An Analysis of Efficiency and Profitability in the Turkish Banking System

Since the mid-1990s, a number of studies have been conducted that analyze the profitability and cost structure of Turkish banks by using different research methodologies. Due to the advances in modeling techniques during the 2000s, it is now possible to address the same issues in a more detailed and rigorous manner. The main objective of this study is to conduct an analysis of profitability and cost in the Turkish banking sector by using data between 1960 and 2009. The particular data set that is to be used in this study makes it possible to examine the issue of profitability and cost over a much longer time period compared to previous studies.

The first step in the study involves the estimation of profit and cost efficiencies by using the stochastic frontier approach. This part of the study presents the changes that took place in the profit and cost efficiency of Turkish banks since the 1960s. The results in this part of the study also make it possible to make efficiency comparisons between banks with different institutional characteristics, such as state-owned versus private banks and Turkish versus foreign banks. The stochastic frontier approach creates an X-efficiency score for each sample bank analyzed. This score is calculated by comparing a specific bank's profit or cost performance against the "best practice" performance determined based on the performances of all banks in the sample. The stochastic frontier approach also generates an "inefficiency" score for each bank based on the same "best practice" guideline. So, for instance, while the "cost efficiency" score of a bank measures how closely that bank performs with respect to the best cost practice in the sample, the "cost inefficiency" score measures the deviation of a bank's cost performance from the best practice guideline. The same efficiency and inefficiency scores can also be calculated for the profit performance of a sample bank.

In the second part of the study, a profitability model is estimated for the Turkish banks and traditional industrial organization hypotheses, such as "collusion" versus "efficiency" are tested. One of the independent variables in this profitability model is the efficiency scores that are calculated in the first part of the study.

The previous studies on the Turkish banking sector that ask a similar research question and adopt a similar methodology mostly focus on the *cost inefficiency* of banks in the market. For instance, the study by Oral and Yolalan (1990) uses the non-parametric data envelopment method and presents results based on a case study conducted about a one sample bank. Later, Zaim (1995) uses the same method and concludes that the Turkish commercial banks benefited from the financial liberalization environment during the 1981-1990 period and experienced increases in their technical and distributional efficiencies. Contrary to these findings, Denizer et al. (2000) utilize a similar methodology and present evidence that there has been a decline in the efficiency of Turkish banks following the market changes that came as a result of financial liberalization.

One of the first studies on Turkish banks that use a stochastic cost estimation approach is by Altunbaş and Molyneux (1994). In this study, the analysis results suggest that there is no difference between state-owned and private commercial banks in terms of their cost inefficiencies. Denizer's 1997 study, on the other hand, shows that, as of 1990, Turkish banks are at least five times more profitable when compared to their peers in the other OECD countries. In a more recent study, Işık and Hassan (2002) employ both parametric and non-parametric methods and analyze the Turkish banks in terms of their distributional, technical, cost and profit efficiencies. Their results imply that the main source of inefficiency for Turkish banks during the 1988-1996 period is not the distributional but technical inefficiency. The succeeding studies by Kasman (2002 and 2005) provide evidence that the Turkish banks enjoy scale efficiencies. Interestingly, the same studies show that although during the 1981-1990 period most banks have experienced an improvement in their efficiencies, there has been no improvement in the bank efficiencies during the following 10 years.

When the literature on the Turkish banks is reviewed, it is seen that most studies analyze either the cost or the profit efficiency of banks. However, these two types of efficiencies are closely related to each other and if they are analyzed together, a more complete picture can be constructed regarding the efficiency of Turkish banks. Moreover, the previous studies mostly use a sample period that goes back as far as the 1980s. The current study proposes to use data that cover approximately five decades and go back as far as the 1960s.

1. Determinants of Bank Profitability

In previous studies that address bank efficiency, bank performance is typically measured by the profitability of the bank. Most of these studies focus their attention on the relation between profitability and deposit or loan market concentration and typically find a positive relation between the two variables. This positive relation can be explained in two ways.

On the one hand, according to the *Structure-Conduct-Performance Hypothesis*, as a result of increasing concentration in the market, banks become aware of their mutual dependence and this gives way to increased collusion among banks. This increased collusion, in turn, may lead to above-normal profits earned by banks in the market (Mason 1939, 1949; Bain 1951, 1956).

On the other hand, according to Demsetz's (1973, 1974) *Efficient Structure Hypothesis,* a few banks will capture the largest market shares and earn the highest profits by operating with a cost advantage compared to the others in the market. Through their profitability and large market shares, these banks end up increasing the amount of concentration in the market. Therefore, according to this second argument, the concentration in the market is a direct result of high performance (profitability) by banks. The studies that provide evidence in favor of this claim measure bank efficiency with bank market share and as a result, a positive relation is found between profitability and efficiency. According to Demsetz, market concentration does not facilitate collusive behavior among banks; on the contrary, it is a direct result of competition among banks.

Recent studies have posited that a bank's share in the loan or deposit market may be a reflection of other factors besides the bank's efficiency. So, these studies attempt to measure bank efficiency more directly instead of using market share as a proxy. Following these studies, this paper estimates a bank's efficiency with the stochastic frontier approach and uses this direct measure to analyze the relation between market concentration and bank profitability. Also, while many of the previous studies focus on either the profit or cost efficiency of banks, this study will analyze both types of efficiencies.

1.1. Hypotheses about Bank Profitability

The profit function estimated in this study has the following general form (Timme and Yang, 1991; Maudos, 1998; Gumbau and Maudos, 2000):

$$\pi = \beta_0 + \beta_1 CR + \beta_2 MS + \beta_3 EF + \alpha' X + \varepsilon \tag{1}$$

In this equation, CR is the concentration ratio in the deposit or loan market, MS is the bank's market share in the deposit or loan market, EF is the profit efficiency estimated with the stochastic frontier approach and X is the vector of other control variables. The estimation of the EF variable is described in detail in the next section. It is possible to form a number of null hypotheses about this profit function:

1. Collusive Behavior Hypothesis: $\beta_1 > 0, \quad \beta_2 = 0, \quad \beta_3 = 0$

According to this hypothesis, the main determinant of profitability is the level of concentration in the market and a bank's market share and efficiency should have no significant effect on its profitability.

