MEASURING COST EFFICIENCY OF TURKISH COMMERCIAL BANKS: A STOCHASTIC FRONTIER APPROACH

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ABSTRACT

MEASURING COST EFFICIENCY OF TURKISH COMMERCIAL BANKS: A STOCHASTIC FRONTIER APPROACH

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This study examines cost efficiency of Turkish commercial banks through a stochastic frontier approach where the inefficiency effects are approximated by a set of bank-specific variables. Empirical results reveal that intermediation ratio, deposits divided by liabilities and labor per branch are the main determinants of the inefficiency of Turkish commercial banks. Moreover, it is observed that cost efficiency of all commercial banks has an upward trend until 2008 and it takes 10 quarters to recover from the effects of 2008 economic crisis. On average, medium and foreign banks appear to be the most cost efficient banks within their bank groups. Moreover, while all sub-groups have an upward trend until 2008, each group recovers from the effects of 2008 economic crisis differently. Finally, empirical results reveal further that cost efficiency of commercial banks is persistent.

Keywords: Stochastic frontier approach, cost efficiency, Turkish commercial banks, persistency

ÖZ

TÜRK MEVDUAT BANKALARININ MALİYET VERİMLİLİĞİNİN ÖLÇÜLMESİ: BİR STOKASTİK SINIR YAKLAŞIMI

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Bu çalışma Türk mevduat bankalarının maliyet verimliliğini, verimlilik etkilerinin bir grup banka spesifik değişkenlere benzetildiği bir stokastik sınır yaklaşımı kullanarak incelemektedir. Ampirik sonuçlar aracılık oranı, mevduatın yükümlülüğe bölümü ve şube başına düşen çalışan sayısının Türk mevduat bankalarının ana verimsizlik belirleyicileri olduğunu ortaya çıkarmaktadır. Bundan başka, bütün mevduat bankalarının mevduat verimliliğinin 2008'e kadar yukarı yönlü trendi olduğu ve 2008 ekonomik krizinin etkilerinden kurtulmanın 10 çeyrek sürdüğü gözlenmektedir. Ortalamada orta ölçekli ve yabancı bankaların kendi gruplarında en etkin bankalar olduğu görülmektedir. Bundan başka, bütün alt grupların 2008'e kadar yukarı yönlü bir trendi olduğunu gösterirken, her grubun 2008 ekonomik krizinin etkilerinden farklı şekilde kurtulduğunu ortaya çıkarmaktadır. Son olarak, ampirik sonuçlar mevduat bankalarının maliyet verimliliğinin kalıcı olduğunu ortaya çıkarmaktadır.

Anahtar kelimeler: Stokastik sınır yaklaşımı, maliyet verimliliği, Türk mevduat bankaları, kalıcılık

To My Father

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TABLE OF CONTENTS

LIST OF TABLES

TABLES

LIST OF FIGURES

FIGURES

CHAPTER 1

INTRODUCTION

Stable and efficient banking system is quite important for development of an economy. After 2001 financial crisis, the Turkish government introduced a banking sector restructuring program, with the aims being restructuring three state owned commercial banks and the banks taken over by Saving Deposit Insurance Fund. Through a successful implementation of the program, private and state owned banks financial structure is strengthened. However, due to 2008 economic crisis, Turkish economy experienced negative growth which makes stability of banks in Turkey questionable as indicated by Assaf, Matousek and Tsionas (2013).

Efficiency of Turkish banks is studied by many researchers in the last decade. Yildirim (2002), Isik and Hassan (2002), Denizer, Dinc and Tarimcilar (2007), Aysan and Ceyhan (2008), Kasman and Kasman (2011) and Fukuyama and Matousek (2011) employ non-parametric approach to measure efficiency. On the other hand, Kasman (2002), Isik and Hassan (2002), El-Gamal and Inanoglu (2005), Demir, Mahmud and Babuscu (2005) and Assaf, Matousek and Tsionas (2013) apply parametric approach for measuring efficiency. However, the most recent study's (Assaf, Matousek and Tsionas (2013)) data ends in 2010 which does not allow us to see how Turkish banks perform during the 2008 economic crisis. Thus, new investigation on the measuring the efficiency of Turkish banks is needed.

The main objective of this study is to measure cost efficiency of 22 Turkish commercial banks over the period of the first quarter of 2003 and the third quarter of 2012. Due to our recent data, we could observe how Turkish commercial banks perform in terms of cost efficiency during 2008 economic crisis. Following Battese and Coelli (1995), we estimate the cost efficiency through stochastic frontier approach, where the inefficiency effects are assumed to be a linear function of a set of bank specific variables. After specifying the most appropriate model, hypothesis tests are performed in order to check the validity of the selected model. Moreover, weighted average of cost efficiency of all commercial banks and sub-groups determined by scale and ownership status are analyzed. Finally, persistency of cost efficiency of all commercial banks and sub-groups are investigated and to the best of our knowledge our study is the first one that provides an analysis for this issue.

Our empirical results reveal that, while intermediation ratio and deposit divided by liabilities have negative effects, labor per branch has a positive effect on the inefficiency of banks. Furthermore, weighted average of cost efficiency shows an upward trend until the third quarter of 2008 means that effects of 2001 financial crisis is disappearing and banking system is strengthening. However, after the third quarter of 2008, commercial banks start to be effected by 2008 economic crisis and it takes 10 quarters to recover from the effects of the crisis. Moreover, analyzing the cost efficiency of sub-groups reveals that, state banks and large banks are the least efficient groups. All sub-groups have an upward trend for cost efficiency until 2008. Furthermore, it is observed that bank groups recover from 2008 economic crisis differently. Finally, cost efficiency of commercial banks is found to be persistent, suggesting that a relatively efficient (inefficient) bank remains relatively efficient (inefficient) for a long period of time.

The rest of the paper is organized as follows. Chapter 2 gives a brief review of the efficiency literature. Chapter 3 presents data and descriptive statistics. Chapter 4 describes the model employed to measure cost efficiency while Chapter 5 discusses the empirical results. Finally, Chapter 6 concludes the paper.

CHAPTER 2

LITERATURE REVIEW

In competitive markets firms are expecting to operate efficiently due to the survival principal. However, many empirical studies including Farrier and Lovell (1990), Mester (1996) and Berger and De Young (1997) provide evidence for existence of the inefficiency. The literature on calculation of efficiency measures dates back to Debreu (1951) and Farrell (1957). Debreu (1951) introduces a coefficient of resource utilization yielding measures of the efficiency of the economy. Moreover, Farrell (1957) suggests that technical efficiency could be analyzed in terms of realized deviations from an idealized frontier isoquant.

There are different types of efficiency concepts.[1] Technical efficiency measures the ability of a firm to obtain maximal output using fixed level of inputs. Allocative efficiency also called price efficiency implies that a firm uses its inputs in the optimal proportions to produce fixed level of output. Economic efficiency (Leibenstein calls X efficiency), on the other hand, is proposed by Leibenstein (1966) and combines technical and allocative efficiencies. In our research we estimate cost efficiency, which combines technical and allocative efficiencies. It provides a measure of how close a bank's actual cost is to the best practice firm's cost for producing an identical output bundle under comparable conditions. When there is single output technical efficiency is easy to estimate however if there are multiple outputs, cost function is used for

[1] There are also scale and profit efficiency concepts. They are not mentioned in the thesis as they are beyond the scope of this thesis. For details, see Coelli, Rao, O'Donnell and Battese (2005).

measuring efficiency.[2] To be able use cost function, behavioral assumption that firms are cost minimizers is imposed. Efficiency analysis has a vast literature based on parametric, non-parametric and semi-parametric approaches.

Data Envelopment Analysis (DEA) is an example of a non-parametric approach. DEA term firstly used by Charnes, Cooper and Rhodes (1978), is a linear programming which allows calculating efficiency without imposing any functional form for the production or the cost process. Despite this advantage, DEA does not allow for random shocks and measurement errors in the model. Random shocks to the model and measurement errors in the variables are considered as inefficiency. In the literature, Isik and Hassan (2002), Yildirim (2002), Denizer, Dinc and Tarimcilar (2007), Aysan and Ceyhan (2008), Fukuyama and Matousek (2011), Kasman and Kasman (2011) use DEA to measure the efficiency in Turkish banking sector.

There are also semi-nonparametric approaches which integrate properties of both parametric and nonparametric approaches to measure efficiency. Stochastic nonparametric envelopment of data proposed by Kuosmanen and Johnson (2010) is an example of a semi-nonparametric approach. Stochastic nonparametric envelopment of data does not impose any functional form for the frontier function, however the model includes stochastic frontier type composite error term, which covers random error and inefficiency of firms. Also environmental factors can be controlled in the model. Coefficients of the outputs are specific to firms which mean that heterogeneity is taken into account as well. Kuosmanen (2012) and Eskelinen and Kuosmanen (2013) apply stochastic nonparametric envelopment of data to Finnish electricity distribution and the branches of a bank in Finnish banking industry, respectively.

Regarding parametric approaches, the most commonly used one is stochastic frontier approach, while distribution free approach and thick frontier approach are two alternatives to the stochastic frontier approach. Stochastic frontier approach is proposed by Aigner, Lovell and

[2] Alternatively, profit function can be used. Also distance functions proposed independently by Malmquist (1953) and Shephard (1953) are used to estimate efficiency and productivity without imposing any behavioral assumptions.

Schmidt (1977) and Meeusen and van den Broeck (1977). In this approach, the disturbance term consists of two components; a non-negative random variable representing production inefficiencies and a random error. Aigner et al. (1977) apply maximum likelihood estimation (MLE) procedure. After the estimation of the frontier, inefficiency part of the composite error is obtained through Jondrow, Lovell, Materov and Schmidt's (1982) method. To be able to use MLE, distributions of inefficiency term and random error should be specified. However, in distribution free approach there is no need to impose any distributional assumptions for the error term and inefficiency term. Time invariant fixed effects model for the frontier approach proposed by Cornwelll, Schmidt and Sickles (1990) is an example of distribution free approach. Functional form for the frontier function is imposed where intercept term gives the relative efficiency compared to the best practice firm. Like distribution free approach, thick frontier approach employed by Berger and Humphrey (1991) does not impose any distributional assumption for inefficiency and random error term. Berger and Humphrey (1991) specify a functional form for the frontier function and divide the sample according to its size and within classes two groups are defined; the lowest cost quartile and the highest cost quartile. Stochastic frontier approach compares the efficiency of firms with the best practice firm under comparable conditions. Unlike the other parametric approaches, in thick frontier approach, the frontier is thick and deviations in the predicted performance values from the lowest and highest quartiles represent inefficiency while deviations from the predicted performance values within the highest and lowest quartiles of observations represent random error.

In the efficiency analysis literature, there are single and cross country studies.[3] In a single country framework bank efficiency is explored in studies by Kumbhakar and Wang (2007) and Du and Girma (2011) for China; Koetter and Wedow (2010) for Germany; Manlagnit (2011) for Philippines and Almanidis (2013) for the USA. Carvallo and Kasman (2005), Kasman and Yildirim (2006), Poghosyan and Kumbhakar (2010) and Williams (2012), on the other hand, are cross country studies, analyzing 16 Latin American countries, new members of the European Union, the former Soviet republics and Central and Eastern European countries and the Latin America, respectively.

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[3] There are also studies analyzing efficiency for branches of a specific bank, see, for example Yang and Liu (2012) and Eskelinen and Kuosmanen (2013).

While making single or cross-country analysis, studies account also for heterogeneity among banks. Mester (1997) indicates existence of heterogeneous markets in the USA and deals with the heterogeneity by estimating different stochastic frontiers for different districts. Bos, Koetter, Kolari and Kool (2009) examine the effects of heterogeneity on efficiency scores and find out that heterogeneity matters. One way to control for differences in environmental factors, risk and managerial preferences is to impose truncated normal distribution for inefficiency term which has heterogeneous mean higher than zero and a linear function of variables that effect inefficiency and has constant variance as suggested by Battese and Coelli (1995). Another way is to include environmental factors into translog functional form. Carvallo and Kasman (2005) directly include density of population, income per capita, density of demand for each country, concentration ratio, average capital ratio, intermediation ratio, money growth, Gross Domestic Product (GDP) growth and accessibility of banking services into the translog functional form without including cross product terms. Greene (2005) proposes another way to account for heterogeneity within firms. Greene (2005) proposes that intercept term is individual specific fixed parameter in the frontier function which he calls true fixed effects model, or intercept term could be random effects which is drawn from a known distribution and he calls it true random effects model. Moreover, Alvarez, Amsler, Orea and Schmidt (2006) suggest another form of truncation model for the stochastic frontier approach. They suggest to scale the mean and the standard deviation of the truncated normally distributed inefficiency variable by the same linear function of the inefficiency variable. On the other hand, there are studies in the literature that takes into account heterogeneity in technology also called heterogeneity in parameters; Swamy and Tavlas (1995), Battese, Rao and O'Donnell (2004), Orea and Kumbhakar (2004), El-Gamal and Inanoglu (2005), Wang and Kumbhakar (2009) and Almanidis (2013).

To control environmental factors, risk and managerial preferences the specification of Battese and Coelli (1995) is utilized by studies Demir, Mahmud and Babuscu (2005), Kasman and Yildirim (2006), Kumbhakar and Wang (2007), Manlagnit (2011) and Kasman, Kasman and Turgutlu (2011). In the studies above, as inefficiency correlates, single country studies use variables that control risk and managerial preferences of banks and bank specific variables such as; size of the bank, ratio of loans to total earning assets, the rate of return on assets, ratio of loan loss provision to total loans, ratio of equity to total assets, intermediation ratio, deposit over liabilities and mergers, stock market listing, bank ownership, size and deregulation dummies and trend. For the cross-country studies environmental factors such as; density of population, GDP per capita, GDP growth, density of demand, density of deposits, average capital ratio, inflation, ratio of M2 to GDP, Hirschman Herfindahl index are used.

Measuring the efficiency of the Turkish banking system is also analyzed by some studies. Zaim (1995), Yildirim (2002), Isik and Hassan (2003), Ozkan-Gunay and Tektas (2006), Denizer, Dinc and Tarimcilar (2007), Aysan and Ceyhan (2008), Kasman and Kasman (2011) and Fukuyama and Matousek (2011) utilize non-parametric approaches to measure efficiency in Turkish banking industry. While Isik and Hassan (2002) use both parametric and non-parametric approaches, Kasman (2002), El-Gamal and Inanoglu (2005), Demir, Mahmud and Babuscu (2005) use stochastic frontier approach to estimate efficiency in Turkish banking system. Moreover, Assaf, Matousek and Tsionas (2013) utilize Bayesian inference for the stochastic frontier estimation by using input distance function.

Zaim (1995) investigates the effects of financial liberalization on efficiency of Turkish banks. On the other hand, Ozkan-Gunay and Tektas (2006), Denizer et al. (2007) and Fukuyama and Matousek (2011) study efficiency of banks before and after crisis period. Other studies such as; Kasman (2002) and Demir, Mahmud and Babuscu (2005) account for heterogeneity in risk and managerial preferences. While Kasman (2002) deals with heterogeneity by including liquidity ratio and ratio of loan loss provision into the cost frontier function, Demir, Mahmud and Babuscu (2005) employ Battese and Coelli (1995) specification which allows heterogeneous means of inefficiency for each bank. They also use two other specifications for the inefficiency. Isik and Hassan (2003) and Aysan and Ceyhan (2008) employ two stage approach in their study. In the first stage by using DEA, they calculate efficiency and productivity measures and in the second stage they find the determinants of productivity and efficiency in Turkey. On the other hand, El-Gamal and Inanoglu (2005) take into account heterogeneity in technology and find out that there exist heterogeneous technologies among private and foreign banks.

This study aims to measure cost efficiency of commercial banks in Turkey. We control risk and managerial preferences of firms by using Battese and Coelli (1995) specification for the inefficiency, which allows heterogeneous means for the inefficiency of each bank as in Demir, Mahmud and Babuscu (2005). We focus on commercial banks in Turkey due to homogeneous technology assumption. Moreover, due to our recent data set, 2003Q1- 2012Q3, we will be able to see the effects of 2008 economic crisis more clearly than the most recent study of Assaf, Matousek and Tsionas (2013). Furthermore, to the best of our knowledge, our study is the first one in the literature that investigates the persistency of the cost efficiency of commercial banks in Turkey.

