to less efficient behavior. Furthermore the correlations between the Total Revenue and Total Revenue over Total Assets to Efficiency scores give mixed signals. The mixed results make it hard to judge efficiency's true effect on competition.

In the 2002-2011 and 2002-2008 regression Risk is positive and significant in the unscaled models leading us to say that the more intermediation risk a bank takes on the higher its Total Revenue should be. Therefore banks are rewarded for taking on risk. While in the Post-Crisis model the amount of Risk a bank takes no longer has a significant positive effect on Total Revenue. Subsequently Risk has become less welcome during the financial crisis.

Another note in the differences between the Pre and Post-Crisis coefficients is that before the crisis the Price of Capital had very little effect on total revenue, hence there would be little repercussions if managers overspent on overhead or assets. While in the Post-Crisis period the Price of Capital is significant in all models showing the increased cost pressures brought about by the crisis.

Focusing on risk and ownership Foreign Banks are negatively correlated with Risk in all three periods in all three models. However, the negative correlation grows unsurprisingly from the Pre-Financial Crisis correlation to the Post-Financial Crisis correlation. Nevertheless, Public Banks negative correlation to Risk in the Pre-Crisis period actually moves closer to zero into an insignificant position. This would lead us to say that the government's initiatives to encourage Public Banks to fill the void in the credit market left by the departure of Foreign Banks has worked in encouraging Public Bank managers to look past Risk in order to increase the loan supply.

When looking at the size variable Too Big, our variable for geographic scope via number of branches it has a positive and significant effect on Total Revenue and Interest Revenue in all periods. Total Deposits also has positive significant effect in terms of Total Revenue and Interest Revenue which combined would make sense as the bigger a bank is or the larger of the geographic range the bank is found over the more money it can potentially make.

Additionally, when we look at Too Big and Total Deposits in relation to efficiency they are positively correlated showing that the larger a bank and larger the geographic scope the bank serves the more efficient they most likely will be.

This leads us into an analysis on efficiency in the Brazilian banking sector. A VRS input oriented three input, three output Data Envelopment Analysis, a non-parametric estimation technique, was used to analyze the quarterly and yearly progression of efficiency developments. The model benchmarks individual bank efficiency against the most efficient banks in its sector. The results are only valid for comparison on banks in the same period,

however taken together they can give an overall trend as to how efficiency is developing in a particular industry.

The empirical results show that the Brazilian banking sector is highly relatively efficient with an overall efficiency score average of 0.835 for the 2002-2011 period. Although, over the 2002-2011 period relative efficiency as a whole fell from 0.884 average efficiency score in 2002 to 0.755 in 2010. On the other hand it would seem as efficiency is on the upswing as overall average quarterly data was improving through Q4 2010 and Q1 2011. Previous studies have stated that efficiency in the Brazilian banking sector has stagnated over time (Staub et al 2010) while others have stated that there was an improvement in efficiency (Pires Goncalves 2007). .

Additionally, we find that efficiency scores vary by ownership type. Overall Public Brazilian banks were the most efficient banks over the life of the study with an average score of 0.899. Moreover, the correlation results show a positive correlation between efficiency and public ownership. The leading efficiency score may be due to the combination of financial backing from the federal or state governments given the fact that the banks are run as nearly private enterprises. This would then give them the flexibility to adjust better to fluctuations in the market without an over imposing government strategy.

Foreign banks on the other hand come in behind Domestic Private Brazilian banks in terms of efficiency. Looking at the quarterly efficiency scores we can see that foreign banks were hit the hardest by the financial crisis and their need to deal with home market issues may have trumped any of their efficiency hopes in non-home markets. The overall efficiency averages were 0.899 for Public Banks, 0.797 for Foreign Banks and 0.849 efficiency for Domestic

Private banks. Therefore we can say that ownership does have a relationship with the level of efficiency and managerial decisions regarding efficiency.

The current financial crisis has had a negative impact on the relative efficiency of Brazilian banks. The Pre-Crisis average DEA efficiency score was 0.881 while the Post-Crisis average was 0.761. Again looking at Ownership Type the results show that Foreign Bank Efficiency was hurt the most, falling from 0.856 to 0.699 in the Post-Financial Crisis period. The Domestic Private Banks fared little better falling from 0.886 to 0.788 efficiency. Even the most efficient Public Banks took a hit falling from 0.937 to 0.842. Consequently we do find that the crisis definitely affected efficiency in the Brazilian banking sector in a negative way.

When looking at Bank Size and the effects of the Financial Crisis the larger banks hold their efficiency remarkably well through the rough financial times regardless of Ownership Type. The Top 10 Banks' average DEA efficiency score only fell 0.025 from their Pre-Financial Crisis Efficiency levels, from 0.961 to 0.936. The Smallest banks, Banks 26-50 saw their relative efficiency fall from 0.842 to 0.717, while the middle banks, Banks 11-25 saw the largest drop, falling from 0.892 efficiency to 0.716.

Taken all together in Brazil the term "bigger is better" does hold weight in terms of efficiency. The Top 5 Banks were the most efficient banks over the life of the study with an average 0.962 efficiency score, followed by Banks 6-10 with 0.946, then Banks 11-25 with 0.823 and Banks 26-50 with 0.796. This effect even held through the financial crisis as the Top 10 Banks were only slightly negatively affected by the crisis losing only about 2.7% of their relative efficiency during the crisis. Combined with the positive correlation and

significant positive coefficient for both size variables in relation to Total Revenue and Interest Revenue, bigger is truly better.

Finally, with the Brazilian banking sector continually concentrating there is a threat that the banks could take over the markets and become inefficient and pass on their inefficiencies to their final customers in the form of higher prices. However, seeing that the largest banks (Top 3, Top 5 and Top 10) have been gaining market share from their smaller competitors while maintaining the highest efficiency scores and efficiency correlating positively with size and revenues we feel it is safe to say that large Brazilian banks are not taking the "Quiet Life" in their managerial endeavors.

Taking into account the usual market fluctuations and recent global financial crisis we find that 'Bigger is Better' in terms of efficiency and the Brazilian Banking Sector has not taken the 'Quiet Life' path. This follows with Demsetz Efficiency Hypothesis that more efficient businesses will win business from their less efficient competitors. And with the combination of increased gaps in efficiency between larger and small banks and the continued concentration in the top 10 banks in the market we can safely conclude that the more efficient banks are winning in the market place.

Additionally finding that the Brazilian market is competing in monopolistic competition allows for the appearance of different levels of competition and efficiency in the Brazilian banking market hence a lack of perfect competition. This lack of perfect competition allows for Demsetz Efficiency Hypothesis to take hold as a market in perfect competition does not allow for less efficient companies to survive. Furthermore, monopolistic competition or monopoly is needed to have the threat of the "Quiet Life." As they allow for inefficiencies

within the system and the differences may allow for banks to take the worst part of the "Quiet Life" the non-fixing of inefficient ways. Therefore monopolistic competition or monopoly are theoretically required in order to have the threat of the "Quiet Life."

## 7.2 Contribution to Scientific Knowledge

This dissertation contributes to scientific knowledge in many ways. It gives an updated account of the market structure of the Brazilian banking sector showing the developments in market share, concentration and participation in terms of ownership type and bank size, which have all continued to concentrate over the 2002-2011 period. These further developments can be used in order to further gauge the trends in the Brazilian banking sector and compare them with other BRIC or G20 banking sectors.

Furthermore, the dissertation shows the effects of the recent financial crisis on the Brazilian banking sector in terms of efficiency effects, changes in competition levels and market structure. Overall the financial crisis had a significantly negative effect on competition and efficiency and Post-Crisis a calming effect on the consolidation of the market. The effects of the financial crisis through a pre and post crisis perspective with notes on the governments non-competitive actions during the crisis is important in determining what should be the appropriate action a banking sector or government should take in order to stave off a potential banking crisis.

Also, the study updates the research on DEA efficiency scores for the sector through the most recent quarter available Q1 2011 showing that overall efficiency has been in decline in the sector on average. However, that the largest banks have held the efficiency levels remarkably

well through the financial crisis. It also shows the efficiency developments by bank size, bigger banks are more efficient, and ownership type, public banks are more efficient.

Additionally, the study analyzes the quarterly developments of efficiency and concentration instead of solely yearly statistics. This allows for a more in-depth analysis of the effects of market shocks and managerial decisions as they can be more easily identified in the data there we can see the quarter where the financial crisis began.

Also the study analyzes the Panzar Rosse H-Statistic up to the most recent quarter Q1 2011 allowing for up-to-date research on competition in the market which allowed for a more robust analysis of the drop in competition between the 2002-2008 period and the 2009-2011 period. It also uses both a scaled and unscaled dependent variable in the Panzar Rosse regression models in order to test for the possible differences in competition levels that may arise due to the variances in dependent variable selection.

## 7.3 Further Research

The study has brought up many further issues that are of interest to bankers, economists and governments. The scope of the dissertation allows for a wide range of possible research paths which each on their own would be beneficial to scientific knowledge.

The first area of further research would focus on the comparison of DEA and SFA efficiency models in terms of Brazil. This would be done in order to further analyze the efficiency gains and losses over the time period and give a more robust analysis of efficiency in the sector. Additionally, as the literature alluded to a need for a continued path of research in terms of

the most appropriate efficiency model it would also allow for a further comparative study between the two principal efficiency models in the literature.

A further study on the effects of the banking crisis on international holdings and investments by international banks. The study would include the efficiency scores of international banks in multiple markets in order to gauge the development of efficiencies scores in foreign markets versus domestic markets. This would enable researchers to note if home country efficiency effects have any correlation with efficiency developments in the bank's foreign operations. It would also allow for a possible check into risky/inefficient banking measures taken by banks before they suffer a financial crisis in their institution.

A third area of further research would be in the area of banking competition and efficiency throughout the BRIC economies in order to gauge their relative efficiency developments as well as their competition levels over the past ten years to see how their rise to prominence on the world stage has affected or been affected by the relative efficiencies in their banking sectors.

A fourth area would be to analyze bank managerial quality using DEA Efficiency Scores as a proxy for bank management. This would then be used in order to analyze if financially troubled, merged or acquired banks had efficiency problems before their downfalls. Finally, as our study did not give a firm enough answer to the question of how efficiency and competition relate further research would need to be done in this area to better understand their interrelationship.

A fifth area of future research would be a comparison study of the European Union, the USA and Brazil. The study would focus on the areas of banking competition and banking efficiency. The extensive research on US and European Union banking institutions would allow for a robust study on the developments in banking efficiency and competition over the pre and post financial crisis period. This would allow for a comparison of the Brazilian sector to more mature and developed banking centers of the US and European Union.

A sixth area of future research would be a set of tests on Panzar Rosse Model papers. The research would focus on the results of using varying dependent variables. The differences in the numerical results in the Panzar Rosse H-Statistics when changing from Total Revenue to Total Revenue over Total Assets or Interest Revenue to Interest Revenue over Total Assets shows the need for a review of previous Panzar Rosse studies to determine if changing the dependent variable would have a dramatic effect on their end results. This would allow to better ascertain which dependent variable is more appropriate in different situations.

The final area of future research deals with financial innovations in Brazil and other developing countries. The research would focus on the types of financial innovations found in developed versus developing markets. Their effects on the market and how they were affected by the 2008/2009 financial crisis would also be analyzed. Then a comparative report on government action in order to regulate financial innovation by country type.

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## Appendix 1: Total Asset Quarterly Concentration Ratios Q1 2002 – Q1 2011

| Quarterly Concentration Ratios for Total Assets Q1 2002-Q1 2011 | | | | |
|---|---|---|---|---|
| | CR 3 | CR 5 | CR 10 | CR 50 |
| 2002 Q1 | 0.3428 | 0.4638 | 0.6164 | 0.8258 |
| 2002 Q2 | 0.3440 | 0.4705 | 0.6287 | 0.8287 |
| 2002 Q3 | 0.3521 | 0.4793 | 0.6308 | 0.8285 |
| 2002 Q4 | 0.3610 | 0.5037 | 0.6416 | 0.8209 |
| 2003 Q1 | 0.3680 | 0.5043 | 0.6435 | 0.8264 |
| 2003 Q2 | 0.3866 | 0.5200 | 0.6584 | 0.8266 |
| 2003 Q3 | 0.3869 | 0.5243 | 0.6602 | 0.8271 |
| 2003 Q4 | 0.3964 | 0.5268 | 0.6764 | 0.8292 |
| 2004 Q1 | 0.3793 | 0.5124 | 0.6652 | 0.8287 |
| 2004 Q2 | 0.3752 | 0.5041 | 0.6609 | 0.8302 |
| 2004 Q3 | 0.3680 | 0.5104 | 0.6658 | 0.8297 |
| 2004 Q4 | 0.3688 | 0.5042 | 0.6642 | 0.8268 |
| 2005 Q1 | 0.3647 | 0.5059 | 0.6686 | 0.8322 |
| 2005 Q2 | 0.3636 | 0.5034 | 0.6751 | 0.8359 |
| 2005 Q3 | 0.3633 | 0.5007 | 0.6790 | 0.8406 |
| 2005 Q4 | 0.3627 | 0.5004 | 0.6823 | 0.8401 |
| 2006 Q1 | 0.3570 | 0.5036 | 0.6870 | 0.8456 |
| 2006 Q2 | 0.3639 | 0.5064 | 0.6889 | 0.8458 |
| 2006 Q3 | 0.3641 | 0.5201 | 0.7010 | 0.8454 |
| 2006 Q4 | 0.3600 | 0.5223 | 0.7109 | 0.8507 |
| 2007 Q1 | 0.3598 | 0.5232 | 0.7066 | 0.8592 |
| 2007 Q2 | 0.3476 | 0.5130 | 0.7016 | 0.8567 |
| 2007 Q3 | 0.3643 | 0.5247 | 0.7059 | 0.8616 |
| 2007 Q4 | 0.3638 | 0.5233 | 0.7065 | 0.8634 |
| 2008 Q1 | 0.3735 | 0.5265 | 0.7034 | 0.8655 |
| 2008 Q2 | 0.3813 | 0.5310 | 0.7161 | 0.8625 |
| 2008 Q3 | 0.3884 | 0.5833 | 0.7421 | 0.8688 |
| 2008 Q4 | 0.4660 | 0.6604 | 0.7655 | 0.8656 |
| 2009 Q1 | 0.4826 | 0.6779 | 0.7770 | 0.8625 |
| 2009 Q2 | 0.4729 | 0.6685 | 0.8500 | 0.9560 |
| 2009 Q3 | 0.4755 | 0.6729 | 0.8514 | 0.9562 |
| 2009 Q4 | 0.4770 | 0.6767 | 0.8520 | 0.9571 |
| 2010 Q1 | 0.4751 | 0.6735 | 0.8487 | 0.9562 |
| 2010 Q2 | 0.4625 | 0.6730 | 0.8505 | 0.9571 |
| 2010 Q3 | 0.4636 | 0.6711 | 0.8466 | 0.9568 |
| 2010 Q4 | 0.4702 | 0.6805 | 0.8497 | 0.9566 |
| 2011 Q1 | 0.4711 | 0.6807 | 0.8486 | 0.9564 |