2. Efficiency Hypothesis: $\beta_1 = 0, \quad \beta_2 = 0, \quad \beta_3 > 0$

According to this argument, the main determinant of profitability is bank efficiency and market concentration and bank's market share should have no significant effect on the bank's profitability.

3. Relative Market Power Hypothesis: $\beta_1 = 0, \quad \beta_2 > 0, \quad \beta_3 > 0$

This hypothesis posits that only those banks with a large market share and highly differentiated products will have market power and as a result will be able to charge monopoly prices. Therefore, while market concentration is expected to have no impact, bank efficiency and market share should have a positive effect on profitability.

4. Efficiency/Collusion Hypothesis: $\beta_1 > 0, \quad \beta_2 = 0, \quad \beta_3 > 0$

According to Schmanleese (1987), while market concentration and bank efficiency are the main determinants of profitability, the market share of a bank should have no significant impact.

These four hypotheses are tested in this study within a multiple regression framework.

1.2. The Empirical Specification of the Profitability Equation

The empirical specification of the profitability equation estimated in this study is as follows:

$$\pi = \beta_0 + \beta_1 CR + \beta_2 MS + \beta_3 EF + \alpha_1 CA + \alpha_2 LR + \alpha_3 OR + \alpha_4 TA + \varepsilon \qquad (2)$$

The dependent variable π is bank profitability. Profitability is measured in two ways. The first measure is *Return on Assets (ROA)* and is equal to the ratio of net income to total assets. This is the traditional profitability measure used in the literature for both financial and nonfinancial firms. As a second measure, bank profitability is equal to *Net Interest Margin (NIM)* which is the ratio of Net Interest Income to Earning Assets. The second profitability measure is more relevant for a bank since it represents the direct results of the bank's main business of gathering deposits and granting loans.

The first independent variable is the *Concentration Ratio (CR).* Since the main areas of competition among banks are the deposits and the loans, it is meaningful to calculate two concentration measures based on these two bank products. The *Loan Concentration Ration (LCR)* represents the total market share of the top three banks in terms of the size of their loan portfolios. Similarly, the Deposit Concentration Ratio (DCR) represents the total market share of the top three banks in terms of the size of their deposit portfolios.

The second independent variable is a bank's Market Share (*MS)* either in the loan market *(LMS)* or in the deposit market *(DMS)*. The LMS variable is used in the same regression with the Loan Concentration Ratio and the DMS variable is used in the same regression with the Deposit Concentration Ratio.

The third independent variable is the *Efficiency Score (EF)* calculated with the stochastic frontier method. As the value of this variable gets closer to 1, the bank's efficiency score increases with respect to the other banks in the market.

The final group of independent variables is included in the model to control for some cross-sectional differences among banks. Based on the traditional risk-return tradeoff in finance, the first three control variables measure the riskiness of a bank. The first risk variable is *Capital Adequacy (CA)* and is equal to the ratio of Total Equity to Total Assets. This ratio measures a bank's solvency risk. Since total equity (or a bank's equity capital) acts as a cushion against losses, banks with a lower ratio are perceived to be riskier. Riskier banks, on the other hand, may be expected to generate higher profits if the reason for a lower equity-to-assets ratio is the growth in the earning assets portfolio through deposit and volatile liability funding. On the other hand, if a bank is growing too fast, its asset quality may be compromised and this may result in decreased profitability.

The other risk variable is *Liquidity Risk (LR)* and is measured as the ratio of Total Loans to Total Deposits. Since loans are typically the least liquid type of asset because of their relatively long average maturity and the deposits (especially demand deposits) carry very short maturities on the liability side, comparing the size of these two portfolios makes it possible to assess the liquidity position of a bank. If this ratio is higher, the bank carries a higher liquidity risk. At the same time, since loans generate the highest return on the asset side, a high liquidity risk ratio would also imply potentially high profits being generated from the loan portfolio.

The third risk measure is *Operational Risk (OR)* and is equal to the ratio of the difference between Non-Interest Income and Non-Interest Expense to Total Assets. The difference in the numerator of this ratio is also called the "burden" for the bank and it is a direct representation of how well the bank can control its non-interest expenses. If a bank is able to generate high non-interest income through its operations, and especially if this amount is large enough to pay for the bank's non-interest expense, this will certainly have a positive impact on the profitability of the bank. Therefore, a higher value for the operational risk measure is expected to contribute positively to a bank's profitability.

The final risk measure is *Credit Risk (CR)* and is measured as the ratio of Loan Loss Reserves to Total Loans. The loss reserves set aside by the bank represents its expectation of loan losses in the near future. When this ratio is high, the bank's loan portfolio suffers from low credit quality and more defaults are expected. When there are a lot of defaults in the loan portfolio, this will affect the bank's profitability adversely.

The last independent variable in the profit equation is Size (TA) which is calculated as the inverse of Total Assets. This variable is included in the model to account for the reputation of the bank in the market and it is also expected to measure the scale differences that exist among banks. Since the market share of a bank and its total asset size are going to be highly correlated, this variable is measured as the inverse of total assets in order to avoid the problem of multicollinearity with the market share variable.