CHAPTER 3

DATA

The data cover the period of the first quarter of 2003 and the third quarter of 2012. The data is extracted from financial statements (balance sheets and income statements) of 22 commercial banks which are published quarterly. Financial statements are obtained from the database of The Banks Association of Turkey. Nonconsolidated financial statements are used because consolidated financial statements include affiliate institutions' information. Due to the fact that we are interested in cost efficiency of commercial banks but not its affiliated businesses, we use nonconsolidated financial statements.

With the assumption of homogeneous technology, we focus on the cost efficiency of commercial banks in Turkey.[4] We include the banks that operate within the first quarter of 2003 and the third quarter of 2012. In the third quarter of 2012, there are 3 state-owned, 10 foreign banks and 12 privately-owned commercial banks in Turkey.[5] List of the banks included into our analysis and the code numbers assigned them are reported in Table 6 in Appendix A.

[4] Development and investment banks are also excluded from our model because they do not accept deposits.

[5] 6 Foreign banks having branches in Turkey are excluded from our model. When we include five of these banks (JPMorgan Chase Bank N.A. is not included because this bank has zero values for deposits) into our model, results are distorted. Model gives misleading results. Moreover, while estimating cost efficiency we impose a behavioral assumption that banks are cost minimizer. There is one bank operating under the Deposit Insurance Fund. We did not include this bank into our analysis because we can-not be sure whether Birleşik Fon Bankası is a cost minimizer. Furthermore, Deutche Bank A.Ş. and Ada Bank A.Ş. are excluded from our model because in some periods, deposits are zero. Finally, Odea Bank A.Ş. is excluded from the model because it is founded in 2012 and high start up costs could cause misleading results.

The 22 banks that we include into our model on average cover 95.43% of the commercial banks in terms of total assets in Turkey. Furthermore, 22 commercial banks on average cover 92.02% of the banking system in Turkey.

As Wang and Kumbhakar (2009) state in their article, services sector take output as exogenous so estimating cost efficiency is more appropriate for the banking industry. Following their study, we prefer to estimate cost efficiency of commercial banks in Turkey. Our dependent variable is total cost (C) which is equal to summation of interest and noninterest expenses. Noninterest expense is equal to summation of provision of loan losses or other receivables and other operating expenses. In our model we have two set of explanatory variables; cost frontier variables and inefficiency correlates. For the cost function, outputs and input prices are required. However, for the banking industry it is difficult to determine outputs and inputs. There are several approaches to determine inputs and outputs for a bank. Intermediation approach proposed by Sealy and Lindley (1977) assumes that banks are financial intermediaries and they use capital, labor and deposits and produce loans and other earning assets. Other approaches are user cost and value added approaches, proposed by Hancock (1985a) and Berger and Humphrey (1992) respectively. In intermediation approach deposits are considered as inputs. In the value added approach, deposits are considered as both an input and an output because it is assumed that banks are financial intermediaries and they provide some financial services such as safekeeping as well. In user cost approach, banking activities are considered as inputs or outputs according to empirical results; according to sign of its derivative in bank's profit function. In the literature, Kasman and Yildirim (2006) utilize value added approach, while Mester (1997), Orea and Kumbhakar (2004), Wang and Kumbhakar (2009), Manlagnit (2011), Du and Girma (2011), Williams (2012) apply the intermediation approach and Devaney and Weber (2002) apply user cost approach. In our analysis we adopt intermediation approach proposed by Sealy and Lindley (1977) and assume that banks are financial intermediaries using physical capital, labor along with deposits and producing loans and other earning assets such as securities.

Our explanatory variables in the frontier function are outputs, input prices, equity and trend. Equity (q) is included in order to capture the observable heterogeneity among banks and equals owners' equity. Trend (t) is included to capture technical changes that affect the cost through time. We determine two outputs and two input prices in our model. Following Kumbhakar and Wang (2007), outputs are determined as total loans (y_1) and other earning assets (y_2). y_1 is equal to summation of short term loans, long term loans and loans under follow up subtracted from specific provisions, y_2 is calculated by summing trading securities, money market securities, investment securities are available for sale and investment securities held to maturity. Following Manlagnit (2011), our input prices cover price of labor, price of physical capital and price of funds. Our first input price is determined as price of physical capital and labor (W_1) and second input price variable is price of loanable funds (W_2). W_1 is calculated by dividing summation of provision of loan losses or other receivables and other operating expenses to total assets.[6] W_2 is equal to interest expenses divided by total deposits. A detailed summary of all variables is provided in Table 1.

Second set of variables represents inefficiency determinants and they cover intermediation ratio $(INTER)$, Deposits/Liabilities (DL) and Labor per branch (LPB).[7] $INTER$ is equal to ratio of loans to deposits. $INTER$, following Kasman and Yildirim (2006) and Manlagnit (2011), is included to capture differences of banks' ability to convert deposits into loans. It is hypothesized that banks which has higher intermediation rates are more efficient, suggesting an inverse relationship between inefficiency and $INTER$. LPB is equal to number of employees divided by number of branches. Orea and Kumbhakar (2004) use LPB in their study as an indicator for technology. In this study we include LPB to control the inefficiency differences

[6] We could not use two separate input price variables for physical capital and labor because data as a proxy for personnel expenses (Payments to personnel and service suppliers obtained from statement of cash flow) is available semiannually from the first quarter of 2003 to the second quarter of 2005. Since we study with quarterly data, to be able to avoid the unbalanced data problem, following Kasman and Yildirim (2006) we augmented these two variables.

[7] We also considered loan provision which equals provision of loan losses divided by total loans, capital ratio is equal to owners' equity divided by total assets and liquidity ratio which is equal to cash and central bank divided by total assets to include in our model. While choosing the appropriate model for our research, we considered these six variables, however loan provision, capital ratio and liquidity ratio are statistically insignificant in our models. That's why we only include the variables reported in Table 1. More details will be given at the empirical results part of the thesis.

among the small banks operating in highly populated cities with more crowded branches and banks with a lot of branches employing fewer employees per branch. Empirical investigation will reveal the relationship between LPB and inefficiency for the commercial banks in Turkey as we can expect both negative and positive relationship between LPB and cost inefficiency. Finally, DL is equal to deposits divided by liabilities. Manlagnit (2011) uses DL to control governance stance of the bank that affects inefficiency. Negative relationship between DL and inefficiency is expected.

Table 1: List of variables

Dependent variable			
Total cost (C)	Interest expense + Noninterest expense		
Cost frontier		***Inefficiency correlates***	
Outputs		Intermediation ratio ($INTER$)	Total Loans / Total Deposits
Total Loans (y_1)	Short term loans + Long term loans + Loans under follow up - Specific provisions	Deposits/Liabilities (DL)	Total Deposits / Liabilities
Other earning assets (y_2)	Trading securities + Money market securities + Investment securities available for sale and held to maturity	Labor per branch (LPB)	(Number of employees) / Number of branch
Input prices			
Price of labor and physical capital (W_1)	(Provision of loan losses or other receivables + Other operating expenses) / Total Assets		
Price of loanable funds (W_2)	(Interest expenses) / Total deposits		
Equity (q)	Owners' Equity		
Trend (t)	Trend		

Cost efficiency is analyzed by calculating for different sub-groups determined by ownership and scale. Information about sub- groups determined by ownership status (privately owned banks, state owned banks and foreign banks) extracted from The Banks Association of Turkey for each quarter. Moreover, market share of all commercial banks are calculated to specify sub-groups determined by scale. Figure 1 shows the market share of all 22 banks in terms of total assets. On average commercial banks' market share is approximately 4.5%. Figure 1 reveals that banks can be divided into three groups according to their market shares: small banks (banks having market share of less than 1 percent), medium sized banks (banks having market share of between 1 and 8 percent) and large banks (banks having market share of more than 8 percent). Based on this classification, there are 7 large, 5 medium scaled and 10 small banks. Although Bank 12's market share is 1.16%, it is considered as a small bank since it barely exceeds 1% barrier.

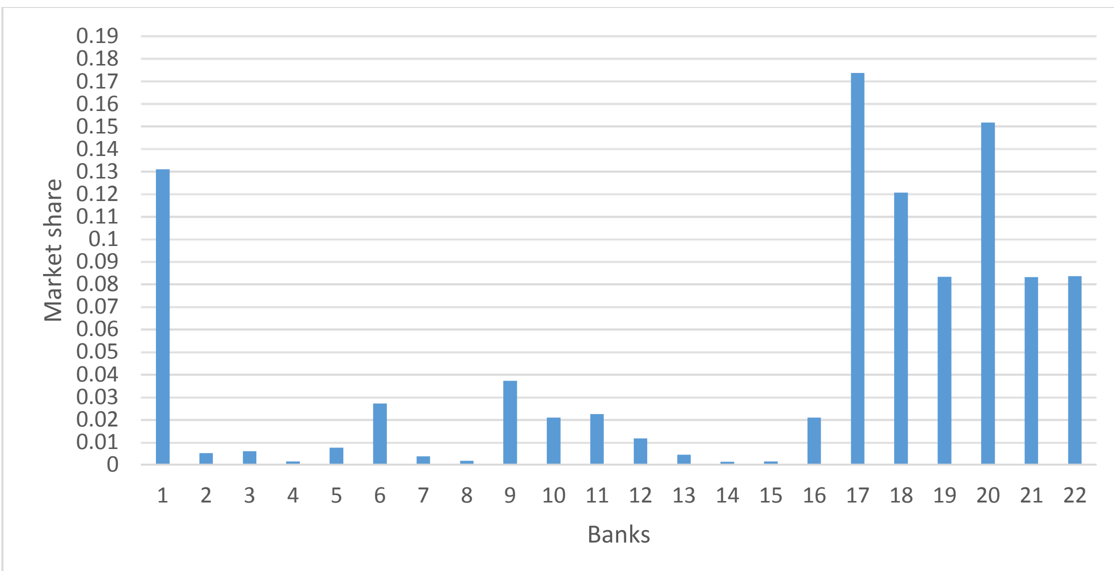

Figure 1: Average market share of 22 commercial banks in terms of total assets over the first quarter of 2003 and the third quarter of 2012. (Source: The Banks Association of Turkey)

Table 2 provides descriptive statistics for all commercial banks and for sub-groups determined by ownership status and scale. C, y_1, y_2, q and ta are the nominal values and the results are given in terms of 1.000.000 Turkish liras (TRY).[8] First row for each variable shows the mean

[8] Descriptive statistics of our variables are reported in nominal values to be able give more insightful picture. However for the analysis we deflated dependent variable, outputs and equity to eliminate the effects of increase in the price level by using consumer price index having base year 1994.

value and the row below shows the standard deviation of each variable for all commercial banks and for sub-groups. $INTER$ and DL are in percentage values while LPB shows the number of employees per branch. Number of observations, number of banks and average number of periods are also reported for all groups. Because of mergers and acquisitions in the banking system there are transitions between groups defined by ownership status.[9] Hence, average number of periods differs among sub-groups.

Average total cost of commercial banks is equal to 689.6 million TRY. Standard deviation is quite high, 834.9 million TRY. For state banks, average total cost is more than twice the overall mean, while average total cost of private bank is slightly higher than the overall mean and average cost of foreign banks is lower than the overall mean. As it is expected, average total cost of large banks is higher than that of medium and small banks. Standard deviations are quite high for all bank groups which suggests that we have dispersion for C, y_1, y_2, q and ta. State banks have higher average total loans, y_1 and other earning assets, y_2 than private and foreign banks. Average equity, q, is equal to 3099 million TRY for all commercial banks. State banks' average q is higher than private banks' and foreign banks' average q. On average ta is equal to 26580 million TRY and the standard deviation is equal to 37287.5 million TRY. On average state banks have higher ta than private and foreign banks. As it is expected, average C, y_1, y_2, q and ta is higher for large banks than for medium and small banks.

Average LPB, is 22.8 employees for all commercial banks. Average LPB is 29.5 employees for foreign banks and it is followed by private and state banks with 20 and 19 employees, respectively. Average LPB are 26.1, 20.5 and 19.7 employees for small, medium, and large banks respectively. Average $INTER$ is 83.12% for all commercial banks. Average $INTER$ is 99.26% for foreign banks and it is followed by private and state banks with 81.68% and 52.33%, respectively. In addition, average $INTER$ are 98.84%, 86.75% and 66.71% for medium, small and large banks respectively. On average 72.45% percent of the liabilities of the banks consist

[9] Through mergers and acquisitions Bank 9 is classified as a foreign bank in the third quarter of 2006, while it was a private bank before. Bank 6 is classified as a foreign bank in the fourth quarter of 2006, while it was a private bank before. Bank 7 and 15 are classified as foreign bank in the first quarter of 2007, while they were private bank before. Bank 11 is classified as foreign bank in the last quarter of 2007, while it was private bank before.

of deposits. State banks has a higher average DL 82.45%, than private and foreign banks with 72.27% and 68.37%, respectively. Average DL are 77.14%, 70.87% and 69.94% for large, medium and small banks respectively. More details can be seen from Table 2.

Table 2: Descriptive statistics for all commercial banks and sup-groups

	Overall	**Private Banks**	**Foreign Banks**	**State Banks**	**Large Banks**	**Medium Banks**	**Small Banks**
Variable							
Standard deviation							
Cost Frontier							
C	689.622	693.639	267.316	1633.425	1723.531	459.159	81.117
	834.979	880.812	303.293	680.427	702.393	268.135	84.198
y_1	13261.97	14149.14	5917.399	26358.09	32403.03	10187.65	1400.378
	19199.6	21474.62	7561.769	20210.07	23246.94	7600.688	1581.329
y_2	8940.27	8118.57	1856.398	28381.44	25030.23	2927.809	683.527
	14442.31	12443.85	2227.415	19946.01	16406.5	2209.573	845.324
W_1	0.144	0.014	0.017	0.008	0.010	0.015	0.016
	0.009	0.008	0.012	0.003	0.007	0.004	0.011
W_2	0.027	0.028	0.025	0.029	0.027	0.026	0.028
	0.012	0.009	0.015	0.013	0.010	0.007	0.014
q	3099.21	3419.108	1200.028	6118.279	7897.954	1905.2	337.095
	4325.243	5070.256	1367.803	3317.808	4734.687	1354.253	317.364
ta	26580.28	26994.17	9361.024	64048.04	68461.82	15903.36	2601.67
	37287.55	39565.69	11239.53	38600.84	40206.69	11068.46	2651.489
Inefficiency correlates							
DL	0.724	0.722	0.683	0.824	0.771	0.708	0.699
	0.145	0.094	0.212	0.056	0.094	0.072	0.188
$INTER$	0.831	0.816	0.992	0.523	0.667	0.988	0.867
	0.362	0.265	0.449	0.254	0.247	0.209	0.437
LPB	22.856	20.048	29.563	19.008	19.734	20.548	26.196
	10.785	4.348	16.524	2.829	3.196	3.921	14.858
Observations	N=858	N=475	N=266	N=117	N=273	N=195	N=390
	n=22	n=15	n=9	n=3	n=7	n=5	n=10
	T=39	T-bar=31.667	T-bar=29.556	T=39	T=39	T=39	T=39

Notes: C, y_1, y_2, q and ta are the nominal values and results reported in terms of 1.000.000 Turkish liras. First row for each variable shows the mean value and the row below shows the standard deviation of each variable. $INTER$ and DL are in percentages while LPB shows the number of employees per branch.

Moreover, according to variance-covariance matrix of dependent and explanatory variables, reported in Table 7 in Appendix A, the explanatory variables included in the cost frontier function are highly correlated. Especially there is high correlation among y_1, y_2 and q and their cross products.

CHAPTER 4

METHODOLOGY

This paper measures the cost efficiency of commercial banks in Turkey through cost functions. Total cost, C_{it} , is expressed as a function of outputs and input prices, where y_{it}, w_{it} and β stands for outputs, input prices and parameters to be estimated, respectively as:

$$C_{it} = c(y_{it}, w_{it}; \beta) \quad (1)$$

When we integrate inefficiency into the model, cost function becomes

$$C_{it} = c(y_{it}, w_{it}; \beta)\exp(u_{it}) \quad (2)$$

where u_{it} represents inefficiency. Equation (2) is a deterministic frontier function where all deviations from minimum cost are ascribed to inefficiency. However, minimum cost itself can be higher or lower due to random exogenous schocks. Effect of exogenous shocks on C_{it} is taken into account by including random error term into the cost function as in Equation (3) and becomes stochastic cost frontier function.

$$C_{it} = c(y_{it}, w_{it}; \beta) exp(v_{it}) exp(u_{it}) \quad (3)$$

This study employs stochastic frontier approach introduced by Aigner et al. (1977) and Meeusen and van den Broeck (1977). As it is shown in Equation (3), the frontier function has a composite error term with two components: u_{it} representing non-negative random variable associated with inefficiencies and v_{it} representing the random error term.