## Appendix 2: Total Deposit Quarterly Concentration Ratios Q1 2002 – Q1 2011

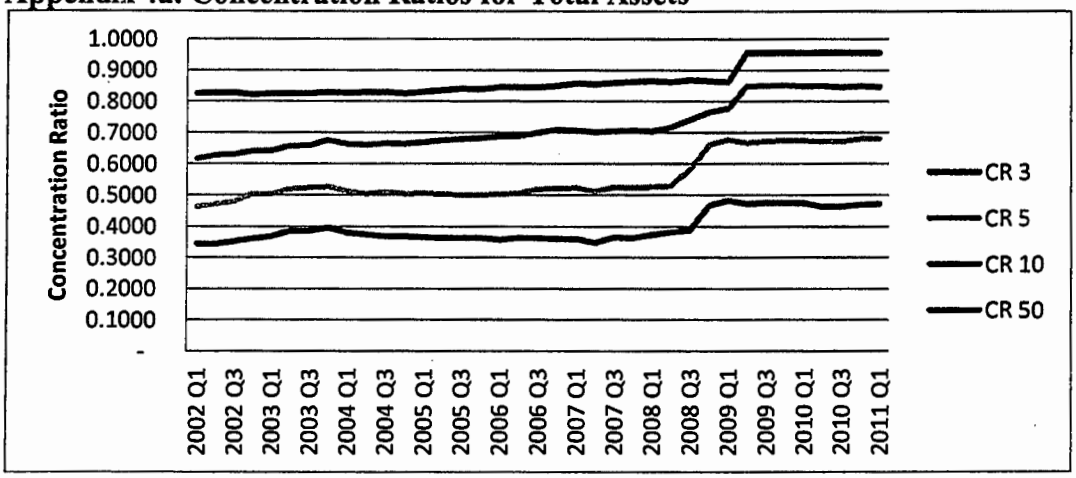
| Quarterly Concentration Ratios for Total Deposits Q1 2002-Q1 2011 | | | | |
|---|---|---|---|---|
| | CR 3 | CR 5 | CR 10 | CR 50 |
| 2002 Q1 | 0.499216 | 0.607981 | 0.745607 | 0.9094 |
| 2002 Q2 | 0.496669 | 0.619904 | 0.721867 | 0.920677 |
| 2002 Q3 | 0.506753 | 0.634455 | 0.73519 | 0.920151 |
| 2002 Q4 | 0.49652 | 0.638341 | 0.78397 | 0.923489 |
| 2003 Q1 | 0.49399 | 0.631812 | 0.765981 | 0.923378 |
| 2003 Q2 | 0.51111 | 0.641854 | 0.806504 | 0.926115 |
| 2003 Q3 | 0.509665 | 0.638319 | 0.800706 | 0.927775 |
| 2003 Q4 | 0.507512 | 0.636855 | 0.815557 | 0.927992 |
| 2004 Q1 | 0.499665 | 0.62415 | 0.802367 | 0.921949 |
| 2004 Q2 | 0.497348 | 0.622179 | 0.768015 | 0.926913 |
| 2004 Q3 | 0.488491 | 0.617457 | 0.798062 | 0.932681 |
| 2004 Q4 | 0.482398 | 0.615617 | 0.808474 | 0.929604 |
| 2005 Q1 | 0.481802 | 0.615459 | 0.806999 | 0.925738 |
| 2005 Q2 | 0.474371 | 0.606014 | 0.796386 | 0.924571 |
| 2005 Q3 | 0.470532 | 0.598949 | 0.798599 | 0.923322 |
| 2005 Q4 | 0.468764 | 0.598244 | 0.798057 | 0.921427 |
| 2006 Q1 | 0.466151 | 0.583895 | 0.799207 | 0.921089 |
| 2006 Q2 | 0.458408 | 0.589882 | 0.788909 | 0.918975 |
| 2006 Q3 | 0.434837 | 0.594273 | 0.789992 | 0.912253 |
| 2006 Q4 | 0.466036 | 0.616239 | 0.793576 | 0.919484 |
| 2007 Q1 | 0.441584 | 0.612397 | 0.78688 | 0.913594 |
| 2007 Q2 | 0.439807 | 0.608483 | 0.779578 | 0.916548 |
| 2007 Q3 | 0.387545 | 0.606204 | 0.778058 | 0.914643 |
| 2007 Q4 | 0.401011 | 0.611803 | 0.782193 | 0.918677 |
| 2008 Q1 | 0.399821 | 0.612175 | 0.780784 | 0.917148 |
| 2008 Q2 | 0.394595 | 0.606705 | 0.785729 | 0.919793 |
| 2008 Q3 | 0.430558 | 0.673555 | 0.838724 | 0.928925 |
| 2008 Q4 | 0.518042 | 0.745639 | 0.859119 | 0.93292 |
| 2009 Q1 | 0.541617 | 0.772346 | 0.870064 | 0.933261 |
| 2009 Q2 | 0.530605 | 0.763475 | 0.873537 | 0.959563 |
| 2009 Q3 | 0.526456 | 0.68704 | 0.869191 | 0.959856 |
| 2009 Q4 | 0.535222 | 0.691294 | 0.864953 | 0.961015 |
| 2010 Q1 | 0.528583 | 0.690621 | 0.860306 | 0.959715 |
| 2010 Q2 | 0.530189 | 0.690197 | 0.85433 | 0.957867 |
| 2010 Q3 | 0.522533 | 0.68206 | 0.851138 | 0.95532 |
| 2010 Q4 | 0.527624 | 0.686386 | 0.852778 | 0.955904 |
| 2011 Q1 | 0.527736 | 0.690948 | 0.853705 | 0.954474 |

## Appendix 3: Total Loans Quarterly Concentration Ratios Q1 2002 – Q1 2011

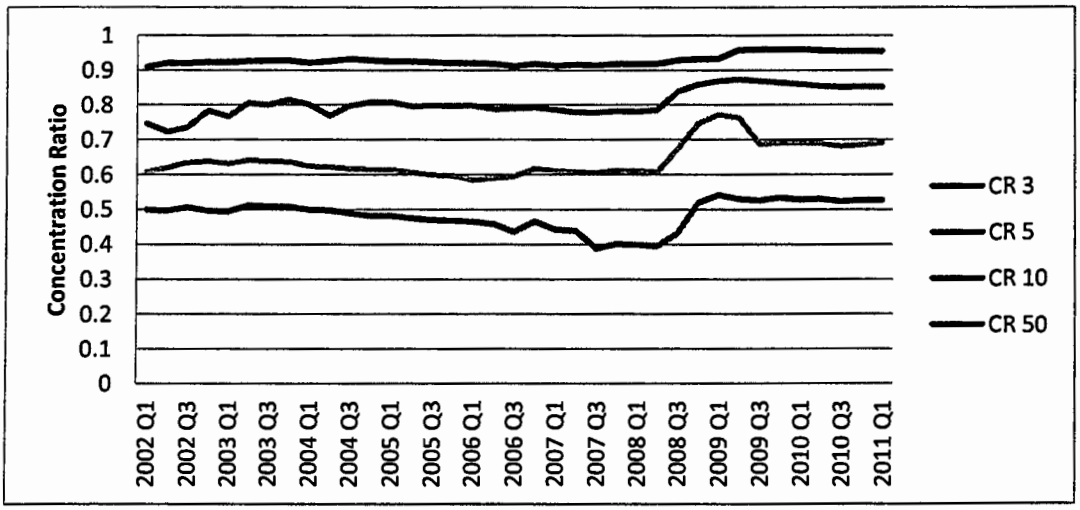
| Quarterly Concentration Ratios for Total Loans Q1 2002-Q1 2011 | | | | |
|---|---|---|---|---|
| | CR 3 | CR 5 | CR 10 | CR 50 |
| 2002 Q1 | 0.327644 | 0.433917 | 0.592093 | 0.79836 |
| 2002 Q2 | 0.330357 | 0.466053 | 0.612161 | 0.804217 |
| 2002 Q3 | 0.3235 | 0.462133 | 0.607584 | 0.79296 |
| 2002 Q4 | 0.324585 | 0.473166 | 0.597187 | 0.783366 |
| 2003 Q1 | 0.329822 | 0.481553 | 0.613969 | 0.791882 |
| 2003 Q2 | 0.345665 | 0.495098 | 0.628105 | 0.780321 |
| 2003 Q3 | 0.346917 | 0.489834 | 0.626787 | 0.77871 |
| 2003 Q4 | 0.344552 | 0.485604 | 0.64306 | 0.77471 |
| 2004 Q1 | 0.344121 | 0.481558 | 0.641603 | 0.775884 |
| 2004 Q2 | 0.347385 | 0.489067 | 0.657282 | 0.78936 |
| 2004 Q3 | 0.343282 | 0.486175 | 0.653614 | 0.789635 |
| 2004 Q4 | 0.347736 | 0.488194 | 0.655198 | 0.784763 |
| 2005 Q1 | 0.350847 | 0.494898 | 0.663699 | 0.789251 |
| 2005 Q2 | 0.356992 | 0.50037 | 0.681299 | 0.797622 |
| 2005 Q3 | 0.3548 | 0.500298 | 0.686854 | 0.79967 |
| 2005 Q4 | 0.355803 | 0.498341 | 0.688199 | 0.799841 |
| 2006 Q1 | 0.35878 | 0.487953 | 0.695034 | 0.805473 |
| 2006 Q2 | 0.362496 | 0.503264 | 0.697373 | 0.809016 |
| 2006 Q3 | 0.328263 | 0.515198 | 0.711728 | 0.812926 |
| 2006 Q4 | 0.367667 | 0.521988 | 0.713455 | 0.819298 |
| 2007 Q1 | 0.33806 | 0.529958 | 0.717575 | 0.8244 |
| 2007 Q2 | 0.336146 | 0.530949 | 0.722767 | 0.83427 |
| 2007 Q3 | 0.394415 | 0.528727 | 0.720386 | 0.832637 |
| 2007 Q4 | 0.396307 | 0.528472 | 0.71903 | 0.8319 |
| 2008 Q1 | 0.399843 | 0.529489 | 0.718772 | 0.834237 |
| 2008 Q2 | 0.403468 | 0.530821 | 0.717275 | 0.837058 |
| 2008 Q3 | 0.402517 | 0.572919 | 0.726733 | 0.836314 |
| 2008 Q4 | 0.46699 | 0.644172 | 0.741052 | 0.832977 |
| 2009 Q1 | 0.475867 | 0.658552 | 0.750714 | 0.830498 |
| 2009 Q2 | 0.471433 | 0.658134 | 0.839561 | 0.945614 |
| 2009 Q3 | 0.467523 | 0.673773 | 0.842926 | 0.948353 |
| 2009 Q4 | 0.464204 | 0.678259 | 0.843806 | 0.952289 |
| 2010 Q1 | 0.46316 | 0.678319 | 0.842891 | 0.950864 |
| 2010 Q2 | 0.465708 | 0.6823 | 0.84505 | 0.952022 |
| 2010 Q3 | 0.463336 | 0.677936 | 0.845682 | 0.951168 |
| 2010 Q4 | 0.464497 | 0.678646 | 0.846138 | 0.953391 |
| 2011 Q1 | 0.463851 | 0.678428 | 0.84657 | 0.95079 |

## Appendix 4: Graphs of Concentration Ratios for Total Assets, Total Deposits and Total Loans Q1 2002 – Q1 2011

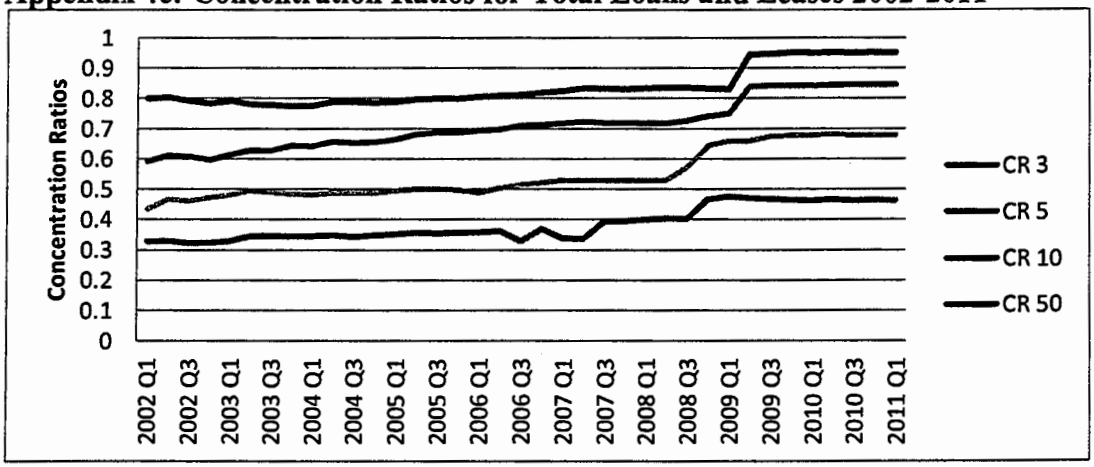
**Appendix 4a: Concentration Ratios for Total Assets**




**Appendix 4b: Concentration Ratios for Total Deposits 2002-2011**




**Appendix 4c: Concentration Ratios for Total Loans and Leases 2002-2011**



# Appendix 5a: Descriptive Characteristics and Averages

**Descriptive Statistics on Quarterly Total Deposits for Top 50 Banks by Year**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Total Deposits 2002 | 200 | 815 | 33838613 | 2574261.83 | 5839861.924 |
| Total Deposits 2003 | 200 | 678 | 38077555 | 2921210.49 | 6696654.049 |
| Total Deposits 2004 | 200 | 52 | 43524654 | 3475222.28 | 7767527.327 |
| Total Deposits 2005 | 200 | 18 | 58810723 | 4892465.79 | 1.070E7 |
| Total Deposits 2006 | 200 | 0 | 74294181 | 6219863.31 | 1.353E7 |
| Total Deposits 2007 | 200 | 0 | 106296216 | 8250340.03 | 1.806E7 |
| Total Deposits 2008 | 200 | 0 | 122793496 | 10785744.66 | 2.432E7 |
| Total Deposits 2009 | 200 | 0 | 194033104 | 12923037.38 | 3.285E7 |
| Total Deposits 2010 | 200 | 0 | 226531319 | 15467188.77 | 3.880E7 |
| Total Deposits 2011 | 50 | 0 | 234404343 | 17873504.00 | 4.534E7 |
| Valid N (listwise) | 50 | | | | |

**Descriptive Statistics on Quarterly Total Assets for Top 50 Banks by Year**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Total Assets 2002 | 200 | 306003 | 72555775 | 6518597.81 | 1.197E7 |
| Total Assets 2003 | 200 | 330532 | 79656807 | 7058768.71 | 1.408E7 |
| Total Assets 2004 | 200 | 372932 | 90044508 | 8237807.47 | 1.606E7 |
| Total Assets 2005 | 200 | 444371 | 110480945 | 11153768.96 | 2.123E7 |
| Total Assets 2006 | 200 | 613379 | 138613854 | 14582101.14 | 2.775E7 |
| Total Assets 2007 | 200 | 824371 | 201970441 | 21847838.14 | 4.121E7 |
| Total Assets 2008 | 200 | 708984 | 270144062 | 27665717.21 | 5.632E7 |
| Total Assets 2009 | 200 | 679449 | 397408923 | 33912258.78 | 7.746E7 |
| Total Assets 2010 | 200 | 2051119 | 467713326 | 45397353.32 | 1.003E8 |
| Total Assets 2011 | 50 | 2584104 | 510636681 | 54377836.74 | 1.210E8 |
| Valid N (listwise) | 50 | | | | |

**Descriptive Statistics on Quarterly Total Loans and Leases for Top 50 Banks by Year**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Total Loans & Leases 2002 | 200 | 84 | 18447878 | 1704021.81 | 3197865.503 |
| Total Loans & Leases 2003 | 200 | 0 | 22706621 | 1850720.69 | 3759818.015 |
| Total Loans & Leases 2004 | 200 | 0 | 28196018 | 2265380.49 | 4641102.499 |
| Total Loans & Leases 2005 | 200 | 0 | 36724544 | 3287365.21 | 6795126.643 |
| Total Loans & Leases 2006 | 200 | 0 | 53259516 | 4422259.63 | 9176527.137 |
| Total Loans & Leases 2007 | 200 | 0 | 78387930 | 6452905.42 | 1.350E7 |
| Total Loans & Leases 2008 | 200 | 0 | 104008070 | 8407877.04 | 1.824E7 |
| Total Loans & Leases 2009 | 200 | 0 | 160633314 | 11656733.79 | 2.733E7 |
| Total Loans & Leases 2010 | 200 | 0 | 200571988 | 16578506.46 | 3.746E7 |
| Total Loans & Leases 2011 | 49 | 0 | 209893304 | 20430491.88 | 4.548E7 |
| Valid N (listwise) | 49 | | | | |