2. Calculation of Bank Efficiency Scores

The bank efficiency measure used in this study is X-efficiency. X-efficiency refers to the level at which a bank utilizes its available technology and managerial skills. If X-efficiency is defined within the context of cost, then it will refer to the ability of the bank to use its inputs in an optimal manner. X-efficiency in a market would refer to the best-practice in that market and, therefore, cost X-efficiency would refer to the lowest cost of operations. The important point to note about the cost X-efficiency concept is that even if a bank is cost efficient, this does not necessarily mean that this bank is also maximizing its profits. Therefore, in addition to a bank's cost X-efficiency, its profit X-efficiency can be calculated. The profit X-efficiency of the bank would represent the bank's ability to keep its profits at the market's "best practice" level while taking into account its changing cost of operations. In the literature, profit efficiency and production efficiency are used interchangeably and, as such, these measures refer to the bank's ability to produce the optimal output in its current market conditions.

The stochastic frontier method used in this study to estimate cost and profit efficiencies was developed by Aigner et al. (1977) and Meeusen and Van Den Broeck (1977). According to Aigner et al. a bank's cost of operations may deviate from the theoretical cost frontier as a result of either inefficiencies in its operations or random influences. With this approach, the bank costs can be modeled as follows:

$$\ln C_i = \ln C_i(y_i, w_i) + e_i^c \quad \text{where } e_i^c = \ln u_i^c + \ln v_i^c \text{ and } i=1,\ldots,N \tag{3}$$

In this equation, $\ln C_i$ is the natural log of bank i's costs, y_i is a vector of bank i's outputs, w_i is a vector of bank i's input prices. The error term e_i^c has two components: u_i^c represents the bank-specific factors that cause cost-inefficiency and v_i^c represents the uncontrollable random factors that contribute to the cost-inefficiency of bank i. While the cost-inefficiency component u_i^c can only take nonnegative values, the random component v_i^c can be either negative or positive. The $\ln C_i(y_i, w_i)$ in Equation (3) represents the theoretical cost frontier and with the addition of the random error term, this frontier becomes a stochastic cost frontier.

In the equation above, v_i^c is assumed to be i.i.d. and the inefficiency term u_i^c is assumed to be distributed independently from v_i^c. In the literature, v_i^c is typically assumed to come from a normal distribution. Aigner et al. (1977) argue that the inefficiency term u_i^c can either come from a half-normal or an exponential distribution. Both of these distributions accommodate the requirement that u_i^c has only nonnegative values. In this study, u_i^c is assumed to have a half-normal distribution.
The stochastic frontier method chooses a functional form for the cost model $\ln C_i = \ln C_i(y_i, w_i)$ that appears in Equation (3) and estimates the model in order to calculate the cost efficiency scores EF_i^C for sample banks in the following manner (Maudos et al., 1997):

$$EF_i^C = \frac{C_i^{min}}{C_i} = \frac{\exp[\ln C_i(y_i, w_i)]\exp[\ln v_i^c]}{\exp[\ln C_i(y_i, w_i)]\exp[\ln u_i^c]\exp[\ln v_i^c]} = \exp[-\ln u_i^c] \tag{4}$$

In this equation, C_i^{min}represents the minimum amount of cost that must be incurred by banks in order to produce the output vector. In other words, C_i^{min} is the stochastic frontier value for total costs. C_i, on the other hand, is the actual total cost incurred by bank *i* while producing the output.

In this study, profit efficiency is also going to be estimated. DeYoung and Nolle (1996) have argued that cost-based models may not always represent the true efficiency of banks. This is because some banks may incur high costs but, in return, may also be able to generate high profits. If the profit efficiency of the bank can cancel out its cost inefficiency, then it may be possible for this bank to increase its profits. According to Berger and Mester (1997) and Berger and DeYoung (2002), compared to cost minimization, profit maximization is a more appropriate way of assessing bank performance since profits will account for both revenues and costs and thus represent the goal of bank managers and shareholders more completely.

Profit efficiency can be estimated based on two types of profit functions. In the *standard profit function*, bank profits are a function of input and output prices, while in the *alternative profit function*, bank pforits are a function of input prices and output quantities. If the alternative profit specification is used, it is possible to estimate the profit and total cost function with the same independent variables. Berger and Mester (1991, 1997) argue that if the banking industry moves away from the assumptions of perfect competition, then it is more appropriate to use the alternative profit specification. Modeling bank profits as a function of output quantities has two other advantages. First, for most banks, data on output prices are proprietary and, therefore, not accessible. Any attempt to measure by looking at balance sheet and income statement numbers will not yield reliable results. Also, in a banking industry where there is severe competition, it is often observed that the main differences among banks will not be in their output prices but in the amounts of output that they produce. For instance, in the mortgage loan market, the loan rates may not change a lot from one bank to another, but, depending on the bank's ability to capture market share, the size of the mortgage loan portfolio can show a lot of variability among banks. Using quantities that have high variability instead of using rates that have low variability is preferable for econometric reasons. Based on all these reasons, the alternative specification of the profit model is adopted in this study.

The stochastic profit function can be written in a very similar fashion to the stochastic cost function:

$$ln(\pi_i + \theta_i) = ln(\pi_i(y_i,w_i)) + e_i^{\pi} \quad \text{where } e_i^{\pi} = ln\, u_i^{\pi} + ln\, v_i^{\pi} \text{ and } i=1,\ldots, N \tag{5}$$

In this equation, π_i represents bank *i*'s profitability and the other variables are defined as in Equation (3). θ_i is a positive constant that is added to profits in order to allow taking logarithms during the estimation process. After choosing a functional form for the profit function in (5), the profit efficiency scores for banks EF_i^{π} can be calculated as follows (Clark and Siems, 2002; Maudos *et al*. 1999):

$$EF_i^C = \frac{\pi_i}{\pi_i^{max}} = \frac{\{\exp[\ln \pi_i(y_i,w_i)]\exp[\ln u_i^{\pi}]\exp[\ln v_i^{\pi}]\}-\theta_i}{\{\exp[\ln \pi_i(y_i,w_i)]\exp[\ln v_i^{\pi}]\}-\theta_i} \tag{6}$$

In this equation, π_i^{max} represents the maximum profit (the stochastic frontier value) thatcan be earned by producing the output vector and π_i represents the actual profit earned by bank *i* while producing the outputs.