There are three main topics to be considered carefully while employing stochastic frontier approach. Firstly, if MLE is applied, distributions for the random error and the inefficiency term should be specified in advance. Secondly, specification of the inefficiency needs to be determined. Finally, appropriate functional form for the frontier function must be determined.

Imposing appropriate distributional forms for the inefficiency and random error term is the first issue to be clarified in the stochastic frontier approach. In literature for the random error part of the composite error term, independently and identically distributed assumption is imposed. For the inefficiency term there are several alternatives. For instance, Aigner et al. (1977) use a normal-half-normal model with mean is zero and also propose normal-exponential model. However zero mean is an unnecessary restriction for the inefficiency term. That is why this inefficiency term is obtained by truncation (at zero) of normal distribution with mean higher than zero. Stevenson (1980) proposes normal-truncated normal and normal-gamma distribution for stochastic frontier estimation, while Greene (1990) proposes an alternative gamma distributed stochastic frontier model. We impose truncation of normal distribution for the inefficiency term because zero mean for the inefficiency term force inefficiency level to be near zero which could cause misleading results. Moreover, for the random error part independently and identically distributed assumption is imposed.

Second issue to deal with is the specification of the inefficiency term. While specifying the inefficiency term, in a panel data setting, it should be first determined whether inefficiency will be time invariant or not. If it is assumed to be time invariant then the model is considered as random effects model proposed by Pitt and Lee (1981) or fixed effects model proposed by Cornwelll et al. (1990). Inefficiency models allowing for time variation are proposed by Cornwell et al.'s (1990), Kumbhakar (1990), Battese and Coelli (1992), Lee and Schmidt (1993), Battese and Coelli (1995) and Alvarez, Amsler, Orea and Schmidt (2006). Model proposed by Battese and Coelli (1995) is used to be able to account bank-specific variables (risk and managerial preferences) that affect the inefficiency while estimating the cost function.

To sum up, in this study, v_{it} in Equation (3) are assumed to be independently identically distributed $N(0,\sigma_v^2)$ random errors and independently distributed of the u_{it}. u_{it} are independently distributed inefficiency effects such that u_{it} is obtained by truncation (at zero) of the normal distribution with mean, $z_{it}\eta$, and variance σ_u^2; z_{it} is a (1 x m) vector of bank specific variables associated with cost efficiency of banks over time; and η is an (m x 1) vector of unknown coefficients as proposed by Battese and Coelli (1995). u_{it}, representing the inefficiency effect, can be formalized as:

$$u_{it} = z_{it}\eta + w_{it} \quad (4)$$

where w_{it} is defined by the truncation of the normal distribution with zero mean and the variance, σ_u^2, such that the point of truncation is $-z_{it}\eta$. As mentioned above u_{it} is defined by non-negative truncation of the $N(z_{it}\eta, \sigma_u^2)$-distribution. If the first variable in z is intercept term and coefficients of all other variables are zero, then, the model becomes equivalent to the model where the inefficiency term has truncation of normal distribution specified in Stevenson (1980). If all elements in the η vector are equal to zero, then half normal distribution proposed by Aigner et al. (1977) is obtained.

Cost efficiency for the i-th bank at t-th observation is defined as:

$$CE_{it} = \frac{c(y_{it}, w_{it}; \beta) exp(v_{it})}{c(y_{it}, w_{it}; \beta) exp(v_{it}) exp(u_{it})} \quad (5)$$

where $c(y_{it}, w_{it}; \beta) exp(v_{it})$ shows the value of cost for the best practice firm at t-th observation and $c(y_{it}, w_{it}; \beta) exp(v_{it}) exp(u_{it})$ shows the value of cost for the i-th firm at t-th observation and the cost efficiency is equavalent to

$$CE_{it} = ex\,p(-u_{it}) = exp(-z_{it}\eta - w_{it}) \quad (6)$$

u_{it}s are obtained using the method proposed by Jondrow et al. (1982), then cost efficiency can be written as

$$\widehat{CE_\iota} = exp\big(-E(\widehat{u_\iota} | \varepsilon_i)\big) \quad (7)$$

where

$$\varepsilon_{it} = u_{it} + v_{it} \quad (8)$$

Cost efficiency takes the value between zero and one.

Final issue to be clarified is determining an appropriate functional form for the cost function in Equation (9). Linear, Cobb-Douglas, Quadratic, Normalized quadratic, Translog, Fourier flexible, Generalized Leontief, Constant Elasticity of Substitution functional forms are the most commonly used ones in the literature. Linear and Cobb-Douglas functional forms are first order flexible functions while the rest are second order flexible functions. To be able to have flexible frontier function, second order flexible functional forms are used, however second order flexible functional forms bring multicollinearity problem. In recent literature, translog and Fourier flexible functional forms are commonly used for cost frontiers for the banking system. Berger and De Young (1997), Altunbas, Evans and Molyneux (2001), Kasman (2002), Kasman and Yildirim (2006) use Fourier flexible functional form for the frontier function to estimate efficiency, while Mester (1997), El-Gamal and Inanoglu (2005), Bos, Koetter, Kolari and Kool (2009), Koetter and Wedow (2010), Williams (2012) and Almanidis (2013) employ translog functional form. For the specification of the cost function we impose flexible trancendental, translog, functional form as commonly used in the literature for the banking industry. This is because translog functional form allows flexibility for the cost function, in addition, as Almanidis (2013) points out factor demand elasticities are not required to be constant as in the Cobb-Douglas functional form case. In general setting, translog functional form is written as:

$$y = exp\left(\beta_0 + \sum_{n=1}^{N}\beta_n lnx_n + \frac{1}{2}\sum_{n=1}^{N-1}\sum_{m=1}^{N-1}\beta_{nm} lnx_n lnx_m\right) \quad (9)$$

To be able to satisfy linearity assumption in parameters, we take logarithm of the both sides of the Equation (3) as:

$$\mathrm{lnC_{it}} = \mathrm{lnc(y_{it}, w_{it}; \beta) + u_{it} + v_{it}} \quad (10)$$

Imposing translog functional form for the cost frontier function yields the following equation:

$$ln(C_{it}) = \beta_0 + \sum_{j=1}^{2}\beta_j lny_{jit} + \sum_{k=1}^{2}\alpha_k ln(w_{kit}) + \frac{1}{2}\sum_{j}^{3}\sum_{l}^{3}\delta_{jl} ln\, y_{jit} ln\, y_{lit} + \frac{1}{2}\sum_{k}^{2}\sum_{p}^{2}\varphi_{kp}\, ln(w_{kit}) ln\left(w_{pit}\right) + \frac{1}{2}\sum_{j}^{3}\sum_{k}^{2}\phi_{jk} lny_{jit}\, ln(w_{kit}) + \psi_1 lnq_{it} + \frac{1}{2}\psi_2 lnq_{it}^2 + \sum_{j}^{3}\psi_{3j}\, lny_{it} lnq_{it} + \sum_{k}^{2}\psi_{4k} ln(w_{kit}) lnq_{it} + \theta_1 t + \theta_2 t^2 + \sum_{j}^{3}\theta_{3j} lny_{jit} t + \sum_{k}^{2}\theta_{4k} ln(w_{kit}) t + \theta_5 lnq_{it} t + u_{it} + v_{it} \quad (11)$$

where t denotes the trend and q_{it} denotes equity. Equity and interaction of equity with output, input prices and trend are included to control observable heterogeneity among banks and trend and interaction terms of trend are included into the model to account for non-neutral technological change.

Regulatory conditions; symmetry and linear homogeneity in input prices for the cost function, are also imposed. Symmetry condition is easily imposed to the translog cost function through the following conditions:

$\delta_{jl} = \delta_{lj} \; \forall \; j, l$, $\varphi_{kp} = \varphi_{pk} \; \forall \; k, p$ and $\phi_{jk} = \phi_{kj} \; \forall \; j, m$

Linearity in input price, on the other hand, implies the following conditions;

$\sum_k \alpha_k = 1$, $\sum_k \sum_p \varphi_{kp} = \sum_k \phi_{jk} = \sum_k \psi_{4k} = \sum_k \theta_{4k} = 0$

Linearity in input prices condition is imposed by dividing input prices and the total cost by one input price (w_2; price of loanable funds) as in El-Gamal and Inanoglu (2005), Kumbhakar and Wang (2007), Manlagnit (2011) and Almanidis (2013). Finally, our model becomes:

$$ln\left(\frac{C_{it}}{w_{2it}}\right) = \beta_0 + \beta_1 lny_{1it} + \beta_2 lny_{2it} + \alpha_1 ln\left(\frac{w_{1it}}{w_{2it}}\right) + \frac{1}{2}\delta_{11} lny_{1it} lny_{1it} + \delta_{12} lny_{1it} lny_{2it} + \frac{1}{2}\delta_{22} lny_{2it} lny_{2it} + \frac{1}{2}\varphi_{11} ln\left(\frac{w_{1it}}{w_{2it}}\right) ln\left(\frac{w_{1it}}{w_{2it}}\right) + \phi_{11} lny_{1it} ln\left(\frac{w_{1it}}{w_{2it}}\right) + \phi_{21} lny_{2it} ln\left(\frac{w_{1it}}{w_{2it}}\right) + \psi_1 lnq_{it} + \frac{1}{2}\psi_2 lnq_{it} lnq_{it} + \psi_{31} lny_{1it} lnq_{it} + \psi_{32} lny_{2it} lnq_{it} + \psi_{41} ln\left(\frac{w_{1it}}{w_{2it}}\right) lnq_{it} + \theta_1 t + \theta_2 t^2 + \theta_{31} lny_{1it} t + \theta_{32} lny_{2it} t + \theta_{41} ln\left(\frac{w_{1it}}{w_{2it}}\right) t + \theta_5 lnq_{it} t + u_{it} + v_{it} \qquad (12)$$

where $u_{it} = z_{it}\eta + w_{it}$.

The model is estimated through MLE. The cost frontier log likelihood function is as follows

$$logL_i = -\frac{T_i}{2}(log2\pi + log\sigma^2) - \frac{(T_i-1)log(1-\gamma)}{2} - \frac{1}{2}\sum_{t=1}^{T_i} \frac{\varepsilon_{it}^2}{(1-\gamma)\sigma^2} - \frac{1}{2} log\left[1 + \gamma\left(\left(\sum_{t=1}^{T_i} g_{it}^2\right) - 1\right)\right] - \frac{1}{2}\left(\frac{\mu_i}{\sigma\sqrt{\gamma}}\right)^2 - log\Phi\left(\frac{\mu_i}{\sigma\sqrt{\gamma}}\right) + \frac{A_i^2}{2} + log\Phi(A_i) \qquad (13)$$

where

$\sigma^2 = \sigma_u^2 + \sigma_v^2$

$\gamma = \sigma_u^2/\sigma^2$

$\varepsilon_{it} = y_{it} - \beta' x_{it}$

$$u_{it} = \eta' z_{it} + w_{it}$$

$$\mu_i = \eta' z_{it}$$

$$g_{it} = exp(\delta' z_{it})$$

$$A_i = \frac{(1-\gamma)\mu_i + \gamma \sum_{t=1}^{T_i} g_{it}\varepsilon_{it}}{\sqrt{\gamma(1-\gamma)\left[1+\gamma\left(\left(\sum_{t=1}^{T_i} g_{it}^2\right)-1\right)\right]}}.$$

The estimator of the inefficiency proposed by Jondrow et al. (1982) is

$$E[u_{it}|\varepsilon_{i1}, \varepsilon_{i2}, \ldots] = g_{it}E[u_i|\varepsilon_{i1}, \varepsilon_{i2}, \ldots] = g_{it}\left[\tilde{\mu}_i + \tilde{\sigma}_i\left(\frac{\phi(\tilde{\mu}_i/\tilde{\sigma}_i)}{\Phi(\tilde{\mu}_i/\tilde{\sigma}_i)}\right)\right] \quad (14)$$

where

$$\tilde{\mu}_i = \frac{(1-\gamma)\mu_i + \gamma \sum_{t=1}^{T_i} g_{it}(\varepsilon_{it})}{(1-\gamma) + \gamma \sum_{t=1}^{T_i} g_{it}^2}$$

$$\tilde{\sigma}_i^2 = \frac{\gamma(1-\gamma)\sigma^2}{(1-\gamma) + \gamma \sum_{t=1}^{T_i} g_{it}^2}.$$

Following the model proposed by Battese and Coelli (1995) parameters in the cost frontier function and in the inefficiency model (Equation (12)) are estimated simultaneously, also called one stage method. In earlier papers, researchers use two stage method as Mester (1996). In this method, firstly inefficiency of firms are estimated by assuming that inefficiency is not related with inefficiency determinants. In the second stage, these inefficiency levels of firms are regressed to the inefficiency correlates. Schmidt (2011) argues that one stage method is more preferable than two stage method.[10] Therefore, following Battese and Coelli (1995) variables in the cost frontier and in the inefficiency model are estimated through one-step MLE.

[10] When we employ two-stage method, if inefficiency correlates and variables in the frontier are correlated then estimators of variables in the frontier will be biased. Moreover, we will underestimate the effects of inefficiency correlates on inefficiency. Finally, testing the joint significance of the inefficiency determinants will not be simple.

CHAPTER 5

EMPIRICAL RESULTS

Description of how we choose the appropriate model for the efficiency analyses, results of tests of hypothesis, interpretation of the inefficiency correlates and efficiency analysis of all commercial banks and sub-groups are evaluated in section 5.1. Persistency of cost efficiency of commercial banks is investigated further in section 5.2.

5.1. Specification of the model and results

Given that Equation (12) includes a large number of explanatory variables while we have a small data set, the first issue to be solved is specification of the explanatory variables to be included. Firstly, we drop squared terms from the model following Koetter and Wedow (2010) and consider 6 variables to include as inefficiency correlates. They are liquidity of the banks, ratio of deposits to liabilities, intermediation ratio, labor per branch and ratio of loan loss provision to total loans and ratio of owners' equity to total assets. To be able to choose the best model that explains our dependent variable, we include variables in the cost frontier without the squared terms and we include six combinations of five, six combinations of four and six combinations of three inefficiency correlates into the model.[11] This procedure yields 41 models to be estimated. Among them 8 models, which have similarly low Akaike information criteria (AIC), are selected. For each selected model, the general to specific approach is applied in order to eliminate insignificant variables and obtain parsimonious forms of the models. After

[11] All of the inefficiency correlates are not included into the model because the likelihood function does not converge.

that, we compare weighted average of cost efficiency of all commercial banks. Among the estimated parsimonious models, the one having minimum AIC is selected and estimation results are reported in Table 7 in the Appendix A. The model that we specify has a combination of explanatory variables on level; $intercept$, lny_1, lny_2, lnw_1, lnq, t and interaction terms; $lny_1.lnw_1$, $lny_2.lnw_1$, $lnw_1.lnq$, $lny_1.t$, $lnw_1.t$, $lnq.t$ in the cost frontier function. Since we are interested in measuring the cost efficiency, we focused on the inefficiency model. Table 3 presents the empirical results of the inefficiency model.

Table 3: Correlates of cost inefficiency

Variable	**Coefficient**	**Standard errors**
$intercept$	2.499	736716.6
DL	-0.676***	0.180
$INTER$	-2.270***	0.193
LPB	0.003**	0.001

Note: *, **, *** denote statistically significant at the 10%, 5% and 1% level respectively.