## Appendix 5b: Quarterly Descriptive Averages Q1 2002 - Q1 2011

| Quarterly Descriptive Characteristics for Top 50 Brazilian Banks based on Total Assets | | | | |
|---|---|---|---|---|
| | Total Assets | Total Deposits | Total Loans | # Employees[44] |
| 2002 Q1 | 7,967,117 | 3,077,400 | 2,250,340 | 9,741 |
| 2002 Q2 | 6,688,221 | 2,663,565 | 1,956,555 | 9,828 |
| 2002 Q3 | 5,600,976 | 2,129,248 | 1,532,740 | 9,875 |
| 2002 Q4 | 5,818,077 | 2,426,834 | 1,647,496 | 9,778 |
| 2003 Q1 | 6,315,326 | 2,572,288 | 1,751,909 | 9,666 |
| 2003 Q2 | 7,033,482 | 2,969,081 | 2,038,860 | 9,704 |
| 2003 Q3 | 7,243,383 | 3,001,572 | 2,053,048 | 9,741 |
| 2003 Q4 | 7,642,884 | 3,155,447 | 2,192,780 | 9,663 |
| 2004 Q1 | 7,835,662 | 3,192,750 | 2,224,189 | 9,859 |
| 2004 Q2 | 7,680,878 | 3,165,981 | 2,212,347 | 9,893 |
| 2004 Q3 | 8,397,408 | 3,574,513 | 2,503,904 | 9,845 |
| 2004 Q4 | 9,037,282 | 4,007,305 | 2,803,363 | 9,954 |
| 2005 Q1 | 9,534,292 | 4,161,764 | 2,918,546 | 9,976 |
| 2005 Q2 | 10,907,211 | 4,793,395 | 3,463,813 | 10,124 |
| 2005 Q3 | 12,152,893 | 5,247,100 | 3,830,591 | 10,099 |
| 2005 Q4 | 12,020,681 | 5,374,976 | 3,890,217 | 10,244 |
| 2006 Q1 | 13,663,014 | 5,900,780 | 4,359,733 | 10,450 |
| 2006 Q2 | 14,197,143 | 6,122,229 | 4,621,192 | 10,467 |
| 2006 Q3 | 14,569,851 | 6,134,615 | 4,818,772 | 10,512 |
| 2006 Q4 | 15,898,397 | 6,721,830 | 5,294,917 | 10,576 |
| 2007 Q1 | 18,438,556 | 7,076,269 | 5,792,123 | 10,522 |
| 2007 Q2 | 20,947,398 | 7,824,129 | 6,521,903 | 10,518 |
| 2007 Q3 | 23,058,360 | 8,488,028 | 7,234,069 | 10,621 |
| 2007 Q4 | 24,947,038 | 9,612,934 | 8,128,844 | 10,861 |
| 2008 Q1 | 26,930,138 | 9,900,398 | 8,710,481 | 10,858 |
| 2008 Q2 | 31,016,661 | 11,896,274 | 10,208,342 | 10,873 |
| 2008 Q3 | 28,300,926 | 11,168,194 | 9,144,741 | 10,902 |
| 2008 Q4 | 24,415,144 | 10,178,112 | 7,902,423 | 11,067 |
| 2009 Q1 | 24,837,650 | 10,222,628 | 8,039,358 | 10,948 |
| 2009 Q2 | 32,857,398 | 12,591,456 | 11,018,372 | 9,384 |
| 2009 Q3 | 38,265,029 | 14,247,596 | 13,188,488 | 9,722 |
| 2009 Q4 | 39,688,958 | 14,633,386 | 14,380,716 | 9,346 |
| 2010 Q1 | 40,464,459 | 14,386,998 | 14,618,002 | 9,779 |
| 2010 Q2 | 42,628,472 | 14,468,841 | 15,427,859 | 9,787 |
| 2010 Q3 | 48,139,106 | 15,901,593 | 17,417,987 | 10,045 |
| 2010 Q4 | 50,357,377 | 17,111,323 | 18,850,177 | 10,320 |
| 2011 Q1 | 54,377,837 | 17,873,504 | 20,021,882 | 10,367 |

[44] Banks with less than two employees are not included for comparison purposes.

## Appendix 6: Quarterly Herfindahl Index Q1 2002 – Q1 2011

| Quarterly Herfindahl Index for Q1 2002 – Q1 2011 | | | |
|---|---|---|---|
| | Total Assets HI | Total Deposits HI | Total Loans HI |
| 2002 Q1 | 0.056017 | 0.10021 | 0.054711 |
| 2002 Q2 | 0.056875 | 0.099097 | 0.056017 |
| 2002 Q3 | 0.05959 | 0.103986 | 0.055033 |
| 2002 Q4 | 0.062812 | 0.102964 | 0.056488 |
| 2003 Q1 | 0.06349 | 0.102139 | 0.058545 |
| 2003 Q2 | 0.067362 | 0.10703 | 0.061592 |
| 2003 Q3 | 0.068044 | 0.10614 | 0.06159 |
| 2003 Q4 | 0.070207 | 0.108017 | 0.062876 |
| 2004 Q1 | 0.067016 | 0.104102 | 0.062532 |
| 2004 Q2 | 0.064517 | 0.10305 | 0.064192 |
| 2004 Q3 | 0.065259 | 0.100482 | 0.063065 |
| 2004 Q4 | 0.064908 | 0.099165 | 0.06394 |
| 2005 Q1 | 0.064954 | 0.099016 | 0.065151 |
| 2005 Q2 | 0.063902 | 0.097019 | 0.0668 |
| 2005 Q3 | 0.063804 | 0.096523 | 0.0662 |
| 2005 Q4 | 0.06391 | 0.097103 | 0.066534 |
| 2006 Q1 | 0.0638 | 0.097051 | 0.067556 |
| 2006 Q2 | 0.0648 | 0.093692 | 0.068219 |
| 2006 Q3 | 0.0671 | 0.095924 | 0.070474 |
| 2006 Q4 | 0.067232 | 0.097044 | 0.072039 |
| 2007 Q1 | 0.067149 | 0.096407 | 0.073673 |
| 2007 Q2 | 0.064726 | 0.094468 | 0.074301 |
| 2007 Q3 | 0.066908 | 0.094755 | 0.073008 |
| 2007 Q4 | 0.066888 | 0.096658 | 0.073003 |
| 2008 Q1 | 0.067871 | 0.096207 | 0.073719 |
| 2008 Q2 | 0.069401 | 0.092444 | 0.074743 |
| 2008 Q3 | 0.07653 | 0.103894 | 0.079112 |
| 2008 Q4 | 0.096802 | 0.12339 | 0.093302 |
| 2009 Q1 | 0.100971 | 0.13444 | 0.097512 |
| 2009 Q2 | 0.105953 | 0.132519 | 0.107876 |
| 2009 Q3 | 0.108161 | 0.132552 | 0.110419 |
| 2009 Q4 | 0.109009 | 0.134149 | 0.110498 |
| 2010 Q1 | 0.107244 | 0.133863 | 0.109329 |
| 2010 Q2 | 0.10614 | 0.132793 | 0.110323 |
| 2010 Q3 | 0.104787 | 0.130075 | 0.10883 |
| 2010 Q4 | 0.107201 | 0.132699 | 0.108481 |
| 2011 Q1 | 0.107023 | 0.133117 | 0.10799 |

## Appendix 7: Quarterly Market Structure by Ownership Q1 2002 – Q1 2011

| Number of Banks by Ownership Type in the Top 50 Banks Based on Assets Q1 2002-Q1 2011 | | | |
|---|---|---|---|
| | Number Public Banks | Number Foreign Banks | Number Private Domestic Banks |
| 2002 Q1 | 9 | 25 | 16 |
| 2002 Q2 | 9 | 24 | 17 |
| 2002 Q3 | 9 | 26 | 15 |
| 2002 Q4 | 10 | 24 | 16 |
| 2003 Q1 | 9 | 24 | 17 |
| 2003 Q2 | 10 | 22 | 18 |
| 2003 Q3 | 10 | 21 | 19 |
| 2003 Q4 | 10 | 20 | 20 |
| 2004 Q1 | 10 | 21 | 19 |
| 2004 Q2 | 10 | 19 | 21 |
| 2004 Q3 | 10 | 19 | 21 |
| 2004 Q4 | 10 | 20 | 20 |
| 2005 Q1 | 10 | 20 | 20 |
| 2005 Q2 | 10 | 20 | 20 |
| 2005 Q3 | 10 | 20 | 20 |
| 2005 Q4 | 10 | 19 | 21 |
| 2006 Q1 | 9 | 20 | 21 |
| 2006 Q2 | 10 | 18 | 22 |
| 2006 Q3 | 10 | 18 | 22 |
| 2006 Q4 | 10 | 18 | 22 |
| 2007 Q1 | 9 | 21 | 20 |
| 2007 Q2 | 9 | 18 | 23 |
| 2007 Q3 | 9 | 21 | 20 |
| 2007 Q4 | 9 | 19 | 22 |
| 2008 Q1 | 9 | 21 | 20 |
| 2008 Q2 | 9 | 20 | 21 |
| 2008 Q3 | 9 | 19 | 22 |
| 2008 Q4 | 9 | 20 | 21 |
| 2009 Q1 | 9 | 19 | 22 |
| 2009 Q2 | 9 | 19 | 22 |
| 2009 Q3 | 9 | 22 | 19 |
| 2009 Q4 | 9 | 21 | 20 |
| 2010 Q1 | 9 | 20 | 21 |
| 2010 Q2 | 9 | 20 | 21 |
| 2010 Q3 | 9 | 20 | 21 |
| 2010 Q4 | 9 | 20 | 21 |
| 2011 Q1 | 9 | 20 | 21 |

## Appendix 8: Quarterly Market Share of Total Assets by Ownership Type Q1 2002 – Q1 2011

| Quarterly Market Share of Total Assets by Ownership Type Q1 2002 - Q1 2011 | | | |
|---|---|---|---|
| | Public Ownership | Foreign Ownership | Private Domestic |
| 2002 Q1 | 0.293554775 | 0.297731811 | 0.408713415 |
| 2002 Q2 | 0.293901914 | 0.300620868 | 0.405477218 |
| 2002 Q3 | 0.299236993 | 0.298844358 | 0.401918649 |
| 2002 Q4 | 0.315638878 | 0.261899088 | 0.422462034 |
| 2003 Q1 | 0.318286286 | 0.25435514 | 0.427358574 |
| 2003 Q2 | 0.326111403 | 0.233269494 | 0.440619102 |
| 2003 Q3 | 0.325530942 | 0.229390662 | 0.445078397 |
| 2003 Q4 | 0.334321155 | 0.218237614 | 0.447441231 |
| 2004 Q1 | 0.330591398 | 0.231597541 | 0.437811061 |
| 2004 Q2 | 0.320120218 | 0.23610629 | 0.443773492 |
| 2004 Q3 | 0.313485504 | 0.232083771 | 0.454430726 |
| 2004 Q4 | 0.314578821 | 0.230563334 | 0.454857845 |
| 2005 Q1 | 0.309785522 | 0.239058767 | 0.451155711 |
| 2005 Q2 | 0.307641256 | 0.243822322 | 0.448536422 |
| 2005 Q3 | 0.30727369 | 0.251551534 | 0.441174776 |
| 2005 Q4 | 0.309217483 | 0.245616045 | 0.445166472 |
| 2006 Q1 | 0.302813134 | 0.255225513 | 0.441961353 |
| 2006 Q2 | 0.305832616 | 0.241495568 | 0.452671816 |
| 2006 Q3 | 0.300958242 | 0.232065981 | 0.466975777 |
| 2006 Q4 | 0.296662558 | 0.24458676 | 0.458750683 |
| 2007 Q1 | 0.287357562 | 0.254832304 | 0.457810133 |
| 2007 Q2 | 0.283234644 | 0.267031483 | 0.449733873 |
| 2007 Q3 | 0.278102271 | 0.266125321 | 0.455772408 |
| 2007 Q4 | 0.278619535 | 0.261773105 | 0.45960736 |
| 2008 Q1 | 0.279690086 | 0.268533415 | 0.451776499 |
| 2008 Q2 | 0.254624656 | 0.275244461 | 0.470130883 |
| 2008 Q3 | 0.269017278 | 0.263428391 | 0.467554331 |
| 2008 Q4 | 0.279890144 | 0.195664066 | 0.52444579 |
| 2009 Q1 | 0.287467061 | 0.186142153 | 0.526390786 |
| 2009 Q2 | 0.296720723 | 0.257778833 | 0.445500444 |
| 2009 Q3 | 0.407103668 | 0.183825838 | 0.409070494 |
| 2009 Q4 | 0.413267283 | 0.178517729 | 0.408214987 |
| 2010 Q1 | 0.407510438 | 0.181782752 | 0.41070681 |
| 2010 Q2 | 0.413188523 | 0.184051838 | 0.402759639 |
| 2010 Q3 | 0.407988541 | 0.185287823 | 0.406723635 |
| 2010 Q4 | 0.408382851 | 0.179005507 | 0.412611642 |
| 2011 Q1 | 0.408894509 | 0.18048476 | 0.410620731 |

## Appendix 9: Quarterly Market Share of Total Deposits by Ownership Type Q1 2002 – Q1 2011

| Quarterly Market Share of Deposits Assets by Ownership Type Q1 2002 - Q1 2011 | | | |
|---|---|---|---|
| | Public Ownership | Foreign Ownership | Private Domestic |
| 2002 Q1 | 0.454932411 | 0.207609375 | 0.337458214 |
| 2002 Q2 | 0.443931354 | 0.219477193 | 0.336591453 |
| 2002 Q3 | 0.449586113 | 0.215346882 | 0.335067006 |
| 2002 Q4 | 0.444194621 | 0.209818979 | 0.345986401 |
| 2003 Q1 | 0.443290187 | 0.212313663 | 0.34439615 |
| 2003 Q2 | 0.45675947 | 0.201050685 | 0.342189845 |
| 2003 Q3 | 0.455346025 | 0.19971497 | 0.344939005 |
| 2003 Q4 | 0.45890677 | 0.198417194 | 0.342676037 |
| 2004 Q1 | 0.450775804 | 0.206492514 | 0.342731682 |
| 2004 Q2 | 0.443043933 | 0.210024054 | 0.346932013 |
| 2004 Q3 | 0.436486027 | 0.217782989 | 0.345730984 |
| 2004 Q4 | 0.428975593 | 0.228353232 | 0.342671175 |
| 2005 Q1 | 0.427437919 | 0.231336207 | 0.341225874 |
| 2005 Q2 | 0.421964171 | 0.238575844 | 0.339459986 |
| 2005 Q3 | 0.422439035 | 0.241522781 | 0.336038184 |
| 2005 Q4 | 0.421503608 | 0.237547561 | 0.340948832 |
| 2006 Q1 | 0.421765162 | 0.240837617 | 0.337397222 |
| 2006 Q2 | 0.412665183 | 0.246951356 | 0.340383461 |
| 2006 Q3 | 0.421263954 | 0.23308772 | 0.345648325 |
| 2006 Q4 | 0.423061656 | 0.234064271 | 0.342874073 |
| 2007 Q1 | 0.421247948 | 0.23372802 | 0.345024032 |
| 2007 Q2 | 0.418621379 | 0.237421637 | 0.343956984 |
| 2007 Q3 | 0.420354671 | 0.237071252 | 0.342574076 |
| 2007 Q4 | 0.420997087 | 0.229817143 | 0.34918577 |
| 2008 Q1 | 0.41871763 | 0.230901347 | 0.350381022 |
| 2008 Q2 | 0.395570044 | 0.2466237 | 0.357806256 |
| 2008 Q3 | 0.391748882 | 0.236136194 | 0.372114924 |
| 2008 Q4 | 0.395923752 | 0.176183634 | 0.427892614 |
| 2009 Q1 | 0.401763039 | 0.172877559 | 0.425359402 |
| 2009 Q2 | 0.308263495 | 0.167984999 | 0.523751506 |
| 2009 Q3 | 0.432731555 | 0.183334558 | 0.383933887 |
| 2009 Q4 | 0.437257524 | 0.175031372 | 0.387711105 |
| 2010 Q1 | 0.445274811 | 0.171280165 | 0.383445024 |
| 2010 Q2 | 0.44007181 | 0.166829013 | 0.393099177 |
| 2010 Q3 | 0.434402519 | 0.170816046 | 0.394781435 |
| 2010 Q4 | 0.439323595 | 0.170245114 | 0.390431291 |
| 2011 Q1 | 0.440904715 | 0.163969708 | 0.395125576 |