2.2 Empirical Specification of Cost and Profit Functions

Before the cost and profit efficiency scores can be calculated for banks, it is necessary to choose a functional form for the cost and profit functions. In this study, total costs are modeled in a translog form. A translog cost function is a second degree Taylor series approximation to an arbitrary cost function that is twice differentiable around an expansion point. Using the translog form has some advantages. First, the translog form is a flexible form and can easily represent the frequently used Cobb-Douglas and CES functions. Also, with a translog form, it is possible to use profits or returns that change with the scale of the bank and, when necessary, the total cost function can take an S shape and the average cost function can take the inverted U form. Finally, when a translog cost function is used, the substitution elasticity between different inputs can be variable and there is no need to make an assumption about these elasticities on a priori basis.

In this study, the Turkish banks are assumed to use three inputs (labor, fixed assets, deposits) and to produce two outputs (loan portfolio and investment portolio). With these inputs and outputs, the empirical specification of the translog cost function can be written as follows:

$$ln\,TC = \alpha_0 + \sum_{k=1}^{3} a_k lnw_k + \frac{1}{2}\sum_{k=1}^{3}\sum_{j=1}^{3} a_{kj} lnw_k lnw_j + \sum_{p=1}^{2} b_p lny_p + \frac{1}{2}\sum_{p=1}^{2}\sum_{s=1}^{2} b_{ps} lny_p lny_s + \sum_{k=1}^{3}\sum_{p=1}^{2} c_{kp} lnw_k lny_p + d_1 S + d_2 F + \varepsilon^C \quad (7)$$

The equation is given without the bank (i) and time (t) subscripts in order to save space. In this equation, TC represents the bank's total cost and is equal to the sum of interest expense and noninterest expense.

Since the banks are assumed to have three types of inputs, there are three corresponding input prices. The first input price, w_1, is the labor price and is calculated by dividing the personnel expenses by the number of employees. The second input price, w_2, is the price of fixed assets and is calculated by dividing the sum of depreciation and noninterest expenses by the net fixed assets of the bank. The last input price w_3, is the price of deposits and is calculated by dividing the interest expense by the total deposits of the bank.

The first output produced by banks, y_1, is the loans and is measured by the size of the total loan portfolio. The second output, y_2, is the investment portfolio and is measured by the size of this portfolio on a bank's balanace sheet.

It has been observed and empirically evidenced that a bank's cost and profit efficiency may change depending on its ownership structure. Therefore, the first dummy variable in the model, S, takes a value of 1 if the sample bank is state-owned. Likewise, the second dummy variable, F, takes a value of 1 if the sample bank is a foreign bank operating in Turkey.

The second stochastic frontier to be estimated in the study is the profit frontier. The empirical specification of the profir model also assumes the banks to be producing two outputs by using three inputs. The only difference between the profit and the cost frontiers is the dependent variable. In the profit frontier, the dependent variable is a measure of bank's profitability and is equal to either the return on assets or the net interest margin for the bank. As explained above, a positive constant is added to these profit measures in order to be able to take logs of negative profit values. The translog profit function can be written as follows:

$$ln\,(\pi + \theta) = \beta_0 + \sum_{k=1}^{3} e_k lnw_k + \frac{1}{2}\sum_{k=1}^{3}\sum_{j=1}^{3} e_{kj} lnw_k lnw_j + \sum_{p=1}^{2} f_p lny_p + \frac{1}{2}\sum_{p=1}^{2}\sum_{s=1}^{2} f_{ps} lny_p lny_s + \sum_{k=1}^{3}\sum_{p=1}^{2} g_{kp} lnw_k lny_p + h_1 S + h_2 F + \varepsilon^\pi \quad (8)$$

3. Empirical Results

3.1. Data

The sample consists of annual balance sheet and income statement data for 87 Turkish commercial banks between the years 1960 and 2009. The original sample had 135 banks. 37 of these banks were eliminated from the sample because they had less than 10 years of data. Another 12 banks were eliminated because they were investment banks with no deposit-acceptance authority. The balance sheet and income statement data were obtained from the Turkish Banker's Association's annual publication "Banks in Turkey."

In order to calculate the *price of labor* variable, the number of employees working at the sample banks was collected on an annual basis from the same publication of the Turkish Banker's Association[1].

The estimation of the translog cost and profit functions have certain symmetry and homogeneity requirements. In order to satisfy these requirements, the dependent and independent variables in all three of the translog functions were first mean-scaled by dividing each independent variable with its sample average. Also, the total cost variable and the input prices of labor, deposit and fixed assets were normalized by dividing each one with the price of labor. As a result, some of the cross-product terms were dropped from the empirical specification of the translog functions.

3.2. Stochastic Frontier Estimations

The cost and profit translog functions described above were estimated by using the maximum likelihood method based on a sample panel of 87 banks over a period of 50 years.

Table 2 presents the estimation results for the translog profit function when the profit is measured as the bank's Return on Assets (ROA). Bank profitability seems to be negatively affected from price of fixed assets (3rd input price in the equation). This is in line with a priori expectations since larger values of depreciation and noninterest expense will lower the net income for the bank. ROA also seems to have a significant and negative relation with the size of the total loans, which is one of the outputs used in the model. The sign of this variable is perplexing. Since the loan portfolio is the most important source of income for a bank, the a priori expectation for this coefficient is positive. However, if a bank's credit quality deteriorates with the expansion of the loan portfolio, this may increase the amount of defaults and, thus, hurt the bank's profitability. The dummy variable for foreign banks has a significant and positive coefficient. This finding indirectly supports the typical claim that foreign banks enter a banking market if they have confidence that they can generate high, or higher than average, returns in the market that they are entering into. In terms of ROA profitability, foreign banks seem to enjoy an advantage over Turkish banks over the 50-year sample period.