Once the model is specified, we continue with the inefficiency model since we are interested in cost efficiency of commercial banks. As inefficiency correlates there are ratio of deposits to liabilities DL, intermediation ratio, $INTER$, and labor per branch, LPB. Liquidity of the banks, ratio of loan loss provision to total loans and ratio of owners' equity to total assets are statistically insignificant in our models.[12] In addition LPB is statistically significant at the 5% significance level where other two inefficiency correlates are statistically significant at the 1% significance level. Signs of the inefficiency correlates are in line with our expectations. Manlagnit (2011) also finds DL and $INTER$ statistically significant and negative relationship between the inefficiency for the Philippines banking system. DL shows how much of the liabilities of a bank consist of deposits. As banks increase the share of deposits in their liabilities their cost inefficiency decreases. This is because other alternative is to increase their loans from financial markets which they will pay higher interest rate than what they pay to their

[12] However, Demir et al. (2006) find ratio of loan loss provision to total loans statistically significant for the Turkish banks. Manlagnit (2011) finds statistically significant relationship between the inefficiency and capital ratio and loan loss provision divided by total loans for the Philippines banks. Moreover, Poghosyan and Kumbhakar (2009) reveal a statistically significant relationship between the inefficiency and capital ratio, liquidity ratio and loan loss provisions divided by total loans for German banks.

deposits. $INTER$ shows the capability of banks converting their deposits into loans. It is hypothesized that banks fulfill their intermediation process better than others are more cost efficient and our empirical results confirm this hypothesis. As banks give more percentage of their deposits as loans, their inefficiency will decrease significantly. Other inefficiency determinant is LPB. In our analysis it has a positive impact on inefficiency which means that as banks increase their number of employees per branch their inefficiency will increase.

Table 4: Tests of hypothesis

Null Hypothesis	Critical value	Test statistics	Decision
$H_0: \gamma = 0$	10.371	1562.154	$Reject\ H_0$
$H_0: \mu = 0$	3.841	14.829	$Reject\ H_0$
$H_0: \delta_2 = \delta_3 = \delta_4 = 0$	7.814	996.469	$Reject\ H_0$

Note: All are statistically significant at the 1% level. $\gamma = \sigma_u^2/\sigma_u^2 + \sigma_v^2$

Table 4 summarizes some important hypothesis testing results of the selected model. First we need to test whether using the stochastic frontier approach is necessary or not. γ is the ratio of variance of the inefficiency term to variance of the composite error term. So, if it is equal to zero, it either means that the variance of the inefficiency term equals zero or variance of the random error approaches to infinity. In both cases, the null hypothesis of $\gamma = 0$ indicates that there is no need to include inefficiency term in the cost function. Critical values for this null hypothesis are provided by Kodde and Palm (1986) and it is obvious that there is inefficiency in Turkish commercial banks, which supports the necessity of the use of the stochastic frontier approach. Secondly, we need to test for the significance of the mean of the inefficiency score, $\mu = 0$, which will indicate whether we should impose truncation of normal distribution or half normal distribution assumption for the inefficiency. As null hypothesis, the model is estimated by imposing half normal distribution assumption to the inefficiency term and as alternative hypothesis the model is estimated by imposing truncation of normal distribution assumption to the inefficiency term. Inefficiency correlates are not included into the both of these models. Number of restriction for the likelihood ratio test is one which is the mean of the inefficiency term. Likelihood ratio test results show that truncation of normal distribution assumption is preferable for the inefficiency term. Finally, we need to test for the joint significance of the inefficiency determinants by $\delta_2 = \delta_3 = \delta_4 = 0$. Result of the likelihood ratio test shows that the risk and managerial variables that we include are statistically significant to explain the inefficiency term. To sum up, results of these hypothesis tests indicate that, we should use stochastic frontier approach where the inefficiency term has truncation of normal distribution with inefficiency term being a linear function of the inefficiency correlates.

After we estimate the model, the inefficiencies, u_{it}s, are estimated through the method proposed by Jondrow et al. (1982). In this method the inefficiency term is conditioned on the composite error term and information about the inefficiency model and variance parameters of the inefficiency and random error term are used to estimate inefficiencies. After estimating the inefficiencies, we calculate cost efficiency of banks by using following formula:

$$CE = e^{-u_{it}} \tag{15}$$

where u_{it} represents inefficiency. We calculate the mean cost efficiency of each bank and then rank them in ascending order. Table 5 gives the ranking of commercial banks in terms of their mean cost efficiencies. On average cost efficiency is 67% which means that on average commercial banks are 67 percent cost efficient if we compare with the best practice bank producing same amount of goods and services and having the same conditions. Alternatively, on average commercial banks are approximately 33 percent cost inefficient which means that on average commercial banks can decrease their costs by 33 percent comparing with the best practice bank producing same amount of output and having the same conditions. The most inefficient commercial banks are Bank 17, Bank 14, and Bank 19 while the most cost efficient ones are Bank 2, Bank 15 and Bank 13.[13]

[13] Name of the banks together with their codes can be found in Table 6 in Appendix.

Table 5: Ranking of the banks in terms of cost efficiency

Bank Code	Mean Cost Efficiency	Bank Code	Mean Cost Efficiency
17	0.345	18	0.674
14	0.354	16	0.724
19	0.476	3	0.748
5	0.563	6	0.753
20	0.584	4	0.765
21	0.617	9	0.779
12	0.623	11	0.783
8	0.626	10	0.786
1	0.641	13	0.837
7	0.659	15	0.850
22	0.667	2	0.875
		Average	0.67

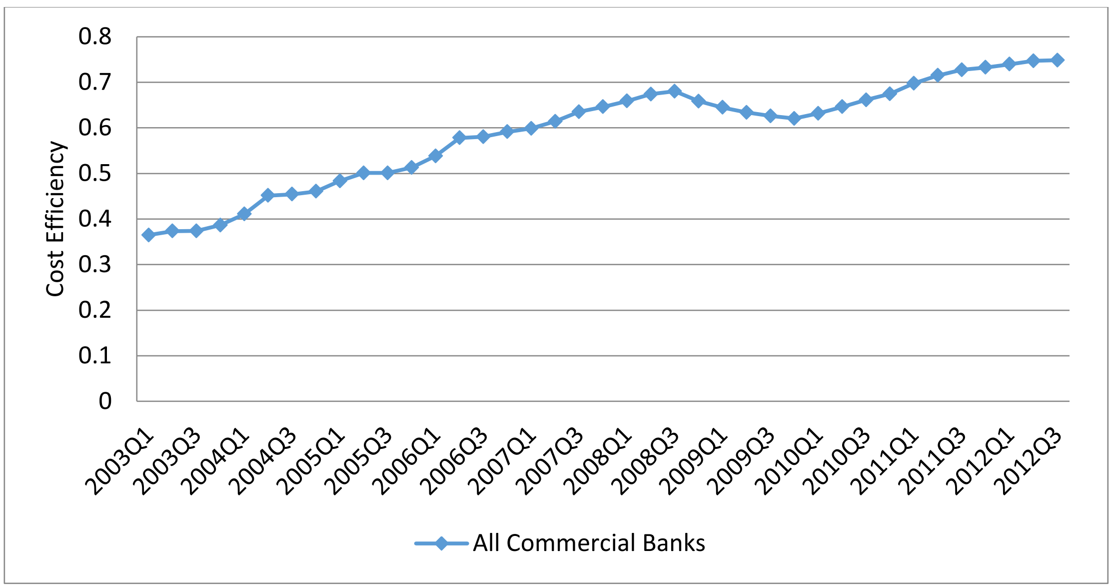

Figure 2: Cost efficiency of all commercial banks

Figure 2 shows the weighted average of cost efficiency of commercial banks over the time period. Weighted average of cost efficiency is 58.8% which means that on average commercial banks are 58.8% cost efficient comparing with the best practice bank producing same amount of output and facing the same conditions. Alternatively, if we subtract efficiency level from one we see that on average commercial banks are approximately 41.2% cost inefficient, on average banks can decrease their cost by 41.2% relative to the best practice bank producing same amount of output and facing the same conditions. Fukuyama and Matousek (2011), the most recent study that measures cost efficiency, find average cost efficiency as %64 by using a non-parametric approach over the period between 1991 and 2007. This finding is quite similar with our simple mean cost efficiency reported in Table 5.

Cost efficiency is in its minimum value, 36.4%, in the first quarter of 2003 and reaches its maximum, 74.8%, in the third quarter of 2012. As seen in Figure 2, there is an upward trend in the cost efficiency from the beginning of our analysis till the third quarter of 2008. In this period we see that effects of 2001 financial crisis are disappearing and financial structure of the commercial banks is getting stronger. 2008 economic crisis reaches its peak with the bankruptcy file of Lehman Brothers on September 15, 2008. After the third quarter of 2008, Turkish commercial banks are started to be effected from 2008 economic crisis in terms of cost efficiency. During the following 5 quarters cost efficiency keep decreasing and reach its bottom, 62%, in the last quarter of 2009. After this period effects of 2008 economic crisis is started to disappear and cost efficiency turned into its upward trend again. Effects of 2008 economic crisis is eliminated and turned into it's before crisis level in the first quarter of 2011 and cost efficiency level is 69.7%. In ten quarters, effects of 2008 economic crisis are disappeared.

It is also important to examine cost efficiency of commercial banks for different sub-categories. Firstly, we analyze cost efficiency of commercial banks by scale. As mentioned before, we have 7 large, 5 medium scale and 10 small banks. Figure 3 shows each bank group's market share. According to Figure 3, on average large, medium sized and small banks have market shares of 82.7%, 12.8% and 4.3%, respectively. While the market share of small banks is 4.6% in the first period of the sample, it decreases to 4.5% at the end of the period analyzed. Similar changes occur in the market shares of large and medium sized banks, so that the market share of large banks decreases from 85.6% to 80% and it increase from 9.6% to 15.3% for medium sized banks.

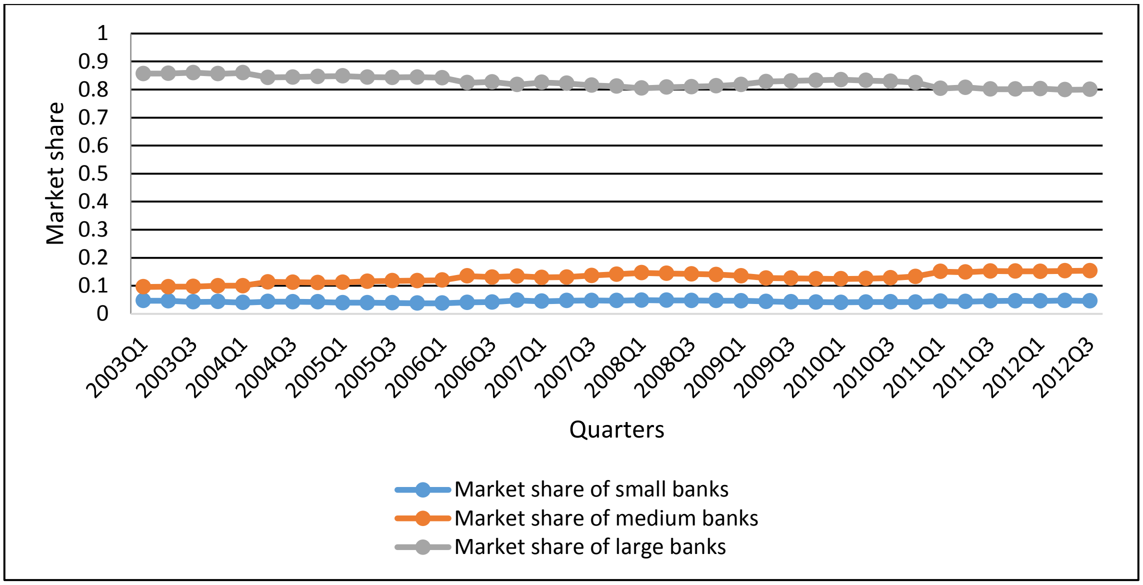

Figure 3: Market share of bank groups determined by scale (Source: The Banks Association of Turkey)

Given the market shares in Figure 3, Figure 4 illustrates weighted average of cost efficiencies for each group of commercial banks. The weighted average of all commercial banks' cost efficiency is also plotted in Figure 4. It is seen that, the highest average cost efficiency is observed for medium sized banks (76.8%), and it is followed by small and large banks with the average cost efficiencies of 68.6% and 55.6%, respectively. Isik and Hassan (2002) also find the same results that medium banks is the most efficient bank group and it is followed by small and large banks respectively.

All commercial banks' cost efficiency follows a pattern quite similar to that of large banks, which is due to the high market share of large banks. Moreover, large banks' cost efficiency starts to decrease after the third quarter of 2008 for subsequent 5 quarters and it takes 10 quarters for large banks to recover from the effects of 2008 economic crisis. After the last quarter of 2009, again cost efficiency follows an upward trend and reaches its maximum, 73.1%, in the last period of the data. Medium and small banks, on the other hand, follow a similar path in terms of cost efficiency. Moreover, in the fourth quarter of 2006 cost efficiency of small and medium banks decreases. The reason might be the mergers and acquisitions performed by foreign banks around that period. After mergers and acquisitions, cost efficiency is expected to decrease and since foreign banks are mostly small and medium banks in our sample, we may infer that cost efficiency decreases for small and medium banks due to mergers and acquisitions in the fourth quarter of 2006. Furthermore, cost efficiency of medium and small banks start to decrease one quarter before large banks getting affected from 2008 economic crisis. Origins of the 2008 economic crisis is abroad and since most of the foreign banks are small and medium banks, they could start to be effected from the crisis one quarter before the large banks which consist of private and state-owned banks. Cost efficiency of medium and small banks decrease for three quarters and after that cost efficiency of medium banks fluctuate around 80 percent and cost efficiency of small banks fluctuate between 70 and 75 percent. In the second quarter of 2011 cost efficiency of medium sized banks exceeds before crisis level and reaches its maximum, 83.5%. Moreover, in the first quarter of 2012 cost efficiency of small banks exceeds before crisis level and reaches its maximum, 77.5%. As you can see from Figure 4 large banks are affected more severely than other two groups. Finally, cost efficiency of large banks converges to the cost efficiency of middle and small banks over the time period.

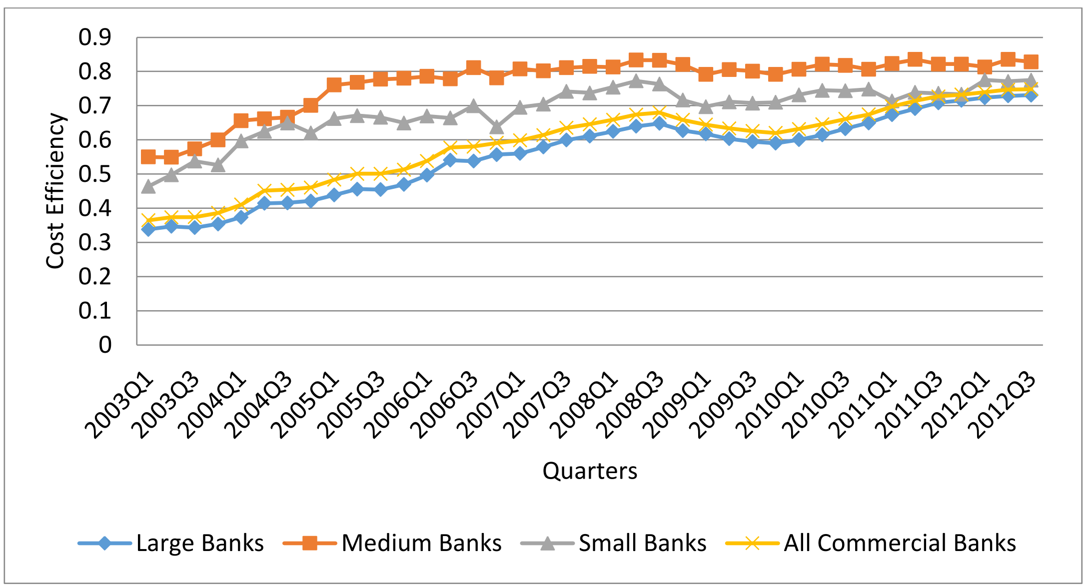

Figure 4: Cost efficiency of bank groups determined by scale

Next, we continue with the cost efficiency analysis regarding the ownership status of commercial banks. The Figure 5 shows the market share of privately owned, foreign and state banks. Average market share of private, foreign and state banks are 57.1%, 8.7% and 34%, respectively. Market share of private banks has an increasing trend between the first quarter of

2003 and the second quarter of 2006 and reaches its maximum in the second quarter of 2006, 63.9%. After the second quarter of 2006 we see that market share of private banks has a decreasing trend. Between the first quarter of 2003 and the third quarter of 2012, market share of private banks decreases from 57.7% to 56.4%. Market share of foreign banks seems steady but increases between the first quarter of 2003 and the third quarter of 2006. In addition, in the fourth quarter of 2006 and in the first quarter of 2008, there are two relatively distinct increases in the market share of foreign banks, while declines are observed in market share of private banks at the same periods obviously due to mergers and acquisitions. In the first quarter of 2008 market share of foreign banks reaches its maximum, 14.1%. After that period, it follows a relatively steady path and in the third quarter of 2012 market share of foreign banks is 13.4%. The market share of state banks, on the other hand, follows a decreasing trend so that it decreases from 39.6% to 30% during the period.