## Appendix 10: Market Share of Total Loans by Ownership Type Q1 2002 – Q1 2011

| Quarterly Market Share of Total Loans by Ownership Type Q1 2002 - Q1 2011 | | | |
|---|---|---|---|
| | Public Ownership | Foreign Ownership | Private Domestic |
| 2002 Q1 | 0.246192874 | 0.287746277 | 0.46606085 |
| 2002 Q2 | 0.247116057 | 0.286611518 | 0.466272424 |
| 2002 Q3 | 0.239855981 | 0.285465552 | 0.474678467 |
| 2002 Q4 | 0.247154369 | 0.254673899 | 0.498171732 |
| 2003 Q1 | 0.255122479 | 0.24681724 | 0.498060281 |
| 2003 Q2 | 0.263777683 | 0.22772375 | 0.508498568 |
| 2003 Q3 | 0.268895265 | 0.226080737 | 0.505023998 |
| 2003 Q4 | 0.267206421 | 0.221595772 | 0.511197806 |
| 2004 Q1 | 0.267185043 | 0.223298388 | 0.509516569 |
| 2004 Q2 | 0.267501073 | 0.224553666 | 0.507945261 |
| 2004 Q3 | 0.263183257 | 0.229575666 | 0.507241077 |
| 2004 Q4 | 0.265903072 | 0.229934489 | 0.504162439 |
| 2005 Q1 | 0.26834481 | 0.231419484 | 0.500235706 |
| 2005 Q2 | 0.270060243 | 0.237336434 | 0.492603323 |
| 2005 Q3 | 0.261743482 | 0.241831515 | 0.496425003 |
| 2005 Q4 | 0.261093484 | 0.240642077 | 0.498264439 |
| 2006 Q1 | 0.263445971 | 0.239181661 | 0.497372369 |
| 2006 Q2 | 0.26765783 | 0.238964723 | 0.493377447 |
| 2006 Q3 | 0.268477436 | 0.229368092 | 0.502154472 |
| 2006 Q4 | 0.27467167 | 0.235965172 | 0.489363158 |
| 2007 Q1 | 0.276197271 | 0.235451172 | 0.488351557 |
| 2007 Q2 | 0.27578984 | 0.23602258 | 0.48818758 |
| 2007 Q3 | 0.269340184 | 0.239970076 | 0.490689741 |
| 2007 Q4 | 0.266487678 | 0.23359653 | 0.499915792 |
| 2008 Q1 | 0.270300561 | 0.235516144 | 0.494183295 |
| 2008 Q2 | 0.279344872 | 0.227497558 | 0.49315757 |
| 2008 Q3 | 0.276595307 | 0.225949581 | 0.497455112 |
| 2008 Q4 | 0.29012456 | 0.170565289 | 0.539310151 |
| 2009 Q1 | 0.30000275 | 0.165868766 | 0.534128484 |
| 2009 Q2 | 0.25141508 | 0.258434339 | 0.490150581 |
| 2009 Q3 | 0.447708404 | 0.162715334 | 0.389576262 |
| 2009 Q4 | 0.454055849 | 0.159817397 | 0.386126753 |
| 2010 Q1 | 0.450616494 | 0.15493713 | 0.394446376 |
| 2010 Q2 | 0.453053916 | 0.153123687 | 0.393822397 |
| 2010 Q3 | 0.445928422 | 0.152946829 | 0.401124749 |
| 2010 Q4 | 0.442902387 | 0.153272206 | 0.403825407 |
| 2011 Q1 | 0.439783976 | 0.151324884 | 0.40889114 |

## Appendix 11: Descriptive Statistics for Regression of Concentration Measures on Competition 2002-2010

**Descriptive Statistics – Yearly Average**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| CR3 Loans | 9 | .32652 | .46976 | .3823524 | .05425772 |
| CR5 Loans | 9 | .45882 | .67930 | .5426691 | .08021400 |
| CR 10 Loans | 9 | .60226 | .84494 | .7085178 | .08148456 |
| HI Loans | 9 | .05556 | .10924 | .0761579 | .01935773 |
| CR3 Deposits | 9 | .41749 | .53348 | .4823897 | .03982784 |
| CR5 Deposits | 9 | .59607 | .72854 | .6408961 | .04356064 |
| CR10 Deposits | 9 | .74666 | .86944 | .8058719 | .03712751 |
| HI Deposits | 9 | .095572 | .133415 | .10752964 | .014796093 |
| CR3 Assets | 9 | .34998 | .47700 | .3931250 | .04758432 |
| CR5 Assets | 9 | .47933 | .67453 | .5518361 | .07389767 |
| CR10 Assets | 9 | .62938 | .84888 | .7160694 | .07660308 |
| HI Assets | 9 | .05882 | .10634 | .0753150 | .01817078 |
| Branches | 9 | 16940 | 19595 | 18049.06 | 919.456 |
| H-Statistic | 9 | .30900 | 1.23900 | .8531789 | .26567502 |
| Valid N (listwise) | 9 | | | | |

## Appendix 12: Correlation Matrix for Concentration Measures and H-Statistics

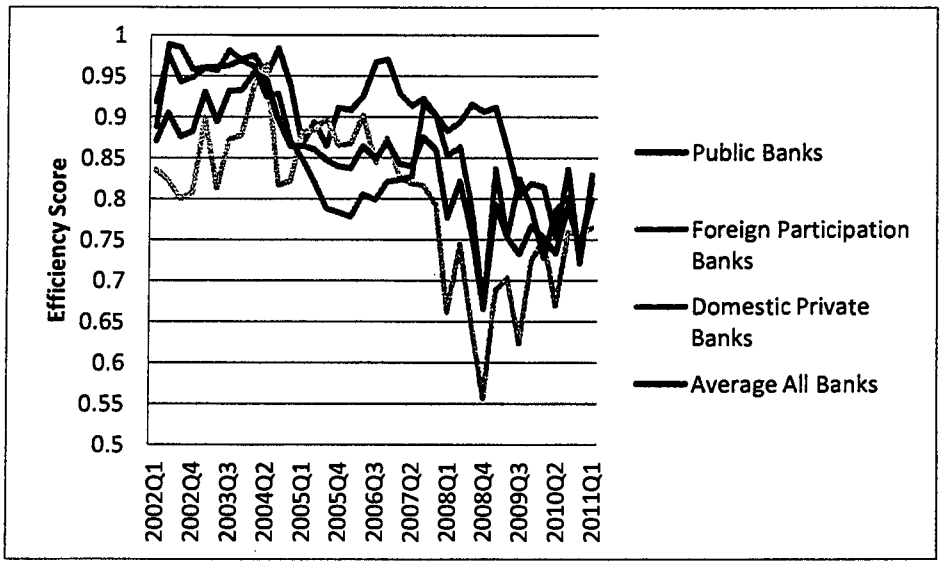
| | H-Statistic | CR5 Assets | CR10 Assets | CR5 Deposits | CR10 Deposits | CR5 Loans | CR 10 Loans | HI Assets | HI Deposits | HI Loans | Branches |
|---|---|---|---|---|---|---|---|---|---|---|---|
| H-Statistic | 1 | -.546 | -.458 | -.682 | -.675 | -.474 | -.362 | -.581 | -.672 | -.472 | -.296 |
| Sig. (2-tailed) | | .128 | .215 | .043 | .046 | .197 | .338 | .101 | .047 | .199 | .440 |
| CR5 Assets | -.546 | 1 | .980 | .913 | .939 | .990 | .929 | .997 | .936 | .983 | .912 |
| Sig. (2-tailed) | .128 | | .000 | .001 | .000 | .000 | .000 | .000 | .000 | .000 | .001 |
| CR10 Assets | -.458 | .980 | 1 | .823 | .924 | .996 | .983 | .975 | .875 | .999 | .965 |
| Sig. (2-tailed) | .215 | .000 | | .006 | .000 | .000 | .000 | .000 | .002 | .000 | .000 |
| CR5 Deposits | -.682 | .913 | .823 | 1 | .833 | .861 | .718 | .913 | .938 | .840 | .696 |
| Sig. (2-tailed) | .043 | .001 | .006 | | .005 | .003 | .029 | .001 | .000 | .005 | .037 |
| CR10 Deposits | -.675 | .939 | .924 | .833 | 1 | .923 | .887 | .937 | .854 | .921 | .857 |
| Sig. (2-tailed) | .046 | .000 | .000 | .005 | | .000 | .001 | .000 | .003 | .000 | .003 |
| CR5 Loans | -.474 | .990 | .996 | .861 | .923 | 1 | .969 | .983 | .891 | .998 | .953 |
| Sig. (2-tailed) | .197 | .000 | .000 | .003 | .000 | | .000 | .000 | .001 | .000 | .000 |
| CR 10 Loans | -.362 | .929 | .983 | .718 | .887 | .969 | 1 | .919 | .777 | .979 | .984 |
| Sig. (2-tailed) | .338 | .000 | .000 | .029 | .001 | .000 | | .000 | .014 | .000 | .000 |
| HI Assets | -.581 | .997 | .975 | .913 | .937 | .983 | .919 | 1 | .956 | .979 | .894 |
| Sig. (2-tailed) | .101 | .000 | .000 | .001 | .000 | .000 | .000 | | .000 | .000 | .001 |
| HI Deposits | -.672 | .936 | .875 | .938 | .854 | .891 | .777 | .956 | 1 | .884 | .736 |
| Sig. (2-tailed) | .047 | .000 | .002 | .000 | .003 | .001 | .014 | .000 | | .002 | .024 |
| HI Loans | -.472 | .983 | .999 | .840 | .921 | .998 | .979 | .979 | .884 | 1 | .959 |
| Sig. (2-tailed) | .199 | .000 | .000 | .005 | .000 | .000 | .000 | .000 | .002 | | .000 |
| Branches | -.296 | .912 | .965 | .696 | .857 | .953 | .984 | .894 | .736 | .959 | 1 |
| Sig. (2-tailed) | .440 | .001 | .000 | .037 | .003 | .000 | .000 | .001 | .024 | .000 | |

## Appendix 13: Quarterly Average DEA Efficiency Scores by Ownership Type Q1 2002 – Q1 2011

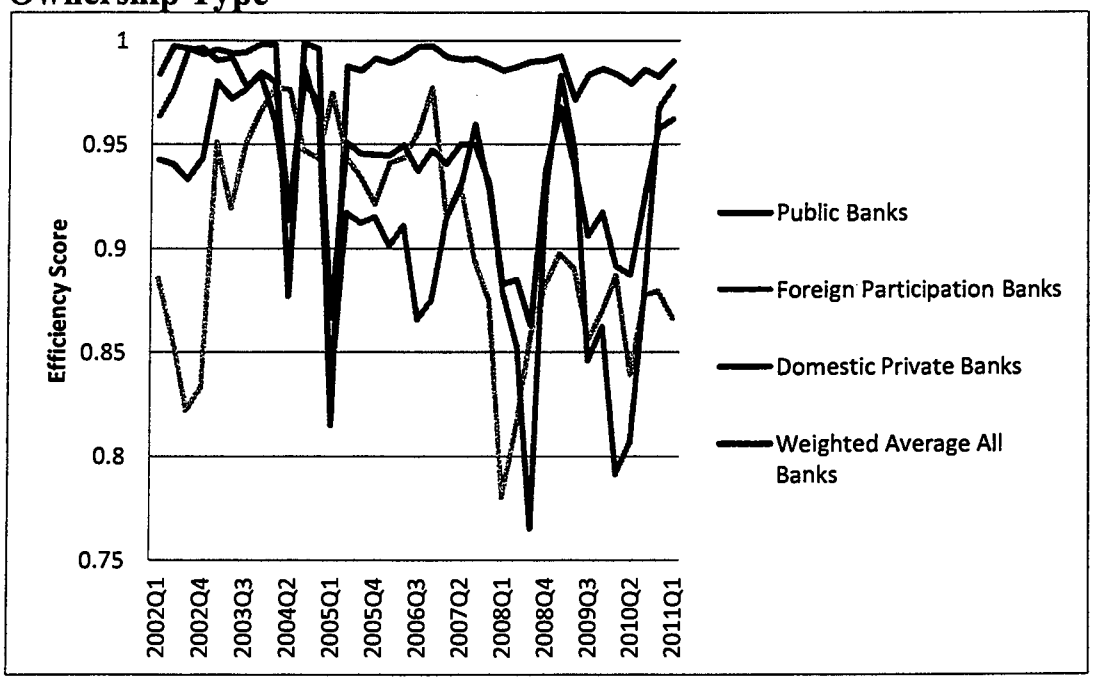
| Average Quarterly DEA Efficiency Scores by Ownership Type 2002 Q1 to 2011 Q1 | | | | |
|---|---|---|---|---|
| | **Public Banks** | **Foreign Participation Banks** | **Domestic Private Banks** | **Average All Banks** |
| **2002Q1** | 0.888252778 | 0.83548276 | 0.918169688 | 0.87144118 |
| **2002Q2** | 0.988973556 | 0.823096708 | 0.976543294 | 0.90512638 |
| **2002Q3** | 0.985313444 | 0.800520346 | 0.943012667 | 0.8765308 |
| **2002Q4** | 0.9581131 | 0.807591583 | 0.948649125 | 0.8828343 |
| **2003Q1** | 0.960363556 | 0.89957225 | 0.959238882 | 0.93080134 |
| **2003Q2** | 0.9610606 | 0.813091 | 0.957009889 | 0.89449572 |
| **2003Q3** | 0.9631701 | 0.872751905 | 0.980966211 | 0.93195698 |
| **2003Q4** | 0.9706007 | 0.87845795 | 0.96875555 | 0.93300554 |
| **2004Q1** | 0.9756124 | 0.937614476 | 0.961873579 | 0.95443252 |
| **2004Q2** | 0.9509959 | 0.963972579 | 0.924749476 | 0.94490354 |
| **2004Q3** | 0.9836153 | 0.816743632 | 0.928521143 | 0.89706452 |
| **2004Q4** | 0.9381387 | 0.8217054 | 0.87094845 | 0.86468928 |
| **2005Q1** | 0.8664809 | 0.88108045 | 0.8489927 | 0.86532544 |
| **2005Q2** | 0.8936272 | 0.88421615 | 0.8209831 | 0.86080514 |
| **2005Q3** | 0.8648478 | 0.89823205 | 0.7882758 | 0.8475727 |
| **2005Q4** | 0.9111517 | 0.865423105 | 0.783958762 | 0.8403538 |
| **2006Q1** | 0.908806444 | 0.8676671 | 0.778393095 | 0.8375771 |
| **2006Q2** | 0.9251059 | 0.901933722 | 0.805843409 | 0.86428842 |
| **2006Q3** | 0.9669937 | 0.844595611 | 0.798504091 | 0.84879496 |
| **2006Q4** | 0.9708121 | 0.874373556 | 0.821162864 | 0.87024856 |
| **2007Q1** | 0.928807333 | 0.825392381 | 0.82381545 | 0.8433763 |
| **2007Q2** | 0.913623333 | 0.819178333 | 0.827536478 | 0.84002318 |
| **2007Q3** | 0.922445111 | 0.816731238 | 0.91651815 | 0.8756745 |
| **2007Q4** | 0.902039778 | 0.792484105 | 0.901657773 | 0.86024054 |
| **2008Q1** | 0.883259 | 0.661267476 | 0.85275935 | 0.7778227 |
| **2008Q2** | 0.894040333 | 0.74443465 | 0.863994857 | 0.82157896 |
| **2008Q3** | 0.915478667 | 0.647099316 | 0.788654455 | 0.75769186 |
| **2008Q4** | 0.906065667 | 0.55544015 | 0.667930905 | 0.66579886 |
| **2009Q1** | 0.912202111 | 0.686661158 | 0.836317409 | 0.79310728 |
| **2009Q2** | 0.860995 | 0.702911 | 0.752068 | 0.75299502 |
| **2009Q3** | 0.803929333 | 0.623776955 | 0.824382579 | 0.73243452 |
| **2009Q4** | 0.819094667 | 0.724270333 | 0.78903475 | 0.76724448 |
| **2010Q1** | 0.814125667 | 0.7497132 | 0.728321524 | 0.75232294 |
| **2010Q2** | 0.753232 | 0.6696006 | 0.785566714 | 0.73336002 |
| **2010Q3** | 0.835791222 | 0.75954135 | 0.801686143 | 0.79096714 |
| **2010Q4** | 0.721330111 | 0.7570144 | 0.736884524 | 0.74213668 |
| **2011Q1** | 0.829238889 | 0.7641946 | 0.819354238 | 0.79906962 |
| **Average** | **0.905363657** | **0.799421066** | **0.851308715** | **0.838597103** |