ROA is a profit measure that is used for financial and nonfinancial corporations alike. In the case of a bank, the Net Interest Margin (NIM) may be considered as a more direct measure of a bank's ability to generate profit. NIM divides the Net Interest Income (NII) by the amount of the earning assets that are used to generate this income. Since the major income for a bank comes from the interest it earns on its loan and investment portfolios and the major expense is the interest it pays on its deposits and other borrowings, looking at NIM as a profitability measure for a bank may even be preferable over ROA. Table 3 presents the translog profit function estimation results when the profit is measured with NIM. This time NIM seems to be negatively affected from the price of deposits (2nd input price in the equation). This is not surprising since the higher the interest expenses, the lower the bank's NII is going to be. Similar to the results from the ROA estimation, NIM also seems to be significantly and negatively affected from the size of the total loans and the investment portfolio. These two asset categories are the largest income sources for a bank and the a priori expectation is to find a positive relation between these two variables and profitability. The negative relation may be evidence for the higher credit risk and lower asset quality that banks are willing to accept in order to expand the size of their loans and investments, leading to losses and decreased profits. It may also be an indication of how banks attempt to stay competitive in the loan market. By charging relatively lower loan rates in order to increase their market share in the loan market, banks are able to increase the size of their loan portfolios but suffer from a relatively lower NIM.

[1] This publication is available online at www.tbb.org.tr dating back to 1958.

In this equation, the dummy for foreign banks is significant and negative. While the foreign banks are at a disadvantage in terms of generating NIM compared to Turkish banks, they are able to still enjoy higher ROAs compared to the average (result from Table 2). Apparently, these banks are able to make up for their relatively poorer performance in terms of NIM by contributing from other sources (such as noninterest income) to the generation of net income.

In either of the two profit equations, the dummy for state-owned banks has an insignificant coefficient. This is somewhat contrary to the usual argument that state-owned banks are less profitable compared to privately-owned commercial banks. In these estimation results, it not possible to provide evidence that supports this contention.

Closely related to a bank's profit-generation ability is its ability to control its costs. Therefore, the results in Table 4 are quite relevant for the profitability discussion. In this equation, a translog cost function is estimated with the same inputs and outputs as independent variables and the log of total costs (interest expense + noninterest expense) as the dependent variable. The bank's costs are higher when its fixed asset prices (depreciation + noninterest expense) are higher. Also, the banks seem to incur larger costs in order to support larger loan portfolios. This is in line with a priori expectations. The loan portfolio represents the largest and the riskiest asset category for a bank. The bank has to expend a lot of resources for maintaining this portfolio since the credit process is not only comprised of the actual granting of the loan but also a detailed and expensive credit analysis stage beforehand and a long credit monitoring process afterwards. Therefore, it is not surprising that the bank's costs are higher when its loan portfolio is larger. Bank costs seem to be lower, on the other hand, when the investment portfolio is larger. This may be evidence for the less costly operations related to forming and maintaining an investment portfolio compared to the loan portfolio.

The foreign bank dummy has a significant and negative coefficient in the cost model as well. This is in line with the NIM results. Foreign banks seem to suffer a disadvantage in terms of the interest expenses that they have to pay, which increases their costs and hurts their Net Interest Margin. This may be the result of foreign banks offering higher interest on their deposits in order to attract customers in a market into which they are entering as outsiders. One obvious way to compete for deposit funds is to offer higher rates relative to competitors and foreign banks' profitability and costs may be suffering from such a competitive pressure, even more so than the Turkish banks.

The main purpose of estimating these three translog functions is to estimate the profit and cost efficiencies for Turkish banks over the sample period. Tables 5, 6, and 7 present annual average efficiency scores estimated with ROA, NIM and Total Costs, respectively. Figure 1 compares the time series of these averages. From the tables and the figure, it is observed that while the cost and NIM efficiencies do not show a lot of variability over the 50-year horizon, the ROA efficiency for Turkish banks has an upward trend. Turkish banks seem to have improved their Return on Asset efficiency with respect to each other over the sample period. When the bank averages are compared over the same period, it is seen that there is a very large gap between the bank with the highest average efficiency score (a score of 0.81) and the bank with the lowest average efficiency score (a score of 0.04). Since annual averages for ROA efficiency trend between 0.15 and 0.50, this implies that the majority of banks have efficiency scores below 0.50. Therefore, the upward trend in these scores may be expected to continue assuming that banks strive to approach the best practice in their industry in terms of profitability.

In terms of cost efficiency, the annual averages are quite high. When we look at the individual banks' annual averages, the highest average cost efficiency score is 0.98 (the lowest total cost average) and the lowest cost efficiency score is 0.43 (the highest total cost average). The annual averages in Table 7 change between 0.80 and 0.90. Therefore, it seems that most of the sample banks have cost efficiency scores above 0.50. This is not a surprising result in a market where banks try to stay competitive by keeping their costs under control.

3.3. Determinants of Profitability

After obtaining the profit efficiency scores for banks, it is now possible to use these scores as one of the explanatory variables in the profit model. As explained above, profit is modeled in this study as a function of market concentration, market share, bank efficiency, and a number of bank-specific control variables. This model is estimated within a regression framework. Tables 8 and 9 present estimation results when profitability is measured by the Net Interest

Margin[2]. In Table 8, market concentration refers to the concentration in the loan market and market share refers to the bank's share in this market. In Table 9, market concentration refers to the concentration in the deposit market and market share refers to the bank's share in this market.
The main hypotheses about the regression results were discussed above. In both of the tables, the coefficients for market concentration and profit efficiency are positive and significant and this result seems to provide evidence in support of the Collusion/Efficiency Hypothesis. The positive relationship between market concentration and profitability implies that banks with higher profitability are able to expand the size of their loan and deposit portfolios over time, which in turn increases the amount of concentration in the banking sector. In addition, the relative performance of banks with respect to each other, which is measured by the efficiency scores, seems to play a significant role as a determinant of profitability: the closer the bank to the stochastic frontier of "best practice" in the market, the more profitable it is.