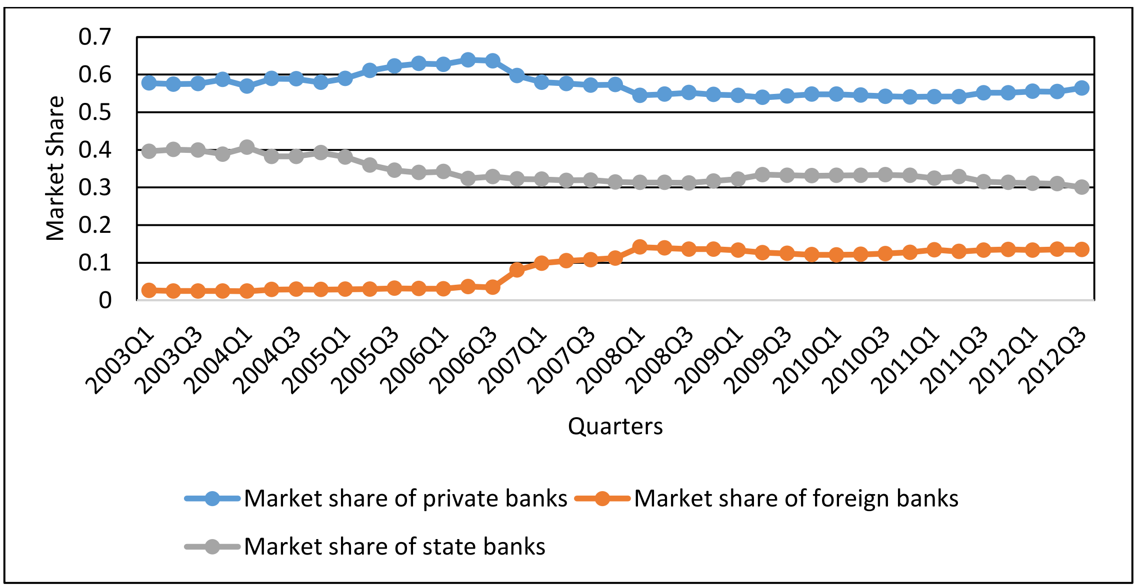

Figure 5: Market share of bank groups determined by ownership status. (Source: The Banks Association of Turkey)

After discussing the market shares of banks based on their ownership status, we plot their cost efficiencies in Figure 6. On average all commercial banks' cost efficiency is 58.8%. Private banks' average cost efficiency is 65.1% which means that on average private banks are 65.1% cost efficient if we compare with the best practice firm producing the same amount of output and having the same conditions. Alternatively, on average private banks can decrease their costs by 34.9% if we compare with the best practice firm producing same amount of output and facing the same conditions. Foreign banks' and state banks' average cost efficiency is 76.5% and 44.5% respectively. State banks' cost efficiency is quite low while foreign banks has the highest average cost efficiency. Zaim (1995) and Isik and Hassan (2002) find similar results. They find that on average foreign banks are more cost efficient than domestic banks and private banks are more efficient than state-owned banks. On the other hand, Fukuyama and Matousek (2011) divide banks into two groups as domestic and foreign banks and they find that on average domestic banks are more efficient than foreign banks. One reason for foreign banks being the most cost efficient could be that foreign banks acquire efficient private banks when they enter the market as Yildirim (2010) states. Another explanation for this finding might be as follows. The banks operate efficiently than others are able make necessary investments to enter foreign markets, thus on average foreign banks could be more cost efficient than domestic banks. The reason for state banks being the least cost efficient bank group might be having other objectives besides cost minimization such as pursuing government policies. Cost efficiency of all commercial banks and private banks follow a similar pattern due to the high market share of private banks. Figure 6 reveals that cost efficiency of private, foreign and state banks converge over time, however cost efficiency of state banks is still lower than other groups.

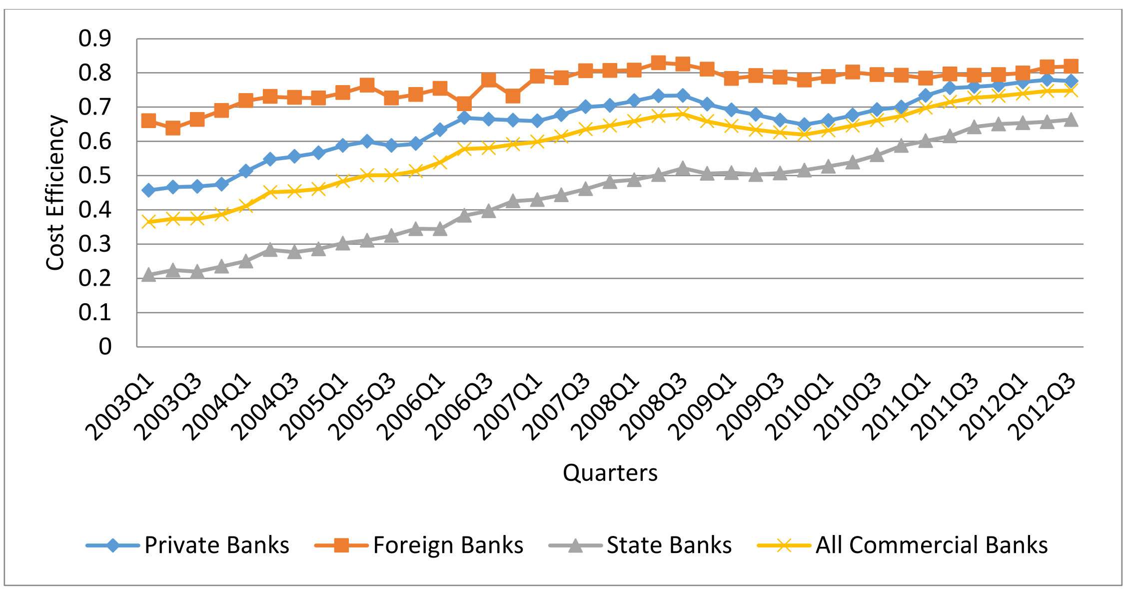

Figure 6: Cost efficiency of bank groups determined by ownership status

Private and state banks in general have an upward trend until the third quarter of 2008 and we see that the effect of 2001 financial crisis is disappearing. In the first and the fourth quarter of 2006 cost efficiency of foreign banks decreases and after the first quarter of the 2006 cost efficiency of private banks decreases for subsequent 3 quarter. The reason for decrease in efficiency of foreign banks might be mergers and acquisitions take place during this period. Yildirim (2010) states that foreign banks commonly target efficient private banks through mergers and acquisitions since some of the efficient banks become foreign banks, private banks' average cost efficiency might decrease as well. After the third quarter of 2008, effects of 2008 economic crisis become obvious for private and state banks. For private banks, decrease in cost efficiency due to the 2008 economic crisis lasts for 5 quarters and the effect of the crisis disappear in the first quarter of 2011. For state banks effects of 2008 economic crisis is disappeared in the first quarter of 2010. It takes 6 quarters for state banks to eliminate the effects of 2008 economic crisis. For foreign banks cost efficiency follows a flatter path relative to state and private banks. Moreover, foreign banks started to be effected from 2008 economic crisis in terms of cost efficiency one quarter before private and state banks. 2008 economic crisis is originating from overseas so to be affected one quarter before the state and private banks is sensible for foreign banks. Cost efficiency of foreign banks is maximum, 82.9%, at the second quarter of 2008 and in the third quarter effects of crisis can be seen. From Figure 6, although we can-not see a substantial decline in cost efficiency, we see that impact of crisis is not disappeared as quickly as in the case for private and state banks. Within our time period cost efficiency fail to reach its before crisis level at the end of the period. Private banks are severely affected from the 2008 economic crisis compared to state-owned and foreign banks. This might be because foreign banks have more options for funding and state-owned banks operate behind the state guarantee.

5.2. Is cost efficiency of Turkish commercial banks persistent?

We also investigate the persistency of cost efficiency of Turkish commercial banks. It is important to examine whether cost inefficient banks have a tendency of being cost efficient over the time period. To reveal that, we analyze the correlation of cost efficiency rankings of banks over the time period and utilize Spearman rank correlation. Following Manlagnit (2011), Spearman rank correlation is calculated as:

$$\rho = \frac{\sum_{i=1}^{n}(r_{1i}-\overline{r_1})(r_{2i}-\overline{r_2})}{\sqrt{\sum_{i=1}^{n}(r_{1i}-\overline{r_{1\iota}})^2 \sum_{i=1}^{n}(r_{2i}-\overline{r_2})^2}} \tag{16}$$

where r_{1i} and r_{2i} denote the ranks of cost efficiency of banks at time period 1 and 2 respectively. Alternatively spearman rank correlation can be calculated as:

$$\rho = 1 - \frac{6\sum_{i=1}^{n} d_i^2}{n(n^2-1)} \tag{17}$$

where $d_i = r_{1i} - r_{2i}$. Statistical significance of the rank correlations is also tested. Test statistic is equal to:

$$t = x\sqrt{\frac{n-2}{1-r^2}} \tag{18}$$

where x equals the observed value of ρ and t distribution has $n-2$ degrees of freedom. Our null hypothesis is that observed value of ρ equals zero.

As described above, firstly, we rank the banks according to their cost efficiency at each time period. After that, we calculate correlation coefficient of rankings with each time period. Having 39 time periods produces a 39 by 39 upper triangular matrix. If rank correlations are positive, high and statistically significant, we conclude that cost efficiency is persistent. We repeat this procedure for all commercial banks and sub-groups determined by ownership status and scale and the results are reported in Appendix A.

Spearman rank correlation calculated for all commercial banks indicate that cost efficiency is persistent which means that if a commercial bank is relatively cost inefficient, then, it is very likely to be relatively cost inefficient over the time period. Alternatively, if a commercial bank has a lower rank in terms of cost efficiency, it is very likely to have lower rank in terms of cost efficiency over time. Moreover, we investigate the persistency of cost efficiency of sub-groups. According to the results reported in Appendix A, cost efficiency is persistent for large banks. More specifically, a relatively cost inefficient large bank is highly likely to be relatively cost inefficient among the large banks over the time period. We prefer to conclude this result although there are more statistically insignificant rank correlations for large banks if we compare with the results of all commercial banks. For medium banks, cost efficiency is not persistent because rank correlations are statistically insignificant and become negative over time. For small banks, rank correlations are statistically significant and positive, implying persistency of cost efficiency for these banks. This result suggests that a small bank which has a relatively high rank in terms of cost efficiency within the small banks, will have relatively high rank within small banks over the time period.

We also investigate Spearman rank correlation of banks grouped by their ownership status. We assign each bank to sub-groups as follows. If a bank is a private bank at the third quarter of 2012, it is assigned to private bank group. Likewise, if it is a foreign bank, it is assigned to foreign bank group and if it is a state owned bank it is assigned to state bank group. According to this classification there are 10 banks in privately owned, 9 banks in foreign and 3 banks in state banks group. Cost efficiency of private banks is quite persistent due to high and positive statistically significant rank correlations. To put it another way, a cost efficient private bank is likely to be cost efficient among private banks over time. Alternatively cost efficiency rankings of private banks are highly correlated over time. For foreign banks picture is not clear, although from 20-th quarter to 31-st quarter cost efficiency of foreign banks is persistent, we can-not generalize our results to the whole sample because there are statistically insignificant and negative rank correlation coefficients. If we look at state banks, cost efficiency of state banks is quite persistent as well. Rank correlations are statistically significant. Moreover, last 28 quarters ranking of state banks does not change in terms of cost efficiency. Please note that there are only three state banks in our analysis.

CHAPTER 6

CONCLUSION

This study investigates the cost efficiency of Turkish commercial banks over the period of the first quarter of 2003 and the third quarter of 2012. Due to our recent data set, we could observe how 22 Turkish commercial banks perform during 2008 economic crisis. Methodologically, we follow Battese and Coelli (1995) and utilize a stochastic frontier approach, which allows mean of the inefficiency to differ across banks by setting the inefficiency term as a linear function of the inefficiency correlates.

Among six candidates, ratio of deposits to liabilities, intermediation ratio and labor per branch are selected as the inefficiency correlates. As banks increase the share of deposits in their liabilities their cost inefficiency decreases because other alternative is to take loans from financial markets which they have to pay higher interest rate than what they pay to their deposits. Moreover, as intermediation ratio increases, their inefficiency decreases significantly. Finally, labor per branch has a positive impact on inefficiency which means that as banks increase their number of employees per branch their inefficiency will increase. Results of the hypothesis testing indicate that inefficiency in the model exists, truncation of normal distribution is an appropriate distribution for the inefficiency term and inefficiency correlates are useful in describing the cost inefficiencies of banks.

After estimation, cost efficiency of all commercial banks is calculated by using weighted average. On average, all commercial banks is 41.2% cost inefficient means that all commercial banks can decrease their cost by 41.2% comparing best practice firm producing same bundle of output and under comparable conditions. Until the third quarter of 2008 cost efficiency has an upward trend which shows that the effect of 2001 financial crisis is disappearing and the financial structure of the banks is strengthening. We observe that from the third quarter of 2008 till the first quarter of 2011, Turkish commercial banks are affected from 2008 economic crisis. However, at the end of the period, banks recovered and average cost efficiency of all commercial banks reaches its maximum, 74.8%.

Moreover, cost efficiencies of sub-groups determined by scale and ownership status are examined. Results show that, the average cost efficiency of medium banks is higher than the average cost efficiency of small and large banks, with large banks having the minimum cost efficiency on the average. Regarding ownership status of banks, foreign banks have higher cost efficiency than private and state banks. This finding is not surprising as foreign banks enter the market by acquiring efficient private banks. Moreover, state banks could have other objectives besides cost minimization such that fulfilling government's policies. Although, there is improvement in cost efficiency of state banks over the period, state banks are still left behind so we argue that privatization of the state banks in Turkey can improve the cost efficiency. Empirical results reveal that private banks and large banks exhibit poorer performance in terms of cost efficiency during 2008 economic crisis in their sub-groups. This might be because foreign banks have more options for funding and state banks fund themselves and operate behind the state guarantee. Moreover, large banks consist of private and state-owned banks and these groups experienced longer lasting decrease in cost efficiency than foreign banks during 2008 economic crisis. While all sub-groups exceed before crisis cost efficiency level over the data, foreign banks, on the other hand, approach but can-not exceed before crisis level over the data.

Finally, persistency of cost efficiency of commercial bank in Turkey is examined. Results indicate that cost efficiency of all commercial banks is persistent which indicates that relatively efficient banks remain relatively efficient over the time period. Also, persistency of cost efficiency of sub-groups determined by scale and ownership status is examined and results reveal that cost efficiency of large, small, private and state banks are persistent.

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APPENDICES

APPENDIX A

DESCRIPTIVE STATISTICS AND RESULTS

Table 6: List of banks included into the study and codes given to them

Bank Code	Name	Bank Code	Name
1	Akbank T.A.Ş.	12	Şekerbank T.A.Ş.
2	Alternatifbank A.Ş.	13	Tekstil Bankası A.Ş.
3	Anadolubank A.Ş.	14	Turkish Bank A.Ş.
4	Arap Türk Bankası A.Ş.	15	Turkland Bank A.Ş.
5	Citibank A.Ş.	16	Türk Ekonomi Bankası A.Ş.
6	Denizbank A.Ş.	17	Türkiye Cumhuriyeti Ziraat Bankası A.Ş.
7	Burgan Bank A.Ş.	18	Türkiye Garanti Bankası A.Ş.
8	Fibabanka A.Ş.	19	Türkiye Halk Bankası A.Ş.
9	Finans Bank A.Ş.	20	Türkiye İş Bankası A.Ş.
10	HSBC Bank A.Ş.	21	Türkiye Vakıflar Bankası T.A.O.
11	ING Bank A.Ş.	22	Yapı ve Kredi Bankası A.Ş.