## Appendix 14: Quarterly Average and Weighted Average DEA Efficiency Scores by Ownership Graphs Q1 2002 – Q1 2011

### Appendix 14a: Average Quarterly DEA Efficiency Scores by Ownership Type




### Appendix 14b: Weighted Average Quarterly DEA Efficiency Scores by Ownership Type



## Appendix 15: Weighted Average Quarterly DEA Efficiency Scores by Ownership Q1 2002 – Q1 2011

| Weighted Average Quarterly DEA Efficiency Scores by Ownership Type 2002 Q1 – 2011Q1 | | | | |
|---|---|---|---|---|
| | **Public Banks** | **Foreign Participation Banks** | **Domestic Private Banks** | **Weighted Average All Banks** |
| **2002Q1** | 0.983679175 | 0.885749499 | 0.963595459 | 0.942668495 |
| **2002Q2** | 0.997312021 | 0.858362966 | 0.975720681 | 0.94080513 |
| **2002Q3** | 0.99632619 | 0.82209844 | 0.99563901 | 0.933293034 |
| **2002Q4** | 0.993259359 | 0.833117809 | 0.996480756 | 0.943126103 |
| **2003Q1** | 0.995629226 | 0.951069087 | 0.990536287 | 0.980350652 |
| **2003Q2** | 0.993754458 | 0.919334034 | 0.991559403 | 0.972042463 |
| **2003Q3** | 0.99434193 | 0.950209749 | 0.978054207 | 0.976742266 |
| **2003Q4** | 0.998368284 | 0.966376361 | 0.982887351 | 0.984783536 |
| **2004Q1** | 0.998122194 | 0.977079232 | 0.961458886 | 0.980450177 |
| **2004Q2** | 0.877136714 | 0.976596439 | 0.913658862 | 0.917475421 |
| **2004Q3** | 0.999035203 | 0.947309857 | 0.986876779 | 0.980402562 |
| **2004Q4** | 0.995882864 | 0.943381733 | 0.964547315 | 0.970567251 |
| **2005Q1** | 0.814850955 | 0.974707655 | 0.832154968 | 0.866663039 |
| **2005Q2** | 0.987471658 | 0.943748274 | 0.91747487 | 0.950901716 |
| **2005Q3** | 0.985559486 | 0.934055969 | 0.912273861 | 0.945579442 |
| **2005Q4** | 0.991434139 | 0.921689907 | 0.915153296 | 0.945141474 |
| **2006Q1** | 0.989139015 | 0.94127451 | 0.901095061 | 0.944748944 |
| **2006Q2** | 0.992203271 | 0.943421047 | 0.911045885 | 0.949634224 |
| **2006Q3** | 0.996957196 | 0.955923243 | 0.865871206 | 0.937259474 |
| **2006Q4** | 0.997305449 | 0.977177097 | 0.875194358 | 0.947096422 |
| **2007Q1** | 0.99206038 | 0.915778205 | 0.914333499 | 0.94075622 |
| **2007Q2** | 0.990900597 | 0.930782959 | 0.929060633 | 0.950042841 |
| **2007Q3** | 0.991505037 | 0.89440105 | 0.959657968 | 0.949780765 |
| **2007Q4** | 0.988641113 | 0.875169155 | 0.927769431 | 0.931465106 |
| **2008Q1** | 0.985571857 | 0.780334972 | 0.879312392 | 0.882941625 |
| **2008Q2** | 0.98751629 | 0.815938353 | 0.852855569 | 0.884931572 |
| **2008Q3** | 0.989959644 | 0.858421775 | 0.765012893 | 0.862991389 |
| **2008Q4** | 0.990408676 | 0.882815804 | 0.927712577 | 0.937836938 |
| **2009Q1** | 0.992501709 | 0.897410481 | 0.983082892 | 0.967732239 |
| **2009Q2** | 0.971412 | 0.8901 | 0.947158 | 0.939300779 |
| **2009Q3** | 0.983481778 | 0.855788554 | 0.845765213 | 0.906328243 |
| **2009Q4** | 0.986492544 | 0.86979586 | 0.862238149 | 0.91730125 |
| **2010Q1** | 0.98376484 | 0.887130251 | 0.791470904 | 0.891613093 |
| **2010Q2** | 0.979287503 | 0.839112363 | 0.806759574 | 0.8874628 |
| **2010Q3** | 0.98596924 | 0.877564939 | 0.879125789 | 0.924380875 |
| **2010Q4** | 0.982542531 | 0.879630256 | 0.967380623 | 0.957432459 |
| **2011Q1** | 0.990241579 | 0.866525578 | 0.97779427 | 0.962118075 |
| **Average** | **0.983014737** | **0.902014915** | **0.920108267** | **0.937949948** |

## Appendix 16: Average Quarterly DEA Efficiency Scores by Bank Size Q1 2002 – Q1 2011

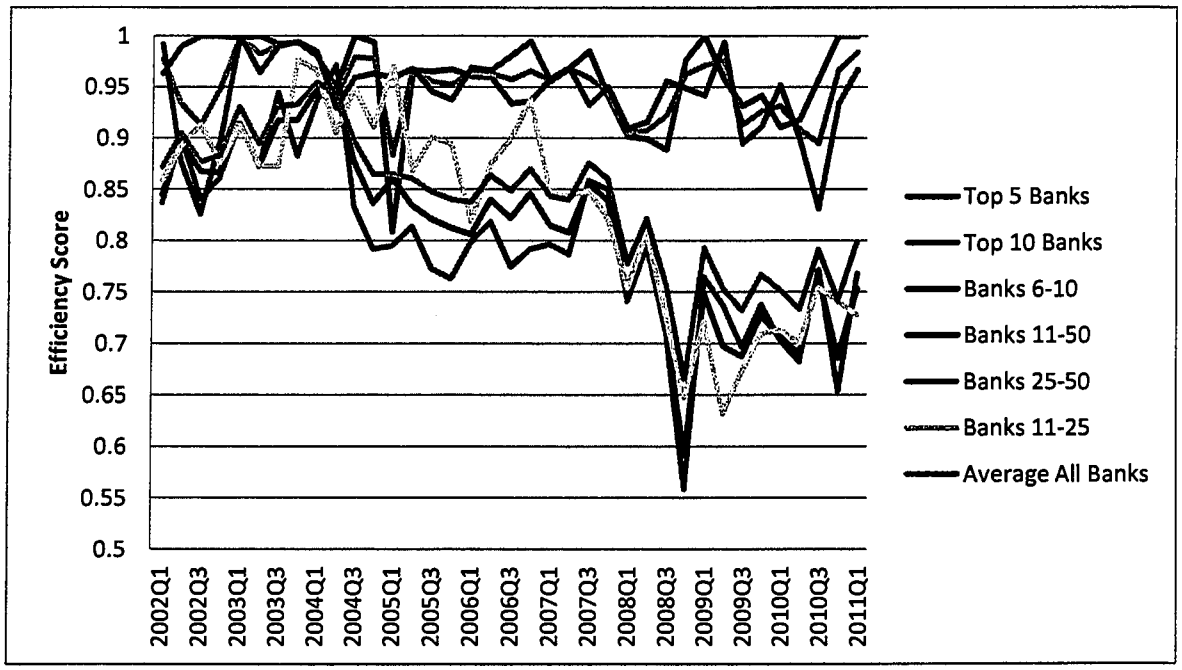
| Average Quarterly DEA Efficiency Scores by Bank Size 2002 Q1 – 2011 Q1 | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Top 5 Banks** | **Top 10 Banks** | **Banks 6-10** | **Banks 11-50** | **Banks 25-50** | **Banks 11-25** | **Average All Banks** |
| **2002Q1** | 0.962841 | 0.9772441 | 0.9916472 | 0.84499045 | 0.83664556 | 0.8588986 | 0.87144118 |
| **2002Q2** | 0.989319 | 0.9330897 | 0.8768604 | 0.89813555 | 0.90136028 | 0.892761 | 0.90512638 |
| **2002Q3** | 1 | 0.9129589 | 0.8259178 | 0.8674237 | 0.84016856 | 0.912849133 | 0.8765308 |
| **2002Q4** | 1 | 0.9475499 | 0.8950998 | 0.8666554 | 0.86141892 | 0.875382867 | 0.8828343 |
| **2003Q1** | 0.99799 | 0.9987074 | 0.9994248 | 0.9138248 | 0.91455596 | 0.912606267 | 0.93080134 |
| **2003Q2** | 1 | 0.9821312 | 0.9642624 | 0.87258685 | 0.87226704 | 0.873119867 | 0.89449572 |
| **2003Q3** | 0.9913106 | 0.990432 | 0.9895534 | 0.9173382 | 0.9444824 | 0.872097933 | 0.93195698 |
| **2003Q4** | 0.9937408 | 0.9938558 | 0.9939708 | 0.9177929 | 0.88258264 | 0.976476867 | 0.93300554 |
| **2004Q1** | 0.9805354 | 0.9826149 | 0.9846944 | 0.9473869 | 0.9357886 | 0.966717467 | 0.95443252 |
| **2004Q2** | 0.9492746 | 0.9392743 | 0.929274 | 0.94631085 | 0.97127704 | 0.904700533 | 0.94490354 |
| **2004Q3** | 1 | 0.9792567 | 0.9585134 | 0.8765164 | 0.83285132 | 0.949291733 | 0.89706452 |
| **2004Q4** | 0.9934674 | 0.9782297 | 0.962992 | 0.83630417 | 0.79187168 | 0.910358333 | 0.86468928 |
| **2005Q1** | 0.8082886 | 0.8837263 | 0.959164 | 0.86072522 | 0.7950208 | 0.9702326 | 0.86532544 |
| **2005Q2** | 0.9662286 | 0.9669019 | 0.9675752 | 0.83428095 | 0.81392292 | 0.868211 | 0.86080514 |
| **2005Q3** | 0.965303 | 0.9552262 | 0.9451494 | 0.82065932 | 0.77241828 | 0.901061067 | 0.8475727 |
| **2005Q4** | 0.9671784 | 0.9521321 | 0.9370858 | 0.81240925 | 0.7634192 | 0.894059267 | 0.8403538 |
| **2006Q1** | 0.9599812 | 0.9646163 | 0.9692514 | 0.8058173 | 0.79827156 | 0.818393533 | 0.8375771 |
| **2006Q2** | 0.959693 | 0.9629429 | 0.9661928 | 0.8396248 | 0.81829604 | 0.875172733 | 0.86428842 |
| **2006Q3** | 0.9339562 | 0.9573341 | 0.980712 | 0.8216601 | 0.77480004 | 0.8997604 | 0.84879496 |
| **2006Q4** | 0.9361754 | 0.9654784 | 0.9947814 | 0.8464411 | 0.7916972 | 0.937680933 | 0.87024856 |
| **2007Q1** | 0.9574906 | 0.9563878 | 0.955285 | 0.8151234 | 0.79658636 | 0.846018533 | 0.8433763 |
| **2007Q2** | 0.968676 | 0.968332 | 0.967988 | 0.8079459 | 0.78650168 | 0.843686467 | 0.84002318 |
| **2007Q3** | 0.9849536 | 0.9587606 | 0.9325676 | 0.8549029 | 0.85850076 | 0.848906667 | 0.8756745 |
| **2007Q4** | 0.9401816 | 0.9449019 | 0.9496222 | 0.8390752 | 0.84972904 | 0.8213188 | 0.86024054 |
| **2008Q1** | 0.9015182 | 0.9054402 | 0.9093622 | 0.7459183 | 0.74135804 | 0.7535188 | 0.7778227 |
| **2008Q2** | 0.8993136 | 0.9075686 | 0.9158236 | 0.80008155 | 0.79537884 | 0.8079194 | 0.82157896 |
| **2008Q3** | 0.888762 | 0.9222475 | 0.955733 | 0.71655295 | 0.71088428 | 0.726000733 | 0.75769186 |
| **2008Q4** | 0.9759054 | 0.9623084 | 0.9487114 | 0.5916714 | 0.55821908 | 0.647425467 | 0.66579886 |
| **2009Q1** | 1 | 0.9709986 | 0.9419972 | 0.74863445 | 0.76485192 | 0.721605333 | 0.79310728 |
| **2009Q2** | 0.9573876 | 0.9753685 | 0.9933494 | 0.69740165 | 0.736605 | 0.632062733 | 0.75299502 |
| **2009Q3** | 0.9312892 | 0.9128353 | 0.8943814 | 0.6873343 | 0.6960978 | 0.672728533 | 0.73243452 |
| **2009Q4** | 0.9411606 | 0.9264196 | 0.9116786 | 0.7274507 | 0.7379626 | 0.709930867 | 0.76724448 |
| **2010Q1** | 0.9105576 | 0.9311262 | 0.9516948 | 0.7076221 | 0.70406612 | 0.7135488 | 0.75232294 |
| **2010Q2** | 0.91805 | 0.9086263 | 0.8992026 | 0.68954345 | 0.68274104 | 0.7008808 | 0.73336002 |
| **2010Q3** | 0.9583468 | 0.8948466 | 0.8313464 | 0.7649972 | 0.77139372 | 0.754336533 | 0.79096714 |
| **2010Q4** | 1 | 0.9664751 | 0.9329502 | 0.6860520 | 0.653013 | 0.7411172 | 0.74213668 |
| **2011Q1** | 1 | 0.9834179 | 0.9668358 | 0.75298255 | 0.76799672 | 0.727958933 | 0.79906962 |
| **Average** | **0.959158** | **0.951885** | **0.94461221** | **0.8102750** | **0.797973028** | **0.83077829** | **0.838597103** |