The one unexpected estimation result in the two tables is the negative and significant coefficient of the market share (for both loan market share and deposit market share). The Collusion/Efficiency Hypothesis does not foresee such a finding. However, empirically this result seems to suggest that banks are under competitive pressure when they are pricing their loans and deposits. In order to increase their market share for loans, banks have to offer competitively lower loan rates, and, in order to increase their market share for deposits, they have to offer competitively higher deposit rates. These relatively lower loan rates and higher deposit rates end up causing a decline in bank profitability (as measured by the NIM).

In addition to these three variables, bank profitability also seems to have a negative and significant relation with capital adequacy and liquidity risk. Capital adequacy is measured as the ratio of Total Equity to Total Assets. When this ratio is higher, this may imply that the bank is somewhat conservative in the growth rate of its asset portfolio, since additional equity would have to be acquired for the continued growth of the bank on the asset side. With such a bank, profitability may be relatively lower since the risk-taking tendency for such a bank is expected to be relatively weaker, as well.

Liquidity risk, on the other hand, is measured as the ratio of Total Loans to Total Deposits. This ratio compares the amount of the least liquid assets with the amount of the most liquid liabilities. Evidently, for those Turkish banks whose liquidity risk is higher, the mismatch between the average maturity of the loan and deposit portfolios create liquidity problems. When a bank experiences payment problems as a result of such a mismatch, it may have to offer higher deposit rates in order to attract new depositors or to maintain the existing ones. As a result, its profitability will be negatively affected.

The coefficient for the operational risk variable is significant and positive. This implies that the sample banks are able to generate high non-interest income in order to pay for their noninterest expenses and this seems to have a positive impact on the profitability of these banks.

The final risk variable for credit risk is marginally significant and positive at the 10% alpha level. This variable is a direct measure of expected losses in the loan portfolio. It is not surprising to find that a lower credit quality and higher risk in the loan portfolio has a positive contribution to profitability for sample banks. Apparently, some of the gambles that these banks take on in the loan portfolio pay off and increase the NIM. Especially in the presence of deposit insurance, which has been the norm for the Turkish banking system for about half of the sample period, taking relatively higher risks in the loan portfolio is a lot easier. In the end, if these gambles pay off, the bank will be better off; however, if the loan portfolio risks backfire, it will be the depositors and the deposit insurance fund that will have to suffer the severity of the consequences.

4. Conclusions

The main objective of this study is to conduct an analysis of profitability and cost in the Turkish banking sector by using data between 1960 and 2009. In the first step of the study, profit and cost efficiencies are calculated for Turkish banks by using the stochastic frontier approach. The results in this part suggest that ROA and NIM efficiencies seem to be significantly and negatively affected from the size of the total loans and the investment portfolio. These two asset

[2] The same regressions are estimated with ROA as the dependent variable. The results are qualitatively the same and not presented here in order to conserve space.

categories are the largest income sources for a bank and the a priori expectation is to find a positive relation between these two variables and profitability. The negative relation may be evidence for the higher credit risk and lower asset quality that banks are willing to accept in order to expand the size of their loans and investments, leading to losses and decreased profits. It may also be an indication of how banks attempt to stay competitive in the loan market. By charging relatively lower loan rates in order to increase their market share in the loan market, banks are able to increase the size of their loan portfolios but suffer from a relatively lower NIM.

In the ROA equation, the dummy for foreign banks is significant and positive, while in the NIM equation, the foreign bank dummy has a significant and negative coefficient. While the foreign banks are at a disadvantage in terms of generating NIM compared to Turkish banks, they are still able to enjoy higher ROAs compared to the average. The estimation results also fail to present any evidence that state-owned banks in Turkey have a poorer profit performance compared to the other banks in the market.

When the translog cost function is estimated, it is observed that bank costs are higher when the fixed asset prices are higher and the loan portfolio is larger. This is in line with a priori expectations. Since the loan portfolio represents the largest and the riskiest asset category for a bank, banks have to expend many resources for maintaining this portfolio. In addition, bank costs seem to be lower when the investment portfolio is larger. This may be evidence for the less costly operations related to forming and maintaining an investment portfolio compared to the loan portfolio.

When the determinants of profitability are analyzed in a regression framework, it is seen that market concentration and bank efficiency both contribute positively to bank profitability. This finding lends support to the Collusion/Efficiency Hypothesis. Contrary to the predictions of this hypothesis, however, loan and deposit market share both seem to have a negative impact on profitability. This may be due to the competitive pressures that the banks operate under and make it necessary to offer relatively lower loan rates and relatively higher deposit rates in order to conserve market share.