Table 7: Parameter estimates stochastic cost frontier estimation

Dependent variable: lnc		
	Coefficient	**Standard errors**
Cost Frontier		
$intercept$	1.437***	0.195
lny_1	0.653***	0.033
lny_2	0.046***	0.013
lnw_1	0.554***	0.122
lnq	0.265***	0.050
t	-0.007*	0.004
$lny_1.lnw_1$	-0.129***	0.032
$lny_2.lnw_1$	-0.091***	0.017
$lnw_1.lnq$	0.224***	0.027
$lny_1.t$	0.004***	0.001
$lnw_1.t$	0.004***	0.001
$lnq.t$	-0.004***	0.001
Inefficiency correlates		
$intercept$	2.499	736716.600
DL	-0.676***	0.180
$INTER$	-2.270***	0.193
LPB	0.003**	0.001
Variance parameters of the compound error		
λ	3.394	199717.200
$\sigma(u)$	0.281	17860.270
$Log\ likelihood$	856.080	
AIC	-1676.200	
$Number\ of\ observations$	858	

Notes: *, **, *** denote statistically significant at the 10%, 5% and 1% level respectively. $\lambda = \sigma_u/\sigma_v$ where σ_u and σ_v denote standard error of the inefficiency term and random error, respectively.

Table 8: Variance- covariance matrix of dependent and explanatory variables used in the cost frontier

	lnc	lny1	lny2	lnw1	lnq	lny1.lny1	lny1.lny2	lny1.lnw1	lny1.lnq	lny1.t	lny2.lny2	lny2.lnw1	lny2.lnq	lny2.t	lnw1.lnw1	lnw1.lnq	lnw1.t	lnq.lnq	lnq.t
lnc	1.000																		
lny1	0.950	1.000																	
lny2	0.935	0.873	1.000																
lnw1	-0.081	-0.168	-0.285	1.000															
lnq	0.967	0.929	0.945	-0.191	1.000														
lny1.lny1	0.964	0.984	0.898	-0.175	0.96	1.000													
lny1.lny2	0.971	0.946	0.976	-0.247	0.977	0.969	1.000												
lny1.lnw1	-0.315	-0.382	-0.487	0.951	-0.409	-0.398	-0.466	1.000											
lny1.lnq	0.973	0.967	0.932	-0.192	0.988	0.989	0.984	-0.414	1.000										
lny1.t	0.462	0.539	0.340	0.070	0.453	0.558	0.456	-0.051	0.512	1.000									
lny2.lny2	0.928	0.858	0.995	-0.303	0.945	0.891	0.974	-0.508	0.930	0.341	1.000								
lny2.lnw1	-0.320	-0.359	-0.517	0.949	-0.416	-0.377	-0.472	0.988	-0.407	-0.008	-0.540	1.000							
lny2.lnq	0.954	0.896	0.984	-0.259	0.981	0.932	0.988	-0.472	0.968	0.398	0.989	-0.493	1.000						
lny2.t	0.505	0.564	0.421	0.034	0.504	0.59	0.517	-0.095	0.555	0.988	0.423	-0.063	0.468	1.000					
lnw1.lnw1	0.016	0.008	0.216	-0.794	0.095	0.022	0.135	-0.769	0.063	-0.161	0.236	-0.792	0.176	-0.108	1.000				
lnw1.lnq	-0.311	-0.365	-0.496	0.958	-0.415	-0.383	-0.464	0.993	-0.410	-0.027	-0.520	0.995	-0.482	-0.075	-0.773	1.000			
lnw1.t	-0.202	-0.332	-0.291	0.701	-0.293	-0.356	-0.340	0.736	-0.335	-0.493	-0.310	0.686	-0.311	-0.513	-0.505	0.709	1.000		
lnq.lnq	0.958	0.916	0.945	-0.204	0.997	0.953	0.976	-0.421	0.986	0.451	0.951	-0.429	0.986	0.505	0.106	-0.429	-0.305	1.000	
lnq.t	0.471	0.539	0.361	0.066	0.472	0.562	0.471	-0.056	0.525	0.997	0.364	-0.018	0.421	0.993	-0.148	-0.037	-0.493	0.472	1.000

Table 9: Spearman rank correlation of cost efficiency of all commercial banks

	r1	r2	r3	r4	r5	r6	r7	r8	r9	r10	r11	r12	r13
r1	1.000												
r2	0.969*	1.000											
r3	0.799*	0.888*	1.000										
r4	0.801*	0.890*	0.980*	1.000									
r5	0.813*	0.909*	0.961*	0.971*	1.000								
r6	0.765*	0.862*	0.949*	0.959*	0.975*	1.000							
r7	0.725*	0.829*	0.928*	0.941*	0.972*	0.979*	1.000						
r8	0.660*	0.775*	0.904*	0.918*	0.950*	0.940*	0.961*	1.000					
r9	0.622*	0.753*	0.880*	0.878*	0.918*	0.914*	0.928*	0.956*	1.000				
r10	0.642*	0.767*	0.909*	0.909*	0.936*	0.934*	0.935*	0.969*	0.978*	1.000			
r11	0.568*	0.708*	0.849*	0.855*	0.904*	0.890*	0.918*	0.960*	0.974*	0.981*	1.000		
r12	0.603*	0.716*	0.786*	0.810*	0.862*	0.831*	0.847*	0.910*	0.898*	0.917*	0.936*	1.000	
r13	0.705*	0.791*	0.751*	0.766*	0.849*	0.794*	0.806*	0.854*	0.869*	0.874*	0.889*	0.937*	1.000
r14	0.672*	0.716*	0.598*	0.619*	0.712*	0.681*	0.665*	0.715*	0.731*	0.744*	0.748*	0.840*	0.928*
r15	0.721*	0.771*	0.666*	0.691*	0.784*	0.741*	0.739*	0.774*	0.769*	0.795*	0.801*	0.889*	0.966*
r16	0.576*	0.689*	0.760*	0.774*	0.840*	0.820*	0.835*	0.902*	0.923*	0.918*	0.926*	0.967*	0.925*
r17	0.646*	0.739*	0.736*	0.754*	0.839*	0.786*	0.803*	0.864*	0.906*	0.889*	0.900*	0.924*	0.961*
r18	0.573*	0.677*	0.695*	0.710*	0.805*	0.764*	0.782*	0.846*	0.899*	0.885*	0.904*	0.926*	0.952*
r19	0.584*	0.695*	0.744*	0.751*	0.836*	0.812*	0.815*	0.873*	0.927*	0.922*	0.924*	0.922*	0.933*
r20	0.533*	0.660*	0.779*	0.796*	0.834*	0.811*	0.808*	0.879*	0.930*	0.922*	0.917*	0.919*	0.869*
r21	0.429*	0.563*	0.714*	0.717*	0.766*	0.770*	0.754*	0.819*	0.896*	0.884*	0.888*	0.885*	0.821*
r22	0.413	0.548*	0.729*	0.734*	0.761*	0.766*	0.754*	0.831*	0.906*	0.899*	0.897*	0.872*	0.809*
r23	0.444*	0.585*	0.756*	0.760*	0.780*	0.776*	0.768*	0.846*	0.902*	0.890*	0.891*	0.906*	0.821*
r24	0.400	0.542*	0.703*	0.716*	0.721*	0.747*	0.708*	0.770*	0.843*	0.839*	0.831*	0.864*	0.760*
r25	0.349	0.480*	0.656*	0.663*	0.669*	0.708*	0.664*	0.747*	0.802*	0.792*	0.778*	0.815*	0.709*
r26	0.331	0.481*	0.665*	0.664*	0.696*	0.707*	0.688*	0.776*	0.838*	0.817*	0.822*	0.848*	0.739*
r27	0.369	0.516*	0.692*	0.692*	0.726*	0.743*	0.722*	0.794*	0.852*	0.834*	0.832*	0.867*	0.756*
r28	0.359	0.509*	0.695*	0.680*	0.708*	0.718*	0.698*	0.779*	0.834*	0.815*	0.805*	0.836*	0.731*
r29	0.363	0.515*	0.703*	0.679*	0.724*	0.722*	0.719*	0.794*	0.860*	0.825*	0.826*	0.827*	0.739*
r30	0.350	0.497*	0.688*	0.664*	0.703*	0.717*	0.700*	0.784*	0.847*	0.825*	0.820*	0.822*	0.731*
r31	0.371	0.517*	0.700*	0.681*	0.726*	0.739*	0.727*	0.803*	0.857*	0.829*	0.828*	0.838*	0.730*
r32	0.313	0.450*	0.618*	0.592*	0.647*	0.668*	0.655*	0.717*	0.788*	0.748*	0.752*	0.764*	0.678*
r33	0.351	0.369	0.276	0.256	0.356	0.294	0.269	0.384	0.425*	0.398	0.411	0.611*	0.647*
r34	0.367	0.381	0.287	0.251	0.364	0.323	0.297	0.398	0.413	0.390	0.401	0.587*	0.627*
r35	0.412	0.428*	0.330	0.302	0.420	0.380	0.354	0.448*	0.448*	0.434*	0.444*	0.635*	0.660*
r36	0.546*	0.574*	0.463*	0.420	0.550*	0.499*	0.471*	0.550*	0.577*	0.558*	0.556*	0.689*	0.754*
r37	0.499*	0.528*	0.467*	0.429*	0.543*	0.517*	0.498*	0.573*	0.590*	0.564*	0.575*	0.721*	0.722*
r38	0.471*	0.511*	0.434*	0.409	0.539*	0.508*	0.489*	0.575*	0.583*	0.568*	0.585*	0.743*	0.742*
r39	0.455*	0.505*	0.420	0.412	0.547*	0.521*	0.497*	0.584*	0.591*	0.575*	0.595*	0.748*	0.751*

	r14	**r15**	**r16**	**r17**	**r18**	**r19**	**r20**	**r21**	**r22**	**r23**	**r24**	**r25**	**r26**
r14	1.000												
r15	0.975*	1.000											
r16	0.854*	0.881*	1.000										
r17	0.890*	0.910*	0.953*	1.000									
r18	0.881*	0.906*	0.963*	0.988*	1.000								
r19	0.860*	0.885*	0.966*	0.969*	0.986*	1.000							
r20	0.774*	0.792*	0.949*	0.927*	0.932*	0.954*	1.000						
r21	0.731*	0.739*	0.907*	0.880*	0.902*	0.928*	0.969*	1.000					
r22	0.703*	0.707*	0.891*	0.878*	0.891*	0.911*	0.957*	0.980*	1.000				
r23	0.710*	0.721*	0.919*	0.865*	0.878*	0.901*	0.971*	0.974*	0.968*	1.000			
r24	0.698*	0.690*	0.873*	0.805*	0.823*	0.848*	0.927*	0.954*	0.943*	0.967*	1.000		
r25	0.656*	0.640*	0.847*	0.765*	0.783*	0.806*	0.888*	0.920*	0.905*	0.939*	0.970*	1.000	
r26	0.653*	0.648*	0.869*	0.802*	0.821*	0.840*	0.917*	0.953*	0.935*	0.961*	0.967*	0.968*	1.000
r27	0.673*	0.670*	0.888*	0.817*	0.835*	0.856*	0.925*	0.960*	0.943*	0.968*	0.971*	0.960*	0.991*
r28	0.651*	0.646*	0.875*	0.797*	0.810*	0.832*	0.901*	0.916*	0.907*	0.943*	0.945*	0.951*	0.978*
r29	0.622*	0.629*	0.865*	0.815*	0.823*	0.837*	0.891*	0.915*	0.915*	0.930*	0.911*	0.914*	0.968*
r30	0.639*	0.633*	0.855*	0.804*	0.812*	0.827*	0.874*	0.911*	0.924*	0.919*	0.920*	0.923*	0.962*
r31	0.647*	0.638*	0.876*	0.811*	0.817*	0.835*	0.890*	0.916*	0.913*	0.925*	0.920*	0.920*	0.965*
r32	0.618*	0.583*	0.796*	0.765*	0.766*	0.771*	0.815*	0.874*	0.882*	0.870*	0.875*	0.872*	0.926*
r33	0.684*	0.648*	0.609*	0.648*	0.642*	0.604*	0.587*	0.617*	0.568*	0.602*	0.577*	0.579*	0.640*
r34	0.689*	0.646*	0.591*	0.616*	0.603*	0.566*	0.525*	0.563*	0.513*	0.547*	0.535*	0.566*	0.612*
r35	0.732*	0.689*	0.638*	0.654*	0.639*	0.603*	0.566*	0.592*	0.531*	0.570*	0.559*	0.585*	0.625*
r36	0.808*	0.771*	0.716*	0.754*	0.738*	0.714*	0.649*	0.657*	0.600*	0.623*	0.596*	0.604*	0.651*
r37	0.751*	0.727*	0.724*	0.721*	0.713*	0.689*	0.654*	0.689*	0.623*	0.665*	0.651*	0.674*	0.710*
r38	0.780*	0.762*	0.754*	0.747*	0.749*	0.725*	0.666*	0.691*	0.623*	0.660*	0.646*	0.661*	0.700*
r39	0.782*	0.771*	0.776*	0.7662	0.776*	0.756*	0.688*	0.704*	0.629*	0.669*	0.655*	0.684*	0.699*
	r27	**r28**	**r29**	**r30**	**r31**	**r32**	**r33**	**r34**	**r35**	**r36**	**r37**	**r38**	**r39**
r27	1.000												
r28	0.979*	1.000											
r29	0.967*	0.983*	1.000										
r30	0.965*	0.975*	0.987*	1.000									
r31	0.974*	0.978*	0.985*	0.988*	1.000								
r32	0.941*	0.937*	0.957*	0.967*	0.967*	1.000							
r33	0.644*	0.635*	0.634*	0.637*	0.628*	0.656*	1.000						
r34	0.617*	0.625*	0.628*	0.645*	0.636*	0.670*	0.967*	1.000					
r35	0.639*	0.634*	0.628*	0.645*	0.655*	0.675*	0.946*	0.983*	1.000				
r36	0.666*	0.663*	0.672*	0.684*	0.696*	0.696*	0.901*	0.937*	0.963*	1.000			
r37	0.719*	0.697*	0.706*	0.718*	0.731*	0.731*	0.891*	0.933*	0.957*	0.958*	1.000		

r38	0.717*	0.698*	0.698*	0.714*	0.732*	0.719*	0.896*	0.931*	0.962*	0.963*	0.978*	1.000	
r39	0.716*	0.697*	0.687*	0.698*	0.722*	0.690*	0.846*	0.873*	0.913*	0.919*	0.924*	0.974*	1.000

Note: r1, r2, … denote ranking of the banks in terms of the cost efficiency at first quarter, second quarter, … respectively. * denotes the statistical significance of the rank correlations at the 5% significance level.