## Appendix 17: Weighted Average DEA Efficiency Scores by Bank Size Q1 2002 – Q1 2011

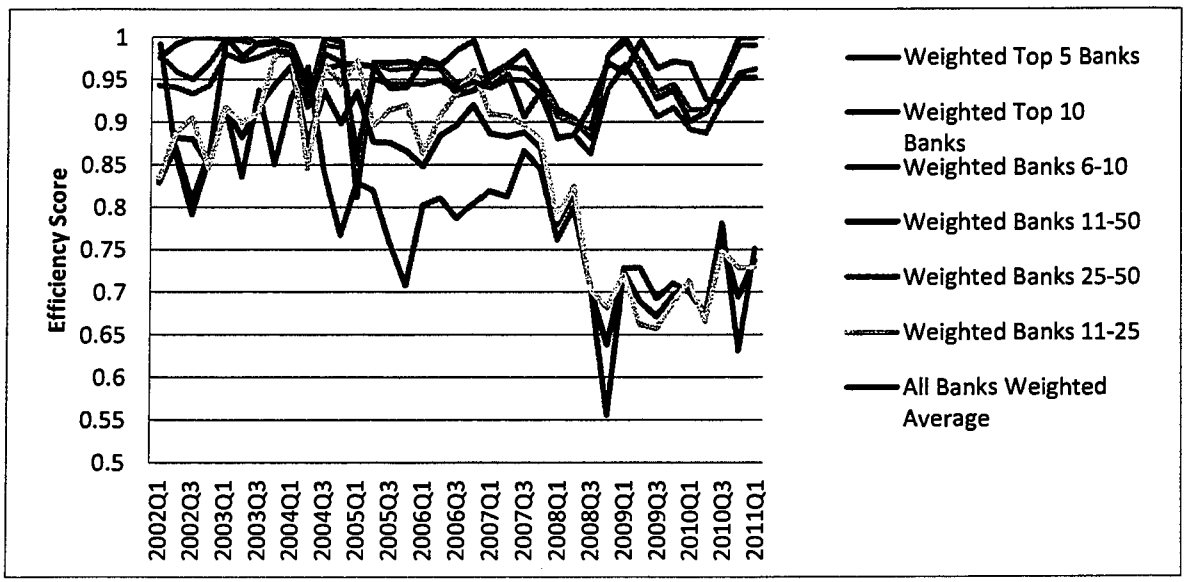
| Weighted Average Quarterly DEA Efficiency Scores by Bank Size 2002 Q1 – 2011 Q1 | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Weighted Top 5 Banks** | **Weighted Top 10 Banks** | **Weighted Banks 6-10** | **Weighted Banks 11-50** | **Weighted Banks 25-50** | **Weighted Banks 11-25** | **All Banks Weighted Average** |
| **2002Q1** | 0.9758404 | 0.97980487 | 0.9918478 | 0.8333282 | 0.8289406 | 0.834793 | 0.9426684 |
| **2002Q2** | 0.9915265 | 0.9594769 | 0.8641743 | 0.8821006 | 0.8704664 | 0.8861435 | 0.94080513 |
| **2002Q3** | 1 | 0.9498922 | 0.7913875 | 0.88034922 | 0.8078845 | 0.9051193 | 0.9332930 |
| **2002Q4** | 1 | 0.9691742 | 0.8565935 | 0.84997061 | 0.8617551 | 0.8461087 | 0.9431261 |
| **2003Q1** | 0.9980627 | 0.9983006 | 0.9991630 | 0.91721382 | 0.91729325 | 0.91718643 | 0.98035065 |
| **2003Q2** | 1 | 0.9950505 | 0.9764550 | 0.88196227 | 0.836049509 | 0.89875696 | 0.97204246 |
| **2003Q3** | 0.9910011 | 0.9914832 | 0.9933445 | 0.91844620 | 0.936626173 | 0.91193711 | 0.97674226 |
| **2003Q4** | 0.9934335 | 0.9940075 | 0.9960274 | 0.94393345 | 0.850213149 | 0.97985364 | 0.98478353 |
| **2004Q1** | 0.9824417 | 0.9839516 | 0.9890153 | 0.96620285 | 0.929465769 | 0.97870791 | 0.98045017 |
| **2004Q2** | 0.9240923 | 0.9286286 | 0.9432124 | 0.87394713 | 0.964302689 | 0.84576235 | 0.91747542 |
| **2004Q3** | 1 | 0.9911173 | 0.9619419 | 0.93687960 | 0.842393897 | 0.96835836 | 0.98040256 |
| **2004Q4** | 0.9944870 | 0.98815139 | 0.9681924 | 0.89873778 | 0.766998003 | 0.94383720 | 0.97056725 |
| **2005Q1** | 0.8116104 | 0.8497425 | 0.9683218 | 0.93578439 | 0.829360945 | 0.97214878 | 0.86666303 |
| **2005Q2** | 0.9696535 | 0.9684298 | 0.9648435 | 0.87726499 | 0.819450839 | 0.89594108 | 0.95090171 |
| **2005Q3** | 0.9699897 | 0.9620647 | 0.9398016 | 0.87635272 | 0.758268331 | 0.91471010 | 0.94557944 |
| **2005Q4** | 0.9713987 | 0.9633481 | 0.9411982 | 0.86644434 | 0.707855166 | 0.91976708 | 0.94514147 |
| **2006Q1** | 0.9644043 | 0.9671329 | 0.9746280 | 0.84783832 | 0.802195423 | 0.86279479 | 0.9447489 |
| **2006Q2** | 0.9635759 | 0.96445981 | 0.9669117 | 0.88456133 | 0.810400273 | 0.90779898 | 0.9496342 |
| **2006Q3** | 0.9321951 | 0.94558763 | 0.9841119 | 0.89683048 | 0.787203557 | 0.93378467 | 0.9372594 |
| **2006Q4** | 0.9367283 | 0.9523757 | 0.9957208 | 0.92025376 | 0.803304431 | 0.96094134 | 0.9470964 |
| **2007Q1** | 0.955992595 | 0.952328466 | 0.94187845 | 0.88717326 | 0.81897292 | 0.90949016 | 0.94075622 |
| **2007Q2** | 0.9678439 | 0.9648359 | 0.95665474 | 0.883141947 | 0.812468456 | 0.90798856 | 0.95004284 |
| **2007Q3** | 0.9829818 | 0.9633048 | 0.9063340 | 0.8884558 | 0.86666815 | 0.8936726 | 0.9497807 |
| **2007Q4** | 0.94810035 | 0.9453493 | 0.9374891 | 0.8689315 | 0.84368840 | 0.8787746 | 0.9314651 |
| **2008Q1** | 0.9155161 | 0.9067992 | 0.8808618 | 0.7793726 | 0.76129290 | 0.7864331 | 0.8829416 |
| **2008Q2** | 0.9035484 | 0.8988019 | 0.8851845 | 0.8170646 | 0.79999396 | 0.8245907 | 0.8849315 |
| **2008Q3** | 0.8814918 | 0.8899348 | 0.9209533 | 0.7051170 | 0.70791074 | 0.7038539 | 0.8629913 |
| **2008Q4** | 0.9780075 | 0.9769122 | 0.9700295 | 0.6390046 | 0.55497503 | 0.6815847 | 0.9378369 |
| **2009Q1** | 1 | 0.9946243 | 0.9578433 | 0.7233435 | 0.72812948 | 0.7204222 | 0.9677322 |
| **2009Q2** | 0.9638161 | 0.97048925 | 0.9950717 | 0.6891728 | 0.72876805 | 0.6622503 | 0.9393007 |
| **2009Q3** | 0.9277406 | 0.9351785 | 0.9632148 | 0.6718397 | 0.69285513 | 0.6575684 | 0.9063282 |
| **2009Q4** | 0.9375333 | 0.9445241 | 0.9715044 | 0.6964785 | 0.71062816 | 0.6874607 | 0.917301 |
| **2010Q1** | 0.9008002 | 0.9148236 | 0.9687343 | 0.7083222 | 0.69955973 | 0.7137776 | 0.8916130 |
| **2010Q2** | 0.9114655 | 0.9147957 | 0.9274233 | 0.6693783 | 0.6752054 | 0.6657153 | 0.8874628 |
| **2010Q3** | 0.9517585 | 0.9457420 | 0.9227277 | 0.7603667 | 0.7803711 | 0.7483793 | 0.9243808 |
| **2010Q4** | 1 | 0.9905152 | 0.9523752 | 0.6943291 | 0.6312582 | 0.7290806 | 0.9574324 |
| **2011Q1** | 1 | 0.9906437 | 0.9527128 | 0.7375688 | 0.7514174 | 0.7294379 | 0.962118 |
| **Average** | **0.959379** | **0.9568049** | **0.9480510** | **0.8299314** | **0.791745** | **0.8429088** | **0.9379499** |

## Appendix 18: Average and Weighted Average Quarterly DEA Efficiency Scores by Bank Size Graphs Q1 2002 – Q1 2011

### Appendix 18a: Average Quarterly DEA Efficiency Scores by Bank Size




### Appendix 14b: Weighted Average Quarterly DEA Efficiency Scores by Bank Size



## Appendix 19: Correlation Matrix for 2002-2011 Panzar Rosse Model B[45]

| | Total Revenue | Price of Funds | Price of Labor | Price of Capital | Total Deposits | Risk Factor 1 | Too Big to Fail | Efficiency | Public Bank | Foreign Bank |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Revenue | 1.000 | .038 | .023 | -.075 | .838 | .089 | .692 | .119 | .177 | -.075 |
| Price of Funds | .038 | 1.000 | .111 | -.053 | -.154 | .110 | -.139 | -.111 | -.212 | .040 |
| Price of Labor | .023 | .111 | 1.000 | .048 | -.111 | -.088 | -.396 | -.292 | -.324 | .245 |
| Price of Capital | -.075 | -.053 | .048 | 1.000 | -.063 | -.016 | -.020 | -.095 | .078 | .023 |
| Total Deposits | .838 | -.154 | -.111 | -.063 | 1.000 | -.013 | .718 | .187 | .258 | -.237 |
| Risk Factor 1 | .089 | .110 | -.088 | -.016 | -.013 | 1.000 | .031 | -.059 | -.149 | -.216 |
| Too Big to Fail | .692 | -.139 | -.396 | -.020 | .718 | .031 | 1.000 | .250 | .465 | -.248 |
| Efficiency | .119 | -.111 | -.292 | -.095 | .187 | -.059 | .250 | 1.000 | .132 | -.136 |
| Public Bank | .177 | -.212 | -.324 | .078 | .258 | -.149 | .465 | .132 | 1.000 | -.371 |
| Foreign Bank | -.075 | .040 | .245 | .023 | -.237 | -.216 | -.248 | -.136 | -.371 | 1.000 |
| Total Revenue | . | .057 | .171 | .001 | .000 | .000 | .000 | .000 | .000 | .001 |
| Price of Funds | .057 | . | .000 | .013 | .000 | .000 | .000 | .000 | .000 | .046 |
| Price of Labor | .171 | .000 | . | .021 | .000 | .000 | .000 | .000 | .000 | .000 |
| Price of Capital | .001 | .013 | .021 | . | .004 | .250 | .196 | .000 | .000 | .165 |
| Total Deposits | .000 | .000 | .000 | .004 | . | .288 | .000 | .000 | .000 | .000 |
| Risk Factor 1 | .000 | .000 | .000 | .250 | .288 | . | .097 | .007 | .000 | .000 |
| Too Big to Fail | .000 | .000 | .000 | .196 | .000 | .097 | . | .000 | .000 | .000 |
| Efficiency | .000 | .000 | .000 | .000 | .000 | .007 | .000 | . | .000 | .000 |
| Public Bank | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | . | .000 |
| Foreign Bank | .001 | .046 | .000 | .165 | .000 | .000 | .000 | .000 | .000 | . |

[45] Sig. 1-tailed.

## Appendix 20: Correlation Matrix for 2002-2011 Panzar Rosse Model IR[46]

| | Interest Revenue | Price of Funds | Price of Labor | Price of Capital | Total Deposits | Risk Factor 1 | Too Big to Fail | Efficiency | Public Bank | Foreign Bank |
|---|---|---|---|---|---|---|---|---|---|---|
| Interest Revenue | 1.000 | .072 | .006 | -.083 | .841 | .108 | .680 | .148 | .153 | -.097 |
| Price of Funds | .072 | 1.000 | .126 | -.055 | -.166 | .090 | -.154 | -.109 | -.221 | .055 |
| Price of Labor | .006 | .126 | 1.000 | .047 | -.102 | -.074 | -.394 | -.300 | -.323 | .238 |
| Price of Capital | -.083 | -.055 | .047 | 1.000 | -.061 | -.017 | -.018 | -.097 | .079 | .020 |
| Total Deposits | .841 | -.166 | -.102 | -.061 | 1.000 | -.024 | .713 | .190 | .251 | -.226 |
| Risk Factor 1 | .108 | .090 | -.074 | -.017 | -.024 | 1.000 | .020 | -.057 | -.161 | -.207 |
| Too Big to Fail | .680 | -.154 | -.394 | -.018 | .713 | .020 | 1.000 | .257 | .465 | -.241 |
| Efficiency | .148 | -.109 | -.300 | -.097 | .190 | -.057 | .257 | 1.000 | .135 | -.140 |
| Public Bank | .153 | -.221 | -.323 | .079 | .251 | -.161 | .465 | .135 | 1.000 | -.369 |
| Foreign Bank | -.097 | .055 | .238 | .020 | -.226 | -.207 | -.241 | -.140 | -.369 | 1.000 |
| Interest Revenue | . | .001 | .405 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| Price of Funds | .001 | . | .000 | .011 | .000 | .000 | .000 | .000 | .000 | .011 |
| Price of Labor | .405 | .000 | . | .024 | .000 | .001 | .000 | .000 | .000 | .000 |
| Price of Capital | .000 | .011 | .024 | . | .006 | .242 | .229 | .000 | .000 | .200 |
| Total Deposits | .000 | .000 | .000 | .006 | . | .158 | .000 | .000 | .000 | .000 |
| Risk Factor 1 | .000 | .000 | .001 | .242 | .158 | . | .204 | .008 | .000 | .000 |
| Too Big to Fail | .000 | .000 | .000 | .229 | .000 | .204 | . | .000 | .000 | .000 |
| Efficiency | .000 | .000 | .000 | .000 | .000 | .008 | .000 | . | .000 | .000 |
| Public Bank | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | . | .000 |
| Foreign Bank | .000 | .011 | .000 | .200 | .000 | .000 | .000 | .000 | .000 | . |

[46] Sig. 1 tailed.

# Appendix 21: Correlation Matrix for 2002-2011 Model X

**Correlations**

| | | Total Revenue | Price of Funds | Price of Labor | Price of Capital | Total Deposits | Risk Factor 1 | Too Big to Fail |
|---|---|---|---|---|---|---|---|---|
| Pearson Correlation | Total Revenue | 1.000 | .038 | .023 | -.075 | .838 | .089 | .692 |
| | Price of Funds | .038 | 1.000 | .111 | -.053 | -.154 | .110 | -.139 |
| | Price of Labor | .023 | .111 | 1.000 | .048 | -.111 | -.088 | -.396 |
| | Price of Capital | -.075 | -.053 | .048 | 1.000 | -.063 | -.016 | -.020 |
| | Total Deposits | .838 | -.154 | -.111 | -.063 | 1.000 | -.013 | .718 |
| | Risk Factor 1 | .089 | .110 | -.088 | -.016 | -.013 | 1.000 | .031 |
| | Too Big to Fail | .692 | -.139 | -.396 | -.020 | .718 | .031 | 1.000 |
| Sig. (1-tailed) | Total Revenue | . | .057 | .171 | .001 | .000 | .000 | .000 |
| | Price of Funds | .057 | . | .000 | .013 | .000 | .000 | .000 |
| | Price of Labor | .171 | .000 | . | .021 | .000 | .000 | .000 |
| | Price of Capital | .001 | .013 | .021 | . | .004 | .250 | .196 |
| | Total Deposits | .000 | .000 | .000 | .004 | . | .288 | .000 |
| | Risk Factor 1 | .000 | .000 | .000 | .250 | .288 | . | .097 |
| | Too Big to Fail | .000 | .000 | .000 | .196 | .000 | .097 | . |

## Appendix 22: Correlation Matrix for 2002-2008 Pre-Financial Crisis Model B[47]

| | Total Revenue | Price of Funds | Price of Labor | Price of Capital | Total Deposits | Risk Factor | Too Big to Fail | Efficiency | Public Bank | Foreign Bank |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Revenue | 1.000 | .127 | -.033 | -.001 | .823 | .056 | .722 | .129 | .162 | -.065 |
| Price of Funds | .127 | 1.000 | .213 | -.111 | -.073 | .096 | -.133 | -.229 | -.211 | .028 |
| Price of Labor | -.033 | .213 | 1.000 | .091 | -.197 | -.094 | -.521 | -.269 | -.410 | .359 |
| Price of Capital | -.001 | -.111 | .091 | 1.000 | .007 | .031 | -.057 | -.125 | .083 | .037 |
| Total Deposits | .823 | -.073 | -.197 | .007 | 1.000 | -.071 | .749 | .252 | .260 | -.240 |
| Risk Factor 1 | .056 | .096 | -.094 | .031 | -.071 | 1.000 | .032 | -.063 | -.177 | -.203 |
| Too Big to Fail | .722 | -.133 | -.521 | -.057 | .749 | .032 | 1.000 | .271 | .483 | -.251 |
| Efficiency | .129 | -.229 | -.269 | -.125 | .252 | -.063 | .271 | 1.000 | .168 | -.166 |
| Public Bank | .162 | -.211 | -.410 | .083 | .260 | -.177 | .483 | .168 | 1.000 | -.411 |
| Foreign Bank | -.065 | .028 | .359 | .037 | -.240 | -.203 | -.251 | -.166 | -.411 | 1.000 |
| Total Revenue | . | .000 | .109 | .491 | .000 | .019 | .000 | .000 | .000 | .008 |
| Price of Funds | .000 | . | .000 | .000 | .003 | .000 | .000 | .000 | .000 | .149 |
| Price of Labor | .109 | .000 | . | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| Price of Capital | .491 | .000 | .000 | . | .392 | .124 | .017 | .000 | .001 | .083 |
| Total Deposits | .000 | .003 | .000 | .392 | . | .004 | .000 | .000 | .000 | .000 |
| Risk Factor 1 | .019 | .000 | .000 | .124 | .004 | . | .118 | .010 | .000 | .000 |
| Too Big to Fail | .000 | .000 | .000 | .017 | .000 | .118 | . | .000 | .000 | .000 |
| Efficiency | .000 | .000 | .000 | .000 | .000 | .010 | .000 | . | .000 | .000 |
| Public Bank | .000 | .000 | .000 | .001 | .000 | .000 | .000 | .000 | . | .000 |
| Foreign Bank | .008 | .149 | .000 | .083 | .000 | .000 | .000 | .000 | .000 | . |

[47] Sig. 1 Tailed.