Table 1 Variable Definitions
total cost = interest expense + noninterest expense
profit 1 = return on assets = net income / total assets
profit 2 = net interest margin = (interest income - interest expense) / earning assets
labor price = personnel expenses / number of employees
fixed asset price = (depreciation + noninterest expense) / net fixed assets
deposit price = interest expense / total deposits
log1=log(labor price) INPUT PRICE 1
log2=log(fixed asset price) INPUT PRICE 2
log3=log(deposit price) INPUT PRICE 3
log4= (log1*log1)
log5=(log1*log2)
log6=(log1*log3)
log7=(log2*log2)
log8=(log2*log3)
log9=(log3*log3)
log10=log(total loans) OUTPUT 1
log11=log(investment portfolio) OUTPUT 2
log12=(log10*log10)
log13=(log10*log11)
log14=(log11*log11)
log15=log1*log10
log16=log2*log10
log17=log3*log10
log18=log1*log11
log19=log2*log11
log20=log3*log11
dy=Foreign Bank Dummy
dk=State Bank Dummy
loan concentration = (loan market share of top three banks) / total loan market size
deposit concentration = (deposit market share of top three banks) / total deposit market size
loan market share = total loans of bank (i) / total loan market size
deposit market share = total deposits of bank (i) / total deposit market size
capital adequacy = total equity / total assets
liquidity risk = total loans / total deposits
operational risk = (noninterest income - noninterest expense) / total assets
credit risk = loan loss reserves / total loans

Table 2 **Translog Profit Function**		
Profit = Return on Assets		
Variable	Estimate	Pr > |t|
Intercept	**1.013852**	<.0001
log2	**-0.166145**	0.0119
log3	-0.034818	0.3550
log7	0.017991	0.1503
log8	-0.029027	0.0535
log9	**0.024978**	0.0010
log10	**-0.178750**	<.0001
log11	0.044581	0.1482
log12	0.001357	0.7793
log13	**0.031142**	<.0001
log14	**-0.019139**	<.0001
log16	**0.031290**	<.0001
log17	-0.010799	0.0883
log19	**-0.020116**	0.0012
log20	**0.015760**	0.0043
dk	-0.040036	0.4621
dy	**0.122195**	0.0350
_Sigma_v	0.175701	<.0001
_Sigma_u	2.414669	<.0001

Table 3 **Translog Profit Function**		
Profit = Net Interest Margin		
Variable	Estimate	Pr > |t|
Intercept	**1.097194**	<.0001
log2	-0.029114	0.0586
log3	**-0.045202**	<.0001
log7	**0.013885**	<.0001
log8	**-0.011995**	0.0028
log9	**0.006772**	0.0030
log10	**-0.023394**	0.0042
log11	**-0.021662**	0.0156
log12	**-0.004214**	0.0007
log13	**0.007988**	<.0001
log14	0.000243	0.8394
log16	**0.003239**	0.0477
log17	-0.002509	0.1028
log19	0.000107	0.9523
log20	**0.005315**	0.0007
dk	-0.018606	0.2124
dy	**-0.120024**	<.0001
_Sigma_v	0.127600	<.0001
_Sigma_u	0.283100	<.0001

Table 4 **Translog Cost Function**		
Total Cost = Interest Expense + Noninterest Expense		
Variable	Estimate	Pr > |t|
Intercept	**-12.128160**	<.0001
log2	-0.278450	0.1147
log3	**0.370313**	0.0004
log7	**0.117328**	0.0004
log8	**-0.175261**	<.0001
log9	**0.059122**	0.0089
log10	**0.459513**	<.0001
log11	**-0.526265**	<.0001
log12	-0.009808	0.5512
log13	0.029901	0.2643
log14	**0.027609**	0.0318
log16	**-0.060914**	0.0028
log17	**0.057895**	0.0035
log19	**0.071910**	0.0003
log20	**-0.050066**	0.0065
dk	-0.009324	0.9641
dy	**1.081870**	<.0001
_Sigma_v	0.665231	<.0001
_Sigma_u	5.692814	<.0001

Table 5
Average Profit Efficiencies By Year

Profit = Return on Assets

Year	Efficiency Score		Year	Efficiency Score
1960	0.361		1985	0.322
1961	0.270		1986	0.351
1962	0.234		1987	0.392
1963	0.280		1988	0.377
1964	0.238		1989	0.356
1965	0.220		1990	0.382
1966	0.258		1991	0.333
1967	0.228		1992	0.306
1968	0.255		1993	0.319
1969	0.261		1994	0.301
1970	0.232		1995	0.245
1971	0.164		1996	0.279
1972	0.204		1997	0.307
1973	0.208		1998	0.323
1974	0.235		1999	0.375
1975	0.241		2000	0.350
1976	0.236		2001	0.309
1977	0.246		2002	0.369
1978	0.166		2003	0.483
1979	0.199		2004	0.361
1980	0.300		2005	0.440
1981	0.340		2006	0.400
1982	0.302		2007	0.422
1983	0.231		2008	0.358
1984	0.260		2009	0.439