Table 10: Spearman rank correlation of cost efficiency of large banks

	r1	**r2**	**r3**	**r4**	**r5**	**r6**	**r7**	**r8**	**r9**	**r10**	**r11**	**r12**	**r13**
r1	1.000												
r2	1.000*	1.000											
r3	1.000*	1.000*	1.000										
r4	0.821*	0.821*	0.821*	1.000									
r5	0.821*	0.821*	0.821*	1.000*	1.000								
r6	0.750	0.750	0.750	0.928*	0.928*	1.000							
r7	0.750	0.750	0.750	0.928*	0.928*	1.000*	1.000						
r8	0.714	0.714	0.714	0.964*	0.964*	0.857*	0.857*	1.000					
r9	0.821*	0.821*	0.821*	0.857*	0.857*	0.892*	0.892*	0.821*	1.000				
r10	0.714	0.714	0.714	0.821*	0.821*	0.821*	0.821*	0.857*	0.964*	1.000			
r11	0.678	0.678	0.678	0.714	0.714	0.678	0.678	0.785*	0.892*	0.964*	1.000		
r12	0.428	0.428	0.428	0.678	0.678	0.785*	0.785*	0.750	0.785*	0.857*	0.821*	1.000	
r13	0.571	0.571	0.571	0.821*	0.821*	0.892*	0.892*	0.857*	0.892*	0.928*	0.857*	0.964*	1.000
r14	0.428	0.428	0.428	0.678	0.678	0.785*	0.785*	0.750	0.785*	0.857*	0.821*	1.000*	0.964*
r15	0.428	0.428	0.428	0.678	0.678	0.785*	0.785*	0.750	0.785*	0.857*	0.821*	1.000*	0.964*
r16	0.428	0.428	0.428	0.678	0.678	0.785*	0.785*	0.750	0.785*	0.857*	0.821*	1.000*	0.964*
r17	0.571	0.571	0.571	0.821*	0.821*	0.892*	0.892*	0.857*	0.892*	0.928*	0.857*	0.964*	1.000*
r18	0.428	0.428	0.428	0.678	0.678	0.785*	0.785*	0.750	0.785*	0.857*	0.821*	1.000*	0.964*
r19	0.428	0.428	0.428	0.678	0.678	0.785*	0.785*	0.750	0.785*	0.857*	0.821*	1.000*	0.964*
r20	0.571	0.571	0.571	0.821*	0.821*	0.892*	0.892*	0.857*	0.892*	0.928*	0.857*	0.964*	1.000*
r21	0.571	0.571	0.571	0.821*	0.821*	0.892*	0.892*	0.857*	0.892*	0.928*	0.857*	0.964*	1.000*
r22	0.571	0.571	0.571	0.821*	0.821*	0.892*	0.892*	0.857*	0.892*	0.928*	0.857*	0.964*	1.000*
r23	0.571	0.571	0.571	0.821*	0.821*	0.892*	0.892*	0.857*	0.892*	0.928*	0.857*	0.964*	1.000*
r24	0.642	0.642	0.642	0.750	0.750	0.928*	0.928*	0.678	0.857*	0.785*	0.678	0.857*	0.892*
r25	0.750	0.750	0.750	0.928*	0.928*	1.000*	1.000*	0.857*	0.892*	0.821*	0.678	0.785*	0.892*
r26	0.571	0.571	0.571	0.857*	0.857*	0.964*	0.964*	0.785*	0.785*	0.714	0.535	0.750	0.857*
r27	0.535	0.535	0.535	0.750	0.750	0.928*	0.928*	0.642	0.714	0.607	0.428	0.714	0.785*
r28	0.357	0.357	0.357	0.535	0.535	0.750	0.750	0.392	0.428	0.285	0.107	0.500	0.535
r29	0.428	0.428	0.428	0.607	0.607	0.821*	0.821*	0.464	0.571	0.428	0.250	0.571	0.642
r30	0.428	0.428	0.428	0.607	0.607	0.821*	0.821*	0.464	0.571	0.428	0.250	0.571	0.642
r31	0.357	0.357	0.357	0.535	0.535	0.750	0.750	0.392	0.428	0.285	0.107	0.500	0.535
r32	0.357	0.357	0.357	0.535	0.535	0.750	0.750	0.392	0.428	0.285	0.107	0.500	0.535
r33	0.464	0.464	0.464	0.678	0.678	0.857*	0.857*	0.571	0.571	0.464	0.285	0.642	0.678

r34	0.464	0.464	0.464	0.678	0.678	0.857*	0.857*	0.571	0.571	0.464	0.285	0.642	0.678
r35	0.464	0.464	0.464	0.678	0.678	0.857*	0.857*	0.571	0.571	0.464	0.285	0.642	0.678
r36	0.785*	0.785*	0.785*	0.750	0.750	0.892*	0.892*	0.607	0.785*	0.642	0.535	0.642	0.714
r37	0.892*	0.892*	0.892*	0.785*	0.785*	0.857*	0.857*	0.642	0.821*	0.678	0.607	0.571	0.678
r38	0.714	0.714	0.714	0.678	0.678	0.821*	0.821*	0.535	0.642	0.500	0.392	0.571	0.607
r39	0.464	0.464	0.464	0.642	0.642	0.750	0.750	0.607	0.500	0.464	0.357	0.678	0.642

	r14	**r15**	**r16**	**r17**	**r18**	**r19**	**r20**	**r21**	**r22**	**r23**	**r24**	**r25**	**r26**
r14	1.000												
r15	1.000*	1.000											
r16	1.000*	1.000*	1.000										
r17	0.964*	0.964*	0.964*	1.000									
r18	1.000*	1.000*	1.000*	0.964*	1.000								
r19	1.000*	1.000*	1.000*	0.964*	1.000*	1.000							
r20	0.964*	0.964*	0.964*	1.000*	0.964*	0.964*	1.000						
r21	0.964*	0.964*	0.964*	1.000*	0.964*	0.964*	1.000*	1.000					
r22	0.964*	0.964*	0.964*	1.000*	0.964*	0.964*	1.000*	1.000*	1.000				
r23	0.964*	0.964*	0.964*	1.000*	0.964*	0.964*	1.000*	1.000*	1.000*	1.000			
r24	0.857*	0.857*	0.857*	0.892*	0.857*	0.857*	0.892*	0.892*	0.892*	0.892*	1.000		
r25	0.785*	0.785*	0.785*	0.892*	0.785*	0.785*	0.892*	0.892*	0.892*	0.892*	0.928*	1.000	
r26	0.750	0.750	0.750	0.857*	0.750	0.750	0.857*	0.857*	0.857*	0.857*	0.892*	0.964*	1.000
r27	0.714	0.714	0.714	0.785*	0.714	0.714	0.785*	0.785*	0.785*	0.785*	0.928*	0.928*	0.964*
r28	0.500	0.500	0.500	0.535	0.500	0.500	0.535	0.535	0.535	0.535	0.785*	0.750	0.821*
r29	0.571	0.571	0.571	0.642	0.571	0.571	0.642	0.642	0.642	0.642	0.857*	0.821*	0.892*
r30	0.571	0.571	0.571	0.642	0.571	0.571	0.642	0.642	0.642	0.642	0.857*	0.821*	0.892*
r31	0.500	0.500	0.500	0.535	0.500	0.500	0.535	0.535	0.535	0.535	0.785*	0.750	0.821*
r32	0.500	0.500	0.500	0.535	0.500	0.500	0.535	0.535	0.535	0.535	0.785*	0.750	0.821*
r33	0.642	0.642	0.642	0.678	0.642	0.642	0.678	0.678	0.678	0.678	0.857*	0.857*	0.892*
r34	0.642	0.642	0.642	0.678	0.642	0.642	0.678	0.678	0.678	0.678	0.857*	0.857*	0.892*
r35	0.642	0.642	0.642	0.678	0.642	0.642	0.678	0.678	0.678	0.678	0.857*	0.857*	0.892*
r36	0.642	0.642	0.642	0.714	0.642	0.642	0.714	0.714	0.714	0.714	0.928*	0.892*	0.821*
r37	0.571	0.571	0.571	0.678	0.571	0.571	0.678	0.678	0.678	0.678	0.857*	0.857*	0.750
r38	0.571	0.571	0.571	0.607	0.571	0.571	0.607	0.607	0.607	0.607	0.857*	0.821*	0.750
r39	0.678	0.678	0.678	0.642	0.678	0.678	0.642	0.642	0.642	0.642	0.750	0.750	0.714

	r27	**r28**	**r29**	**r30**	**r31**	**r32**	**r33**	**r34**	**r35**	**r36**	**r37**	**r38**	**r39**
r27	1.000												
r28	0.928*	1.000											
r29	0.964*	0.964*	1.000										
r30	0.964*	0.964*	1.000*	1.000									
r31	0.928*	1.000*	0.964*	0.964*	1.000								

r32	0.928*	1.000*	0.964*	0.964*	1.000*	1.000							
r33	0.964*	0.964*	0.928*	0.928*	0.964*	0.964*	1.000						
r34	0.964*	0.964*	0.928*	0.928*	0.964*	0.964*	1.000*	1.000					
r35	0.964*	0.964*	0.928*	0.928*	0.964*	0.964*	1.000*	1.000*	1.000				
r36	0.892*	0.821*	0.857*	0.857*	0.821*	0.821*	0.857*	0.857*	0.857*	1.000			
r37	0.785*	0.678	0.750	0.750	0.678	0.678	0.714	0.714	0.714	0.964*	1.000		
r38	0.857*	0.857*	0.821*	0.821*	0.857*	0.857*	0.892*	0.892*	0.892*	0.964*	0.892*	1.000	
r39	0.785*	0.785*	0.678	0.678	0.785*	0.785*	0.892*	0.892*	0.892*	0.750	0.607	0.857*	1.000

Note: r1, r2, … denote ranking of the banks in terms of the cost efficiency at first quarter, second quarter, … respectively. * denotes the statistical significance of the rank correlations at the 5% significance level.

Table 11: Spearman rank correlation of cost efficiency of small banks

	r1	**r2**	**r3**	**r4**	**r5**	**r6**	**r7**	**r8**	**r9**	**r10**	**r11**	**r12**	**r13**
r1	1.000												
r2	0.939*	1.000											
r3	0.709*	0.793*	1.000										
r4	0.709*	0.793*	1.000*	1.000									
r5	0.806*	0.915*	0.951*	0.951*	1.000								
r6	0.721*	0.781*	0.987*	0.987*	0.939*	1.000							
r7	0.551	0.684*	0.903*	0.903*	0.878*	0.927*	1.000						
r8	0.527	0.636*	0.878*	0.878*	0.830*	0.890*	0.951*	1.000					
r9	0.442	0.612	0.842*	0.842*	0.818*	0.830*	0.927*	0.963*	1.000				
r10	0.551	0.660*	0.927*	0.927*	0.854*	0.915*	0.915*	0.975*	0.951*	1.000			
r11	0.490	0.660*	0.878*	0.878*	0.854*	0.866*	0.951*	0.975*	0.987*	0.963*	1.000		
r12	0.539	0.684*	0.781*	0.781*	0.830*	0.757*	0.757*	0.830*	0.830*	0.842*	0.842*	1.000	
r13	0.745*	0.842*	0.745*	0.745*	0.842*	0.733*	0.721*	0.793*	0.769*	0.793*	0.793*	0.915*	1.000
r14	0.709*	0.757*	0.563	0.566	0.709*	0.575	0.551	0.612	0.563	0.587	0.587	0.842*	0.939*
r15	0.793*	0.830*	0.612	0.612	0.757*	0.624	0.587	0.636*	0.575	0.612	0.612	0.818*	0.951*
r16	0.551	0.684*	0.769*	0.769*	0.818*	0.757*	0.781*	0.866*	0.878*	0.866*	0.866*	0.975*	0.927*
r17	0.612	0.733*	0.733*	0.733*	0.806*	0.709*	0.721*	0.818*	0.854*	0.830*	0.830*	0.927*	0.939*
r18	0.612	0.733*	0.733*	0.733*	0.806*	0.709*	0.721*	0.818*	0.854*	0.830*	0.830*	0.927*	0.939*
r19	0.612	0.733*	0.733*	0.733*	0.806*	0.709*	0.721*	0.818*	0.854*	0.830*	0.830*	0.927*	0.939*
r20	0.527	0.684*	0.793*	0.793*	0.842*	0.757*	0.733*	0.745*	0.830*	0.793*	0.793*	0.878*	0.781*
r21	0.466	0.587	0.818*	0.818*	0.793*	0.781*	0.709*	0.769*	0.806*	0.842*	0.781*	0.903*	0.757*
r22	0.309	0.430	0.781*	0.781*	0.684*	0.733*	0.709*	0.818*	0.866*	0.890*	0.830*	0.806*	0.648*
r23	0.309	0.466	0.818*	0.818*	0.745*	0.781*	0.769*	0.818*	0.866*	0.878*	0.842*	0.854*	0.660*
r24	0.333	0.490	0.842*	0.842*	0.769*	0.793*	0.757*	0.793*	0.842*	0.866*	0.830*	0.842*	0.636*
r25	0.248	0.381	0.757*	0.757*	0.684*	0.733*	0.733*	0.806*	0.830*	0.842*	0.806*	0.866*	0.636*
r26	0.260	0.430	0.757*	0.757*	0.709*	0.721*	0.769*	0.854*	0.903*	0.878*	0.878*	0.890*	0.697*
r27	0.297	0.442	0.793*	0.793*	0.721*	0.757*	0.757*	0.842*	0.878*	0.890*	0.854*	0.878*	0.684*

r28	0.2606	0.430	0.757*	0.757*	0.709*	0.721*	0.769*	0.854*	0.903*	0.878*	0.878*	0.890*	0.697*
r29	0.200	0.381	0.697*	0.697*	0.648*	0.648*	0.721*	0.830*	0.890*	0.854*	0.866*	0.866*	0.684*
r30	0.175	0.345	0.672*	0.672*	0.600	0.612	0.660*	0.793*	0.854*	0.842*	0.830*	0.830*	0.660*
r31	0.187	0.369	0.697*	0.697*	0.648*	0.660*	0.721*	0.818*	0.878*	0.842*	0.842*	0.866*	0.660*
r32	0.175	0.333	0.600	0.600	0.551	0.539	0.575	0.745*	0.806*	0.793*	0.769*	0.842*	0.684*
r33	0.284	0.272	0.090	0.090	0.212	0.042	-0.078	0.066	0.090	0.127	0.066	0.539	0.527
r34	0.272	0.284	0.066	0.066	0.212	0.030	-0.030	0.115	0.127	0.139	0.115	0.575	0.587
r35	0.393	0.381	0.187	0.187	0.333	0.175	0.066	0.163	0.151	0.187	0.139	0.624	0.612
r36	0.624	0.648*	0.381	0.381	0.551	0.357	0.248	0.333	0.345	0.369	0.333	0.721*	0.793*
r37	0.345	0.369	0.321	0.321	0.418	0.309	0.236	0.345	0.345	0.369	0.321	0.745*	0.672*
r38	0.345	0.369	0.321	0.321	0.418	0.309	0.236	0.345	0.345	0.369	0.321	0.745*	0.672*
r39	0.272	0.309	0.260	0.260	0.357	0.248	0.187	0.309	0.321	0.333	0.284	0.721*	0.636*
	r14	**r15**	**r16**	**r17**	**r18**	**r19**	**r20**	**r21**	**r22**	**r23**	**r24**	**r25**	**r26**
r14	1.000												
r15	0.987*	1.000											
r16	0.842*	0.818*	1.000										
r17	0.842*	0.830*	0.975*	1.000									
r18	0.842*	0.830*	0.975*	1.000*	1.000								
r19	0.842*	0.830*	0.975*	1.000*	1.000*	1.000							
r20	0.672*	0.648*	0.903*	0.903*	0.903*	0.903*	1.000						
r21	0.648*	0.612	0.903*	0.866*	0.866*	0.866*	0.951*	1.000					
r22	0.454	0.430	0.830*	0.806*	0.806*	0.806*	0.854*	0.927*	1.000				
r23	0.503	0.466	0.854*	0.793*	0.793*	0.793*	0.903*	0.963*	0.963*	1.000			
r24	0.466	0.442	0.818*	0.757*	0.757*	0.757*	0.890*	0.951*	0.951*	0.987*	1.000		
r25	0.515	0.466	0.854*	0.769*	0.769*	0.769*	0.854*	0.939*	0.939*	0.975*	0.963*	1.000	
r26	0.539	0.503	0.890*	0.830*	0.830*	0.830*	0.866*	0.915*	0.951*	0.963*	0.951*	0.975*	1.000
r27	0.527	0.490	0.878*	0.818*	0.818*	0.818*	0.878*	0.951*	0.975*	0.987*	0.975*	0.987*	0.987*
r28	0.539	0.503	0.890*	0.830*	0.830*	0.830*	0.866*	0.915*	0.951*	0.963*	0.951*	0.975*	1.000*
r29	0.515	0.478	0.866*	0.818*	0.818*	0.818*	0.818*	0.866*	0.939*	0.927*	0.915*	0.939*	0.987*
r30	0.478	0.442	0.830*	0.793*	0.793*	0.793*	0.781*	0.854*	0.951*	0.915*	0.903*	0.915*	0.963*
r31	0.503	0.454	0.878*	0.818*	0.818*	0.818*	0.854*	0.903*	0.939*	0.951*	0.927*	0.963*	0.987*
r32	0.527	0.478	0.854*	0.830*	0.830*	0.830*	0.781*	0.854*	0.927*	0.878*	0.854*	0.890*	0.939*
r33	0.672*	0.600	0.503	0.539	0.539	0.539	0.454	0.490	0.321	0.309	0.297	0.357	0.333
r34	0.745*	0.672*	0.539	0.563	0.563	0.563	0.418	0.442	0.272	0.272	0.248	0.333	0.333
r35	0.793*	0.721*	0.587	0.587	0.587	0.587	0.515	0.539	0.297	0.345	0.321	0.406	0.357
r36	0.890*	0.854*	0.721*	0.769*	0.769*	0.769*	0.672*	0.636*	0.406	0.430	0.406	0.430	0.430
r37	0.806*	0.721*	0.721*	0.697*	0.697*	0.697*	0.648*	0.697*	0.503	0.551	0.515	0.612	0.563
r38	0.806*	0.721*	0.721*	0.697*	0.697*	0.697*	0.648*	0.697*	0.503	0.551	0.515	0.612	0.563
r39	0.769*	0.672*	0.709*	0.684*	0.684*	0.684*	0.636*	0.684*	0.490	0.539	0.490	0.600	0.551

	r27	r28	r29	r30	r31	r32	r33	r34	r35	r36	r37	r38	r39
r27	1.000												
r28	0.987*	1.000											
r29	0.963*	0.987*	1.000										
r30	0.951*	0.963*	0.987*	1.000									
r31	0.975*	0.987*	0.975*	0.951*	1.000								
r32	0.927*	0.939*	0.963*	0.975*	0.951*	1.000							
r33	0.345	0.333	0.345	0.369	0.321	0.466	1.000						
r34	0.321	0.333	0.357	0.369	0.321	0.466	0.975*	1.000					
r35	0.369	0.357	0.333	0.321	0.345	0.418	0.951*	0.951*	1.000				
r36	0.442	0.430	0.406	0.393	0.418	0.490	0.878*	0.878*	0.927*	1.000			
r37	0.575	0.563	0.539	0.527	0.551	0.600	0.915*	0.915*	0.963*	0.890*	1.000		
r38	0.575	0.563	0.539	0.527	0.551	0.600	0.915*	0.915*	0.963*	0.890*	1.000*	1.000	
r39	0.563	0.551	0.527	0.515	0.563	0.612	0.903*	0.903*	0.951*	0.878*	0.987*	0.987*	1.000

Note: r1, r2, … denote ranking of the banks in terms of the cost efficiency at first quarter, second quarter, … respectively. * denotes the statistical significance of the rank correlations at the 5% significance level.