## Appendix 23: Correlation Matrix for 2002-2008 Pre-Financial Crisis 2002-2008 Model IR[48]

| | Interest Revenue | Price of Funds | Price of Labor | Price of Capital | Total Deposits | Risk Factor 1 | Too Big to Fail | Efficiency | Public Bank | Foreign Bank |
|---|---|---|---|---|---|---|---|---|---|---|
| Interest Revenue | 1.000 | .160 | -.045 | -.005 | .828 | .073 | .708 | .150 | .139 | -.090 |
| Price of Funds | .160 | 1.000 | .230 | -.112 | -.083 | .083 | -.148 | -.227 | -.220 | .044 |
| Price of Labor | -.045 | .230 | 1.000 | .091 | -.191 | -.086 | -.519 | -.277 | -.409 | .354 |
| Price of Capital | -.005 | -.112 | .091 | 1.000 | .010 | .032 | -.057 | -.126 | .082 | .037 |
| Total Deposits | .828 | -.083 | -.191 | .010 | 1.000 | -.075 | .745 | .259 | .254 | -.230 |
| Risk Factor 1 | .073 | .083 | -.086 | .032 | -.075 | 1.000 | .026 | -.058 | -.185 | -.196 |
| Too Big to Fail | .708 | -.148 | -.519 | -.057 | .745 | .026 | 1.000 | .279 | .482 | -.243 |
| Efficiency | .150 | -.227 | -.277 | -.126 | .259 | -.058 | .279 | 1.000 | .173 | -.174 |
| Public Bank | .139 | -.220 | -.409 | .082 | .254 | -.185 | .482 | .173 | 1.000 | -.410 |
| Foreign Bank | -.090 | .044 | .354 | .037 | -.230 | -.196 | -.243 | -.174 | -.410 | 1.000 |
| Interest Revenue | . | .000 | .048 | .421 | .000 | .004 | .000 | .000 | .000 | .000 |
| Price of Funds | .000 | . | .000 | .000 | .001 | .001 | .000 | .000 | .000 | .054 |
| Price of Labor | .048 | .000 | . | .000 | .000 | .001 | .000 | .000 | .000 | .000 |
| Price of Capital | .421 | .000 | .000 | . | .360 | .123 | .018 | .000 | .001 | .086 |
| Total Deposits | .000 | .001 | .000 | .360 | . | .003 | .000 | .000 | .000 | .000 |
| Risk Factor 1 | .004 | .001 | .001 | .123 | .003 | . | .174 | .017 | .000 | .000 |
| Too Big to Fail | .000 | .000 | .000 | .018 | .000 | .174 | . | .000 | .000 | .000 |
| Efficiency | .000 | .000 | .000 | .000 | .000 | .017 | .000 | . | .000 | .000 |
| Public Bank | .000 | .000 | .000 | .001 | .000 | .000 | .000 | .000 | . | .000 |
| Foreign Bank | .000 | .054 | .000 | .086 | .000 | .000 | .000 | .000 | .000 | . |

[48] Sig. 1 Tailed.

# Appendix 24 Correlation Matrix for 2002-2008 Pre-Financial Crisis Model X

**Correlations**

| | | Total Revenue | Price of Funds | Price of Labor | Price of Capital | Total Deposits | Risk Factor 1 | Too Big to Fail |
|---|---|---|---|---|---|---|---|---|
| Pearson Correlation | Total Revenue | 1.000 | .127 | -.033 | -.001 | .823 | .056 | .722 |
| | Price of Funds | .127 | 1.000 | .213 | -.111 | -.073 | .096 | -.133 |
| | Price of Labor | -.033 | .213 | 1.000 | .091 | -.197 | -.094 | -.521 |
| | Price of Capital | -.001 | -.111 | .091 | 1.000 | .007 | .031 | -.057 |
| | Total Deposits | .823 | -.073 | -.197 | .007 | 1.000 | -.071 | .749 |
| | Risk Factor 1 | .056 | .096 | -.094 | .031 | -.071 | 1.000 | .032 |
| | Too Big to Fail | .722 | -.133 | -.521 | -.057 | .749 | .032 | 1.000 |
| Sig. (1-tailed) | Total Revenue | . | .000 | .109 | .491 | .000 | .019 | .000 |
| | Price of Funds | .000 | . | .000 | .000 | .003 | .000 | .000 |
| | Price of Labor | .109 | .000 | . | .000 | .000 | .000 | .000 |
| | Price of Capital | .491 | .000 | .000 | . | .392 | .124 | .017 |
| | Total Deposits | .000 | .003 | .000 | .392 | . | .004 | .000 |
| | Risk Factor 1 | .019 | .000 | .000 | .124 | .004 | . | .118 |
| | Too Big to Fail | .000 | .000 | .000 | .017 | .000 | .118 | . |

## Appendix 25: Correlation Matrix for 2009-2011 Post-Financial Crisis Model B[49]

| | Total Revenue | Price of Funds | Price of Labor | Price of Capital | Total Deposits | Risk Factor 1 | Too Big to Fail | Efficiency | Public Bank | Foreign Bank |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Revenue | 1.000 | -.059 | .040 | -.213 | .870 | .100 | .681 | .267 | .251 | -.074 |
| Price of Funds | -.059 | 1.000 | .037 | -.078 | -.244 | .357 | -.209 | -.050 | -.246 | .037 |
| Price of Labor | .040 | .037 | 1.000 | .104 | -.074 | -.197 | -.143 | -.260 | -.166 | .047 |
| Price of Capital | -.213 | -.078 | .104 | 1.000 | -.139 | -.103 | .118 | -.279 | .058 | -.119 |
| Total Deposits | .870 | -.244 | -.074 | -.139 | 1.000 | .077 | .749 | .286 | .300 | -.200 |
| Risk Factor 1 | .100 | .357 | -.197 | -.103 | .077 | 1.000 | .058 | .062 | -.020 | -.259 |
| Too Big to Fail | .681 | -.209 | -.143 | .118 | .749 | .058 | 1.000 | .216 | .404 | -.249 |
| Efficiency | .267 | -.050 | -.260 | -.279 | .286 | .062 | .216 | 1.000 | .067 | -.130 |
| Public Bank | .251 | -.246 | -.166 | .058 | .300 | -.020 | .404 | .067 | 1.000 | -.230 |
| Foreign Bank | -.074 | .037 | .047 | -.119 | -.200 | -.259 | -.249 | -.130 | -.230 | 1.000 |
| Total Revenue | . | .121 | .215 | .000 | .000 | .023 | .000 | .000 | .000 | .071 |
| Price of Funds | .121 | . | .229 | .061 | .000 | .000 | .000 | .162 | .000 | .232 |
| Price of Labor | .215 | .229 | . | .019 | .070 | .000 | .002 | .000 | .000 | .177 |
| Price of Capital | .000 | .061 | .019 | . | .003 | .021 | .009 | .000 | .125 | .009 |
| Total Deposits | .000 | .000 | .070 | .003 | . | .063 | .000 | .000 | .000 | .000 |
| Risk Factor 1 | .023 | .000 | .000 | .021 | .063 | . | .123 | .109 | .348 | .000 |
| Too Big to Fail | .000 | .000 | .002 | .009 | .000 | .123 | . | .000 | .000 | .000 |
| Efficiency | .000 | .162 | .000 | .000 | .000 | .109 | .000 | . | .090 | .005 |
| Public Bank | .000 | .000 | .000 | .125 | .000 | .348 | .000 | .090 | . | .000 |
| Foreign Bank | .071 | .232 | .177 | .009 | .000 | .000 | .000 | .005 | .000 | . |

[49] Sig. 1 Tailed.

## Appendix 26: Correlation Matrix for 2009-2011 Post Financial Crisis Model IR[50]

| | Interest Revenue | Price of Funds | Price of Labor | Price of Capital | Total Deposits | Risk Factor 1 | Too Big to Fail | Efficiency | Public Bank | Foreign Bank |
|---|---|---|---|---|---|---|---|---|---|---|
| Interest Revenue | 1.000 | -.029 | .016 | -.255 | .874 | .133 | .671 | .302 | .222 | -.086 |
| Price of Funds | -.029 | 1.000 | .049 | -.083 | -.265 | .348 | -.226 | -.037 | -.255 | .049 |
| Price of Labor | .016 | .049 | 1.000 | .100 | -.063 | -.187 | -.141 | -.270 | -.164 | .035 |
| Price of Capital | -.255 | -.083 | .100 | 1.000 | -.121 | -.091 | .128 | -.278 | .065 | -.142 |
| Total Deposits | .874 | -.265 | -.063 | -.121 | 1.000 | .004 | .751 | .278 | .294 | -.181 |
| Risk Factor 1 | .133 | .348 | -.187 | -.091 | .004 | 1.000 | .033 | .076 | -.050 | -.248 |
| Too Big to Fail | .671 | -.226 | -.141 | .128 | .751 | .033 | 1.000 | .219 | .403 | -.243 |
| Efficiency | .302 | -.037 | -.270 | -.278 | .278 | .076 | .219 | 1.000 | .064 | -.123 |
| Public Bank | .222 | -.255 | -.164 | .065 | .294 | -.050 | .403 | .064 | 1.000 | -.225 |
| Foreign Bank | -.086 | .049 | .035 | -.142 | -.181 | -.248 | -.243 | -.123 | -.225 | 1.000 |
| Interest Revenue | . | .283 | .373 | .000 | .000 | .004 | .000 | .000 | .000 | .045 |
| Price of Funds | .283 | . | .167 | .051 | .000 | .000 | .000 | .234 | .000 | .165 |
| Price of Labor | .373 | .167 | . | .024 | .106 | .000 | .003 | .000 | .001 | .243 |
| Price of Capital | .000 | .051 | .024 | . | .008 | .037 | .006 | .000 | .099 | .002 |
| Total Deposits | .000 | .000 | .106 | .008 | . | .468 | .000 | .000 | .000 | .000 |
| Risk Factor 1 | .004 | .000 | .000 | .037 | .468 | . | .258 | .066 | .160 | .000 |
| Too Big to Fail | .000 | .000 | .003 | .006 | .000 | .258 | . | .000 | .000 | .000 |
| Efficiency | .000 | .234 | .000 | .000 | .000 | .066 | .000 | . | .105 | .007 |
| Public Bank | .000 | .000 | .001 | .099 | .000 | .160 | .000 | .105 | . | .000 |
| Foreign Bank | .045 | .165 | .243 | .002 | .000 | .000 | .000 | .007 | .000 | . |

[50] Sig. 1 Tailed.

## Appendix 27: Correlation Matrix for 2009-2011 Post Financial Crisis Model X

**Correlations**

| | | Total Revenue | Price of Funds | Price of Labor | Price of Capital | Total Deposits | Risk Factor 1 | Too Big to Fail |
|---|---|---|---|---|---|---|---|---|
| Pearson Correlation | Total Revenue | 1.000 | -.059 | .040 | -.213 | .870 | .100 | .681 |
| | Price of Funds | -.059 | 1.000 | .037 | -.078 | -.244 | .357 | -.209 |
| | Price of Labor | .040 | .037 | 1.000 | .104 | -.074 | -.197 | -.143 |
| | Price of Capital | -.213 | -.078 | .104 | 1.000 | -.139 | -.103 | .118 |
| | Total Deposits | .870 | -.244 | -.074 | -.139 | 1.000 | .077 | .749 |
| | Risk Factor 1 | .100 | .357 | -.197 | -.103 | .077 | 1.000 | .058 |
| | Too Big to Fail | .681 | -.209 | -.143 | .118 | .749 | .058 | 1.000 |
| Sig. (1-tailed) | Total Revenue | . | .121 | .215 | .000 | .000 | .023 | .000 |
| | Price of Funds | .121 | . | .229 | .061 | .000 | .000 | .000 |
| | Price of Labor | .215 | .229 | . | .019 | .070 | .000 | .002 |
| | Price of Capital | .000 | .061 | .019 | . | .003 | .021 | .009 |
| | Total Deposits | .000 | .000 | .070 | .003 | . | .063 | .000 |
| | Risk Factor 1 | .023 | .000 | .000 | .021 | .063 | . | .123 |
| | Too Big to Fail | .000 | .000 | .002 | .009 | .000 | .123 | . |

**Appendix 28: Correlation Matrix 2002-2011 for all banks with Total Revenue to Total Assets and Interest Revenue to Total Assets**

(obs=1743)

| | trta | irta | pfunds | plabor | pcapital | deposits | risk | toobig | efficiency | public | foreign |
|---|---|---|---|---|---|---|---|---|---|---|---|
| trta | 1.0000 | | | | | | | | | | |
| irta | 0.8859 | 1.0000 | | | | | | | | | |
| pfunds | 0.6041 | 0.6551 | 1.0000 | | | | | | | | |
| plabor | 0.0601 | 0.0003 | 0.1225 | 1.0000 | | | | | | | |
| pcapital | 0.0357 | 0.0082 | -0.0538 | 0.0472 | 1.0000 | | | | | | |
| deposits | 0.0256 | 0.0239 | -0.1663 | -0.1031 | -0.0610 | 1.0000 | | | | | |
| risk | 0.1641 | 0.1935 | 0.0895 | -0.0744 | -0.0165 | -0.0272 | 1.0000 | | | | |
| toobig | 0.1188 | 0.0892 | -0.1507 | -0.3923 | -0.0183 | 0.7155 | 0.0213 | 1.0000 | | | |
| efficiency | -0.0377 | 0.0274 | -0.1075 | -0.2979 | -0.0962 | 0.1906 | -0.0572 | 0.2559 | 1.0000 | | |
| public | 0.0553 | 0.0069 | -0.2195 | -0.3215 | 0.0795 | 0.2541 | -0.1593 | 0.4635 | 0.1333 | 1.0000 | |
| foreign | -0.1073 | -0.1692 | 0.0529 | 0.2374 | 0.0207 | -0.2263 | -0.2079 | -0.2396 | -0.1403 | -0.3684 | 1.0000 |

**Appendix 29: Correlation Matrix 2002-2011 for Panel Banks with Total Revenue to Total Assets and Interest Revenue to Total Assets**
(obs=832)

| | trta | irta | pfunds | plabor | pcapital | deposits | risk | toobig | efficiency | public | foreign |
|---|---|---|---|---|---|---|---|---|---|---|---|
| trta | 1.0000 | | | | | | | | | | |
| irta | 0.8810 | 1.0000 | | | | | | | | | |
| pfunds | 0.6242 | 0.6593 | 1.0000 | | | | | | | | |
| plabor | -0.0159 | -0.0859 | 0.1205 | 1.0000 | | | | | | | |
| pcapital | -0.0228 | -0.0573 | -0.1094 | 0.0006 | 1.0000 | | | | | | |
| deposits | -0.0097 | 0.0213 | -0.2582 | -0.1228 | -0.0518 | 1.0000 | | | | | |
| risk | 0.1332 | 0.1859 | 0.0554 | -0.1775 | -0.0424 | 0.2521 | 1.0000 | | | | |
| toobig | 0.1707 | 0.1698 | -0.1858 | -0.5283 | -0.0342 | 0.7615 | 0.2319 | 1.0000 | | | |
| efficiency | 0.0677 | 0.1603 | -0.0066 | -0.3259 | -0.0311 | 0.1765 | -0.0026 | 0.2577 | 1.0000 | | |
| public | 0.1453 | 0.0886 | -0.2372 | -0.4142 | 0.1371 | 0.1878 | -0.0234 | 0.4421 | 0.0703 | 1.0000 | |
| foreign | -0.1971 | -0.2647 | -0.0136 | 0.4419 | 0.0943 | -0.3726 | -0.4144 | -0.4619 | -0.1896 | -0.4364 | 1.0000 |

**Appendix 30: Correlation Matrix 2002-2008 for all banks with Total Revenue to Total Assets and Interest Revenue to Total Assets**

(obs=1355)

| | trta | irta | pfunds | plabor | pcapital | deposits | risk | toobig | efficiency | public | foreign |
|---|---|---|---|---|---|---|---|---|---|---|---|
| trta | 1.0000 | | | | | | | | | | |
| irta | 0.8861 | 1.0000 | | | | | | | | | |
| pfunds | 0.6501 | 0.7039 | 1.0000 | | | | | | | | |
| plabor | 0.1098 | 0.0604 | 0.2273 | 1.0000 | | | | | | | |
| pcapital | -0.0337 | -0.0460 | -0.1127 | 0.0910 | 1.0000 | | | | | | |
| deposits | 0.0536 | 0.0542 | -0.0833 | -0.1908 | 0.0095 | 1.0000 | | | | | |
| risk | 0.1836 | 0.1991 | 0.0840 | -0.0852 | 0.0313 | -0.0788 | 1.0000 | | | | |
| toobig | 0.1103 | 0.0764 | -0.1467 | -0.5182 | -0.0566 | 0.7471 | 0.0259 | 1.0000 | | | |
| efficiency | -0.0970 | -0.0592 | -0.2258 | -0.2750 | -0.1254 | 0.2583 | -0.0586 | 0.2778 | 1.0000 | | |
| public | 0.0669 | 0.0197 | -0.2187 | -0.4082 | 0.0834 | 0.2568 | -0.1829 | 0.4809 | 0.1710 | 1.0000 | |
| foreign | -0.1382 | -0.2091 | 0.0419 | 0.3525 | 0.0368 | -0.2306 | -0.1960 | -0.2419 | -0.1723 | -0.4088 | 1.0000 |

**Appendix 31: Correlation Matrix 2002-2008 for Panel Banks with Total Revenue to Total Assets and Interest Revenue to Total Assets**
(obs=634)

| | trta | irta | pfunds | plabor | pcapital | deposits | risk | toobig | efficiency | public | foreign |
|---|---|---|---|---|---|---|---|---|---|---|---|
| trta | 1.0000 | | | | | | | | | | |
| irta | 0.8868 | 1.0000 | | | | | | | | | |
| pfunds | 0.6921 | 0.7609 | 1.0000 | | | | | | | | |
| plabor | 0.0299 | -0.0290 | 0.2253 | 1.0000 | | | | | | | |
| pcapital | -0.0903 | -0.1145 | -0.1891 | 0.0567 | 1.0000 | | | | | | |
| deposits | 0.0188 | 0.0298 | -0.2101 | -0.2094 | 0.0335 | 1.0000 | | | | | |
| risk | 0.1188 | 0.1637 | 0.0738 | -0.2721 | 0.0160 | 0.2067 | 1.0000 | | | | |
| toobig | 0.1813 | 0.1576 | -0.1738 | -0.5979 | -0.0114 | 0.7608 | 0.2314 | 1.0000 | | | |
| efficiency | -0.0414 | -0.0226 | -0.1821 | -0.2232 | -0.0519 | 0.2473 | 0.0287 | 0.2434 | 1.0000 | | |
| public | 0.1609 | 0.0940 | -0.2507 | -0.4647 | 0.1178 | 0.1995 | -0.0400 | 0.4516 | 0.1242 | 1.0000 | |
| foreign | -0.1671 | -0.2356 | 0.0178 | 0.5274 | 0.0683 | -0.4075 | -0.4086 | -0.4832 | -0.1794 | -0.4775 | 1.0000 |

**Appendix 32: Correlation Matrix 2009-2011 for all banks with Total Revenue to Total Assets and Interest Revenue to Total Assets**

(obs=388)

| | trta | irta | pfunds | plabor | pcapital | deposits | risk | toobig | efficiency | public | foreign |
|---|---|---|---|---|---|---|---|---|---|---|---|
| trta | 1.0000 | | | | | | | | | | |
| irta | 0.8635 | 1.0000 | | | | | | | | | |
| pfunds | 0.3776 | 0.4290 | 1.0000 | | | | | | | | |
| plabor | 0.0707 | -0.0132 | 0.0446 | 1.0000 | | | | | | | |
| pcapital | 0.1427 | -0.0076 | -0.0823 | 0.0986 | 1.0000 | | | | | | |
| deposits | 0.1699 | 0.1781 | -0.2637 | -0.0636 | -0.1234 | 1.0000 | | | | | |
| risk | 0.2987 | 0.4313 | 0.3452 | -0.1898 | -0.0912 | 0.0052 | 1.0000 | | | | |
| toobig | 0.1264 | 0.1077 | -0.2158 | -0.1388 | 0.1280 | 0.7516 | 0.0372 | 1.0000 | | | |
| efficiency | -0.0562 | 0.0714 | -0.0358 | -0.2683 | -0.2755 | 0.2806 | 0.0782 | 0.2190 | 1.0000 | | |
| public | 0.0100 | -0.0459 | -0.2528 | -0.1630 | 0.0651 | 0.2939 | -0.0490 | 0.4015 | 0.0632 | 1.0000 | |
| foreign | -0.0503 | -0.0956 | 0.0452 | 0.0374 | -0.1387 | -0.1787 | -0.2494 | -0.2430 | -0.1294 | -0.2248 | 1.0000 |

**Appendix 33: Correlation Matrix 2009-2011 for Panel Banks with Total Revenue to Total Assets and Interest Revenue to Total Assets**
(obs=198)

| | trta | irta | pfunds | plabor | pcapital | deposits | risk | toobig | efficiency | public | foreign |
|---|---|---|---|---|---|---|---|---|---|---|---|
| trta | 1.0000 | | | | | | | | | | |
| irta | 0.8456 | 1.0000 | | | | | | | | | |
| pfunds | 0.3627 | 0.3074 | 1.0000 | | | | | | | | |
| plabor | 0.0335 | -0.0412 | 0.1652 | 1.0000 | | | | | | | |
| pcapital | 0.2003 | -0.0186 | -0.0875 | -0.0110 | 1.0000 | | | | | | |
| deposits | 0.1336 | 0.2887 | -0.1625 | -0.1868 | -0.3209 | 1.0000 | | | | | |
| risk | 0.4129 | 0.5301 | 0.2620 | -0.1575 | -0.2303 | 0.2378 | 1.0000 | | | | |
| toobig | 0.1987 | 0.2946 | -0.1930 | -0.5023 | -0.1327 | 0.8321 | 0.2030 | 1.0000 | | | |
| efficiency | 0.0782 | 0.2600 | -0.0512 | -0.3292 | -0.2948 | 0.4362 | 0.1472 | 0.4506 | 1.0000 | | |
| public | 0.1096 | 0.0901 | -0.2326 | -0.3663 | 0.3231 | 0.1689 | 0.0283 | 0.4119 | 0.0323 | 1.0000 | |
| foreign | -0.3391 | -0.4071 | -0.1226 | 0.3264 | 0.2781 | -0.2914 | -0.4615 | -0.3861 | -0.2930 | -0.3037 | 1.0000 |

## Appendix 34: Correlation Matrices for Quarterly H-Statistic Results and Total Assets Correlation Measures

(obs=37)

| | hstatrta | hstattr | branches | cr3ta | cr5ta | cr10ta | hita |
|---|---|---|---|---|---|---|---|
| hstatrta | 1.0000 | | | | | | |
| hstattr | 0.5585 | 1.0000 | | | | | |
| branches | -0.0185 | -0.4113 | 1.0000 | | | | |
| cr3ta | -0.2590 | -0.5269 | 0.8372 | 1.0000 | | | |
| cr5ta | -0.1813 | -0.4726 | 0.9088 | 0.9804 | 1.0000 | | |
| cr10ta | -0.0918 | -0.4905 | 0.9594 | 0.9126 | 0.9599 | 1.0000 | |
| hita | -0.2021 | -0.5101 | 0.9015 | 0.9835 | 0.9935 | 0.9665 | 1.0000 |

## Appendix 35: Correlation Matrices for Quarterly H-Statistic Results and Total Deposits Correlation Measures

(obs=37)

| | hstatrta | hstattr | branches | cr3td | cr5td | cr10td | hitd |
|---|---|---|---|---|---|---|---|
| hstatrta | 1.0000 | | | | | | |
| hstattr | 0.5585 | 1.0000 | | | | | |
| branches | -0.0185 | -0.4113 | 1.0000 | | | | |
| cr3td | -0.5323 | -0.4436 | 0.2492 | 1.0000 | | | |
| cr5td | -0.3136 | -0.3505 | 0.6465 | 0.6550 | 1.0000 | | |
| cr10td | -0.1479 | -0.5194 | 0.8119 | 0.5081 | 0.7898 | 1.0000 | |
| hitd | -0.3424 | -0.5078 | 0.7600 | 0.7663 | 0.8914 | 0.8341 | 1.0000 |

## Appendix 36: Correlation Matrices for Quarterly H-Statistic Results and Total Loans Correlation Measures

(obs=37)

| | hstatrta | hstattr | branches | cr3tl | cr5tl | cr10tl | hitl |
|---|---|---|---|---|---|---|---|
| hstatrta | 1.0000 | | | | | | |
| hstattr | 0.5585 | 1.0000 | | | | | |
| branches | -0.0185 | -0.4113 | 1.0000 | | | | |
| cr3tl | -0.0759 | -0.4401 | 0.9237 | 1.0000 | | | |
| cr5tl | -0.1131 | -0.4443 | 0.9500 | 0.9595 | 1.0000 | | |
| cr10tl | 0.0111 | -0.4527 | 0.9642 | 0.9023 | 0.9471 | 1.0000 | |
| hitl | -0.0899 | -0.4766 | 0.9562 | 0.9518 | 0.9913 | 0.9722 | 1.0000 |

**Appendix 37: Relationship Between Competition and Total Assets Concentration (CR3, CR5, CR10 and HI) with Total Revenue over Total Assets as the Dependent Variable**

| Assets TRTA | CR3 | CR5 | CR10 | HI |
|---|---|---|---|---|
| Branches | .00017<br>(.0001) | .00012<br>(.00012) | .00009<br>(.0001) | .00017<br>(.0001) |
| Concentration Measure | -1.4985<br>(1.973) | 1.205<br>(2.108) | 1.219<br>(1.707) | -1.787<br>(5.518) |
| DEA | -2.273**<br>(1.055) | -2.679***<br>(1.027) | -2.670***<br>(1.104) | -2.418**<br>(1.058) |
| PreCrisis | .6299***<br>(.212) | .9201***<br>(.2971) | .8463***<br>(.2226) | .7204***<br>(.194) |
| Constant | -.5543<br>(2.359) | -.7411<br>(2.354) | -.2327<br>2.723 | -.8882<br>(2.621) |
| R-Square | .2802 | .2783 | .2789 | .2755 |
| F-Stat | F(4,32) =<br>4.15*** | F(4,32) =<br>4.44*** | F(4,32) =<br>4.06*** | F(4,32) =<br>4.42*** |
| # Observations | 37 | 37 | 37 | 37 |

Note: t-stat in parentheses, P-Value < 0.05***, P-Value < 0.1**, P-Value <0.15*

## Appendix 38: Relationship Between Competition and Total Deposits Concentration (CR3, CR5, CR10 and HI) with Total Revenue over Total Assets as the Dependent Variable

| Deposits TRTA | CR3 | CR5 | CR10 | HI |
|---|---|---|---|---|
| Branches | .00008<br>(.00011) | .00015)<br>(.0001) | .00015<br>(.0001) | .00016<br>(.0001) |
| Concentration Measure | -2.8451<br>(1.642) | -.3332896<br>(1.623) | .9799<br>(2.150) | -8.4634<br>(6.497) |
| DEA | -1.556<br>(1.084) | -2.500***<br>( .9931) | -2.551***<br>(.9951) | -1.873<br>(1.076) |
| PreCrisis | .3656<br>(.3433) | .72885***<br>(.3070) | .83032***<br>(.2447) | .4505<br>(.2874) |
| Constant | 1.5683<br>( 2.8268) | -.3664<br>(3.408) | -1.326<br>(2.459) | -.2156<br>(2.3614) |
| R-Square | .3293 | .2752 | .2780 | .2927 |
| F-Stat | F( 4,32) =<br>5.69*** | F(4,32) =<br>3.98*** | F(4,32) =<br>4.08*** | F(4,32) =<br>4.23*** |
| # Observations | 37 | 37 | 37 | 37 |

Note: t-stat in parentheses, P-Value < 0.05***, P-Value < 0.1**, P-Value <0.15*

**Appendix 39: Relationship Between Competition and Total Loans Concentration (CR3, CR5, CR10 and HI) with Total Revenue over Total Assets as the Dependent Variable**

| Loans TRTA | CR3 | CR5 | CR10 | HI |
|---|---|---|---|---|
| Branches | .00008<br>(.00013) | .00004<br>(.00017) | -.000011<br>(.00019) | .000052<br>(.00017) |
| Concentration Measure | 2.615<br>( 2.745) | 2.554<br>(2.630) | 2.1362<br>(1.770) | 8.3653<br>(8.7168) |
| DEA | -2.396<br>(1.0530) | -2.673***<br>(1.033) | -2.612***<br>(1.067) | -2.671***<br>(1.062) |
| PreCrisis | .9116<br>(.2236) | .9993***<br>(.2995) | .7829***<br>(.2101) | .9141***<br>(.2399) |
| Constant | -.6234<br>(2.272) | -.02604<br>(2.575) | .9656<br>(3.163) | .6386<br>(3.121) |
| R-Square | .2921 | .2891 | .2943 | .2863 |
| F-Stat | F(4,32) =<br>4.65*** | F(4,32) =<br>4.26*** | F(4,32) =<br>4.06*** | F(4,32) =<br>4.29*** |
| # Observations | 37 | 37 | 37 | 37 |

Note: t-stat in parentheses, P-Value < 0.05***, P-Value < 0.1**, P-Value <0.15*

## Appendix 40: Quarterly H-Statistics with Total Revenue over Total Assets and Total Revenue as the Dependent Variables

| | H-Stat TR/TA | H-Stat TR |
|---|---|---|
| 2002 Q1 | 0.3595 | 0.4664948 |
| 2002 Q2 | 0.3136 | 1.767995 |
| 2002 Q3 | 0.6542 | 2.222048 |
| 2002 Q4 | 0.664 | 2.070544 |
| 2003 Q1 | 0.21893 | 0.4535496 |
| 2003 Q2 | 0.0424 | 0.7143654 |
| 2003 Q3 | 0.3672 | 0.843729 |
| 2003 Q4 | 0.4976 | 0.4022299 |
| 2004 Q1 | 0.6583 | 0.7775292 |
| 2004 Q2 | 0.3218 | 0.8104118 |
| 2004 Q3 | 1.07 | 1.922522 |
| 2004 Q4 | 0.6273 | 0.8628344 |
| 2005 Q1 | 1.2357 | 1.19097 |
| 2005 Q2 | 1.136 | 1.542354 |
| 2005 Q3 | 0.3935 | 0.048511 |
| 2005 Q4 | 0.3119 | -0.1440928 |
| 2006 Q1 | 1.0178 | 1.376455 |
| 2006 Q2 | 0.8125 | 1.331521 |
| 2006 Q3 | 0.4019 | 1.130006 |
| 2006 Q4 | 0.32377 | 0.9357216 |
| 2007 Q1 | 1.12075 | 1.81579 |
| 2007 Q2 | 1.1537 | 1.465695 |
| 2007 Q3 | 1.0938 | 1.596401 |
| 2007 Q4 | 1.1853 | 1.637625 |
| 2008 Q1 | 0.8331 | 1.623584 |
| 2008 Q2 | 1.1185 | 0.7001257 |
| 2008 Q3 | 0.4505 | 1.32198 |
| 2008 Q4 | 0.7107 | 1.293318 |
| 2009 Q1 | 0.4716 | 0.9256716 |
| 2009 Q2 | 0.3787 | -0.0988669 |
| 2009 Q3 | 0.449 | 0.579254 |
| 2009 Q4 | 0.1759 | 0.1403526 |
| 2010 Q1 | 0.7694 | 0.915363 |
| 2010 Q2 | 0.6198 | 0.5665462 |
| 2010 Q3 | 0.60865 | 0.265567 |
| 2010 Q4 | 0.6204 | -0.0223165 |
| 2011 Q1 | 0.4281 | -0.1465013 |

**Appendix 41: Graph of Quarterly H-Statistics with Total Revenue over Total Assets and Total Revenue as the Dependent Variables**