Table 6
Average Profit Efficiencies By Year

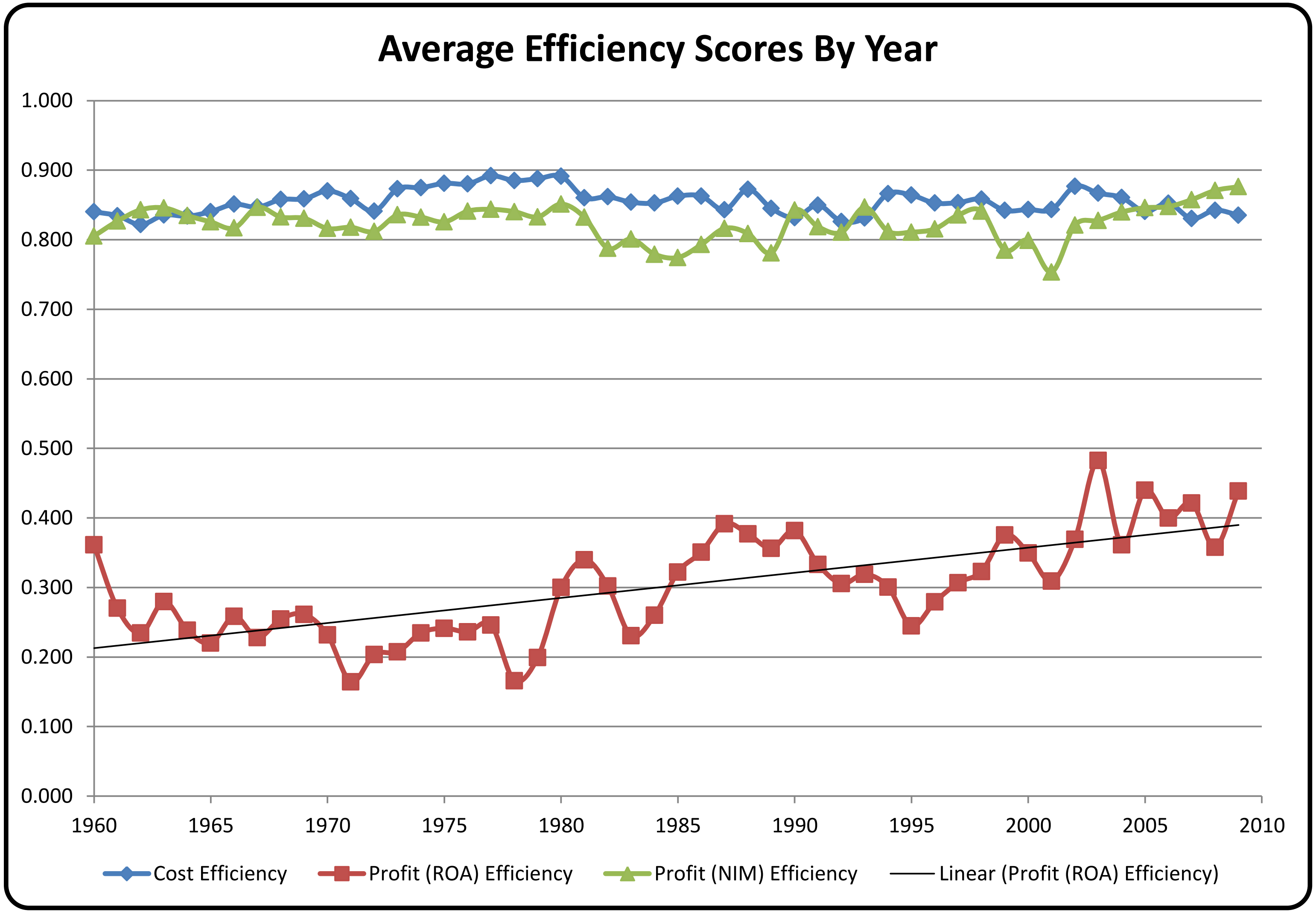
Profit = Net Interest Margin

Year	Efficiency Score		Year	Efficiency Score
1960	0.805		1985	0.774
1961	0.827		1986	0.793
1962	0.843		1987	0.816
1963	0.846		1988	0.809
1964	0.835		1989	0.781
1965	0.826		1990	0.843
1966	0.817		1991	0.819
1967	0.847		1992	0.811
1968	0.833		1993	0.847
1969	0.831		1994	0.812
1970	0.816		1995	0.811
1971	0.818		1996	0.816
1972	0.812		1997	0.836
1973	0.836		1998	0.841
1974	0.833		1999	0.785
1975	0.826		2000	0.799
1976	0.841		2001	0.754
1977	0.844		2002	0.821
1978	0.840		2003	0.828
1979	0.833		2004	0.840
1980	0.851		2005	0.846
1981	0.832		2006	0.848
1982	0.788		2007	0.858
1983	0.801		2008	0.871
1984	0.779		2009	0.876

Table 7
Average Cost Efficiencies By Year

Total Cost = Interest Expense + Noninterest Expense

Year	Efficiency Score		Year	Efficiency Score
1960	0.840		1985	0.863
1961	0.835		1986	0.863
1962	0.822		1987	0.843
1963	0.835		1988	0.872
1964	0.834		1989	0.845
1965	0.840		1990	0.832
1966	0.851		1991	0.850
1967	0.847		1992	0.826
1968	0.858		1993	0.831
1969	0.859		1994	0.866
1970	0.870		1995	0.864
1971	0.859		1996	0.853
1972	0.841		1997	0.853
1973	0.873		1998	0.858
1974	0.875		1999	0.842
1975	0.881		2000	0.844
1976	0.880		2001	0.844
1977	0.892		2002	0.877
1978	0.885		2003	0.867
1979	0.888		2004	0.861
1980	0.891		2005	0.841
1981	0.860		2006	0.853
1982	0.862		2007	0.830
1983	0.854		2008	0.842
1984	0.853		2009	0.835



Average Efficiency Scores By Year
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Cost Efficiency
Profit (ROA) Efficiency
Profit (NIM) Efficiency
Linear (Profit (ROA) Efficiency)

Table 8 **Determinants of Profitability**		
Profit = Net Interest Margin		
With Loan Concentration and Market Share		
Variable	Estimate	Pr > |t|
Intercept	**-0.942650**	<.0001
loanconcentration	**0.373020**	<.0001
loanmarketshare	**-0.625470**	<.0001
profit2eff	**3.454260**	<.0001
capitaladequacy	**-0.030130**	<.0001
liquidityrisk	**-0.003940**	0.0005
operationalrisk	**0.033020**	<.0001
creditrisk	0.000012	0.0959
size	0.000000	0.2629
Adj R-Square	0.60	
F Value	258.60	

Table 9 **Determinants of Profitability**		
Profit = Net Interest Margin		
With Deposit Concentration and Market Share		
Variable	Estimate	Pr > |t|
Intercept	**-1.022020**	<.0001
depositconcentration	**0.585800**	<.0001
depositmarketshare	**-0.906720**	<.0001
profit2eff	**3.476880**	<.0001
capitaladequacy	**-0.037990**	<.0001
liquidityrisk	**-0.005160**	<.0001
operationalrisk	**0.033440**	<.0001
creditrisk	**0.000025**	0.0008
size	0.000000	0.8629
Adj R-Square	0.58	
F Value	234.16	

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