Table 12: Spearman rank correlation of cost efficiency of private banks

	r1	r2	r3	r4	r5	r6	r7	r8	r9	r10	r11	r12	r13
r1	1.000												
r2	0.951*	1.000											
r3	0.903*	0.951*	1.000										
r4	0.878*	0.927*	0.939*	1.000									
r5	0.733*	0.866*	0.890*	0.939*	1.000								
r6	0.842*	0.903*	0.878*	0.939*	0.939*	1.000							
r7	0.745*	0.878*	0.903*	0.927*	0.987*	0.951*	1.000						
r8	0.709*	0.806*	0.878*	0.951*	0.963*	0.890*	0.939*	1.000					
r9	0.672*	0.818*	0.866*	0.854*	0.939*	0.903*	0.975*	0.890*	1.000				
r10	0.551	0.684*	0.806*	0.818*	0.903*	0.818*	0.915*	0.927*	0.939*	1.000			
r11	0.490	0.660*	0.781*	0.757*	0.866*	0.733*	0.878*	0.878*	0.915*	0.975*	1.000		
r12	0.709*	0.806*	0.903*	0.915*	0.915*	0.854*	0.927*	0.951*	0.915*	0.951*	0.927*	1.000	
r13	0.684*	0.793*	0.890*	0.890*	0.927*	0.866*	0.939*	0.939*	0.927*	0.963*	0.939*	0.987*	1.000
r14	0.636*	0.709*	0.769*	0.830*	0.793*	0.781*	0.818*	0.854*	0.818*	0.878*	0.854*	0.939*	0.915*
r15	0.660*	0.745*	0.818*	0.842*	0.830*	0.818*	0.866*	0.866*	0.878*	0.915*	0.890*	0.963*	0.951*
r16	0.660*	0.769*	0.866*	0.903*	0.927*	0.866*	0.939*	0.963*	0.939*	0.975*	0.939*	0.987*	0.975*
r17	0.551	0.684*	0.806*	0.818*	0.903*	0.818*	0.915*	0.927*	0.939*	1.000*	0.975*	0.951*	0.963*
r18	0.515	0.648*	0.757*	0.769*	0.866*	0.806*	0.890*	0.878*	0.927*	0.987*	0.963*	0.927*	0.951*
r19	0.503	0.636*	0.745*	0.733*	0.842*	0.793*	0.878*	0.842*	0.939*	0.975*	0.951*	0.890*	0.915*
r20	0.527	0.697*	0.793*	0.806*	0.915*	0.806*	0.927*	0.915*	0.951*	0.987*	0.987*	0.939*	0.951*
r21	0.442	0.575	0.672*	0.660*	0.793*	0.757*	0.830*	0.781*	0.903*	0.939*	0.915*	0.818*	0.854*

r22	0.466	0.587	0.721*	0.697*	0.818*	0.769*	0.854*	0.818*	0.915*	0.9636*	0.927*	0.866*	0.903*
r23	0.636*	0.757*	0.854*	0.878*	0.939*	0.878*	0.951*	0.951*	0.951*	0.9879*	0.951*	0.975*	0.987*
r24	0.697*	0.793*	0.818*	0.842*	0.903*	0.939*	0.939*	0.854*	0.939*	0.9030*	0.842*	0.890*	0.927*
r25	0.709*	0.793*	0.781*	0.842*	0.903*	0.951*	0.915*	0.842*	0.878*	0.8424*	0.769*	0.830*	0.878*
r26	0.757*	0.854*	0.903*	0.903*	0.951*	0.951*	0.975*	0.915*	0.975*	0.9152*	0.854*	0.903*	0.915*
r27	0.757*	0.854*	0.903*	0.903*	0.951*	0.951*	0.975*	0.915*	0.975*	0.9152*	0.854*	0.903*	0.915*
r28	0.757*	0.854*	0.903*	0.903*	0.951*	0.951*	0.975*	0.915*	0.975*	0.9152*	0.854*	0.903*	0.915*
r29	0.733*	0.830*	0.878*	0.878*	0.939*	0.927*	0.951*	0.903*	0.951*	0.8909*	0.830*	0.854*	0.866*
r30	0.697*	0.781*	0.854*	0.842*	0.915*	0.903*	0.927*	0.878*	0.927*	0.8788*	0.806*	0.830*	0.854*
r31	0.733*	0.830*	0.878*	0.878*	0.939*	0.927*	0.951*	0.903*	0.951*	0.8909*	0.830*	0.854*	0.866*
r32	0.697*	0.781*	0.854*	0.842*	0.915*	0.903*	0.927*	0.878*	0.927*	0.8788*	0.806*	0.830*	0.854*
r33	0.733*	0.781*	0.878*	0.878*	0.878*	0.878*	0.903*	0.890*	0.903*	0.8667*	0.781*	0.878*	0.866*
r34	0.733*	0.781*	0.878*	0.878*	0.878*	0.878*	0.903*	0.890*	0.903*	0.8667*	0.781*	0.878*	0.866*
r35	0.781*	0.842*	0.915*	0.951*	0.927*	0.915*	0.939*	0.951*	0.915*	0.8909*	0.818*	0.939*	0.915*
r36	0.818*	0.890*	0.939*	0.903*	0.903*	0.915*	0.939*	0.878*	0.951*	0.8667*	0.818*	0.890*	0.878*
r37	0.866*	0.927*	0.975*	0.915*	0.890*	0.903*	0.927*	0.866*	0.927*	0.8424*	0.806*	0.903*	0.890*
r38	0.818*	0.890*	0.939*	0.903*	0.903*	0.915*	0.939*	0.878*	0.951*	0.8667*	0.818*	0.890*	0.878*
r39	0.721*	0.818*	0.866*	0.890*	0.951*	0.915*	0.939*	0.927*	0.915*	0.8788*	0.818*	0.842*	0.854*
	r14	**r15**	**r16**	**r17**	**r18**	**r19**	**r20**	**r21**	**r22**	**r23**	**r24**	**r25**	**r26**
r14	1.000												
r15	0.987*	1.000											
r16	0.927*	0.951*	1.000										
r17	0.878*	0.915*	0.975*	1.000									
r18	0.890*	0.927*	0.951*	0.987*	1.000								
r19	0.842*	0.890*	0.927*	0.975*	0.987*	1.000							
r20	0.866*	0.903*	0.963*	0.987*	0.975*	0.963*	1.000						
r21	0.781*	0.830*	0.866*	0.939*	0.963*	0.987*	0.927*	1.000					
r22	0.793*	0.854*	0.903*	0.963*	0.975*	0.987*	0.939*	0.975*	1.000				
r23	0.903*	0.939*	0.987*	0.987*	0.975*	0.951*	0.975*	0.903*	0.939*	1.000			
r24	0.854*	0.903*	0.903*	0.903*	0.927*	0.915*	0.890*	0.890*	0.903*	0.939*	1.000		
r25	0.793*	0.830*	0.842*	0.842*	0.866*	0.842*	0.830*	0.830*	0.830*	0.890*	0.975*	1.000	
r26	0.781*	0.842*	0.927*	0.915*	0.890*	0.903*	0.903*	0.866*	0.890*	0.939*	0.939*	0.903*	1.000
r27	0.781*	0.842*	0.927*	0.915*	0.890*	0.903*	0.903*	0.866*	0.890*	0.939*	0.939*	0.903*	1.000*
r28	0.781*	0.842*	0.927*	0.915*	0.890*	0.903*	0.903*	0.866*	0.890*	0.939*	0.939*	0.903*	1.000*
r29	0.709*	0.769*	0.890*	0.890*	0.854*	0.878*	0.878*	0.854*	0.866*	0.903*	0.890*	0.866*	0.987*
r30	0.660*	0.733*	0.866*	0.878*	0.842*	0.866*	0.854*	0.842*	0.878*	0.890*	0.878*	0.854*	0.975*
r31	0.709*	0.769*	0.890*	0.890*	0.854*	0.878*	0.878*	0.854*	0.866*	0.903*	0.890*	0.866*	0.987*
r32	0.660*	0.733*	0.866*	0.878*	0.842*	0.866*	0.854*	0.842*	0.878*	0.890*	0.878*	0.854*	0.975*
r33	0.733*	0.793*	0.903*	0.866*	0.818*	0.830*	0.830*	0.769*	0.842*	0.890*	0.842*	0.781*	0.951*
r34	0.733*	0.793*	0.903*	0.866*	0.818*	0.830*	0.830*	0.769*	0.842*	0.890*	0.842*	0.781*	0.951*

r35	0.830*	0.866*	0.951*	0.890*	0.842*	0.830*	0.866*	0.757*	0.818*	0.927*	0.866*	0.818*	0.951*
r36	0.769*	0.830*	0.903*	0.866*	0.830*	0.854*	0.854*	0.806*	0.830*	0.890*	0.878*	0.818*	0.975*
r37	0.781*	0.842*	0.890*	0.842*	0.806*	0.818*	0.830*	0.757*	0.793*	0.878*	0.866*	0.806*	0.951*
r38	0.769*	0.830*	0.903*	0.866*	0.830*	0.854*	0.854*	0.806*	0.830*	0.890*	0.878*	0.818*	0.975*
r39	0.684*	0.733*	0.878*	0.878*	0.830*	0.842*	0.866*	0.818*	0.830*	0.890*	0.854*	0.854*	0.963*

	r27	**r28**	**r29**	**r30**	**r31**	**r32**	**r33**	**r34**	**r35**	**r36**	**r37**	**r38**	**r39**
r27	1.000												
r28	1.000*	1.000											
r29	0.987*	0.987*	1.000										
r30	0.975*	0.975*	0.987*	1.000									
r31	0.987*	0.987*	1.000*	0.987*	1.000								
r32	0.975*	0.975*	0.987*	1.000*	0.987*	1.000							
r33	0.951*	0.951*	0.939*	0.951*	0.939*	0.951*	1.000						
r34	0.951*	0.951*	0.939*	0.951*	0.939*	0.951*	1.000*	1.000					
r35	0.951*	0.951*	0.927*	0.915*	0.927*	0.915*	0.975*	0.975*	1.000				
r36	0.975*	0.975*	0.963*	0.939*	0.963*	0.939*	0.951*	0.951*	0.951*	1.000			
r37	0.951*	0.951*	0.927*	0.903*	0.927*	0.903*	0.927*	0.927*	0.939*	0.987*	1.000		
r38	0.975*	0.975*	0.963*	0.939*	0.963*	0.939*	0.951*	0.951*	0.951*	1.000*	0.987*	1.000	
r39	0.963*	0.963*	0.987*	0.975*	0.987*	0.975*	0.915*	0.915*	0.915*	0.927*	0.890*	0.927*	1.000

Note: r1, r2, … denote ranking of the banks in terms of the cost efficiency at first quarter, second quarter, … respectively. * denotes the statistical significance of the rank correlations at the 5% significance level.

Table 13: Spearman rank correlation of cost efficiency of state banks

	r1	**r2**	**r3**	**r4**	**r5**	**r6**	**r7**	**r8**	**r9**	**r10**	**r11**	**r12**	**r13**
r1	1.000												
r2	1.000*	1.000											
r3	1.000*	1.000*	1.000										
r4	0.500	0.500	0.500	1.000									
r5	0.500	0.500	0.500	1.000*	1.000								
r6	0.500	0.500	0.500	1.000*	1.000*	1.000							
r7	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000						
r8	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000					
r9	1.000*	1.000*	1.000*	0.500	0.500	0.500	0.500	0.500	1.000				
r10	1.000*	1.000*	1.000*	0.500	0.500	0.500	0.500	0.500	1.000*	1.000			
r11	1.000*	1.000*	1.000*	0.500	0.500	0.500	0.500	0.500	1.000*	1.000*	1.000		
r12	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000	
r13	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000
r14	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000*
r15	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000*

r16	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000*
r17	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000*
r18	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000*
r19	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000*
r20	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000*
r21	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000*
r22	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000*
r23	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000*
r24	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000*
r25	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000*
r26	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000*
r27	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000*
r28	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000*
r29	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000*
r30	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000*
r31	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000*
r32	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000*
r33	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000*
r34	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000*
r35	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000*
r36	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000*
r37	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000*
r38	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000*
r39	0.500	0.500	0.500	1.000*	1.000*	1.000*	1.000*	1.000*	0.500	0.500	0.500	1.000*	1.000*
	r14	**r15**	**r16**	**r17**	**r18**	**r19**	**r20**	**r21**	**r22**	**r23**	**r24**	**r25**	**r26**
r14	1.000												
r15	1.000*	1.000											
r16	1.000*	1.000*	1.000										
r17	1.000*	1.000*	1.000*	1.000									
r18	1.000*	1.000*	1.000*	1.000*	1.000								
r19	1.000*	1.000*	1.000*	1.000*	1.000*	1.000							
r20	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000						
r21	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000					
r22	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000				
r23	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000			
r24	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000		
r25	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000	
r26	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000
r27	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*
r28	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*

r29	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*
r30	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*
r31	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*
r32	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*
r33	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*
r34	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*
r35	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*
r36	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*
r37	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*
r38	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*
r39	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*
	r27	**r28**	**r29**	**r30**	**r31**	**r32**	**r33**	**r34**	**r35**	**r36**	**r37**	**r38**	**r39**
r27	1.000												
r28	1.000*	1.000											
r29	1.000*	1.000*	1.000										
r30	1.000*	1.000*	1.000*	1.000									
r31	1.000*	1.000*	1.000*	1.000*	1.000								
r32	1.000*	1.000*	1.000*	1.000*	1.000*	1.000							
r33	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000						
r34	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000					
r35	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000				
r36	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000			
r37	1.00*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000		
r38	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000	
r39	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000

Note: r1, r2, … denote ranking of the banks in terms of the cost efficiency at first quarter, second quarter, … respectively. * denotes the statistical significance of the rank correlations at the 5% significance level.

APPENDIX B

TEZ FOTOKOPİSİ İZİN FORMU

ENSTİTÜ

Fen Bilimleri Enstitüsü	
Sosyal Bilimler Enstitüsü	x
Uygulamalı Matematik Enstitüsü	
Enformatik Enstitüsü	
Deniz Bilimleri Enstitüsü	

YAZARIN

Soyadı : GÜNEŞ
Adı : HAKAN
Bölümü : İKTİSAT

TEZİN ADI (İngilizce) : MEASURING COST EFFICIENCY OF TURKISH COMMERCIAL BANKS: A STOCHASTIC FRONTIER APPROACH

TEZİN TÜRÜ : Yüksek Lisans [x] Doktora [ ]

1. Tezimin tamamından kaynak gösterilmek şartıyla fotokopi alınabilir. [x]
2. Tezimin içindekiler sayfası, özet, indeks sayfalarından ve/veya bir bölümünden kaynak gösterilmek şartıyla fotokopi alınabilir. [ ]
3. Tezimden bir bir (1) yıl süreyle fotokopi alınamaz. [ ]

TEZİN KÜTÜPHANEYE TESLİM TARİHİ: