THE DETERMINANTS OF CREDIT RISK IN TURKISH BANKING SECTOR DOES EFFICIENCY MATTER?

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ABSTRACT

THE DETERMINANTS OF CREDIT RISK IN TURKISH BANKING SECTOR

DOES EFFICIENCY MATTER?

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The aim of this thesis is to analyze the bank-specific and macroeconomic determinants of credit risk (i.e., non-performing loans) of the commercial banking sector in Turkey over the period 2002 and 2015. The sample data includes the 23 commercial banks, which represents the 90 % of the total banking sector in Turkey. By employing traditional pooled OLS, fixed effect (FE) and random effects (RE) estimators we found significant evidence both with bank-specific and macroeconomic factors. The empirical findings of this thesis is important mainly for the policy makers within financial institutions, bank regulators and bank managers. Accordingly, we found great deal of evidence between efficiency and credit risk. In other words, high technical efficient commercial banks tent to make high quality loans and thus, have better asset quality. We surprisingly found that the rapid growth of commercial and consumer loans over the last decade did not adversely affected the credit risk of commercial banks in Turkey. State-owned banks are found more prone to have higher degree of non-performing loans compared to domestic and foreign private banks. The Global Financial Crisis (GFC) in late 2008 unfavorably influenced the credit risk. Besides the bank-specific (internal) factors we had significant results with macroeconomic factors. Each

macroeconomic factor have different effects on the level of non-performing loans. We found negative link between Growth rate of GDP (business cycle) stock market index (BIST 100) and level of credit risk and positive relationship with unemployment, interest and exchange rates and credit risk.

Keywords: Credit risk, Technical efficiency, Macroeconomic factors, Panel data analysis.

ÖZET

TÜRK TİCARET BANKACILIĞINDA KREDİ RİSKİNİ BEKLİRLEYEN FAKTÖRLER

ETKİNLİK ÖNEMLİ BİR FAKTÖR MÜDÜR?

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Bu tezde Türk ticaret bankacılık sektöründe kredi riskini (takipteki kredileri) belirleyen makroekonomik ve banka kaynaklı faktörler 2002 – 2015 yılları arasında çeyrek dönemli veriler kullanılarak incelemektedir. Çalışmada toplam 23 adet ticari (mevduat) bankası kullanılmış olup bu bankalar aynı zamanda Türk bankacılık sektörünün yaklaşık % 90'ını teşkil etmektedir. Geleneksel sabit etkiler, tesadüfi etkiler ve havuzlanmış-EKK yöntemlerinin kullanıldığı analizlerde kredi riskinin hem içsel (banka-kaynaklı) hem de dışsal (makroekonomik) faktörlerden kaynaklandığına dair önemli bulgulara ulaşılmıştır. Çalışmanın sonunda elde edilen bulgular gerek kanun yapıcı (düzenleyici) ve denetleyici otoriterler gerekse de banka yöneticileri için önem arz etmektedir. Buna göre, Türk mevduat bankacılık sektöründe etkin (teknik etkinlik) bankaların daha düşük kredi riskine (takipteki krediler oranına) sahip olduğu görülmüştür. Yine aynı şekilde, özellikle son 10 yılda bankacılık sektöründe kurumsal ve bireysel krediler hacminde görülen hızlı artışın mevduat

bankacılık sektöründeki kredi riski üzerinde olumsuz etkisinin olmadığı sonucuna varılmıştır. Devlet bankalarının yerli ve yabancı özel mevduat bankalarına göre daha fazla kredi riskine sahip oldukları bulunmuştur. 2008'in sonlarında yaşanan ve Türkiye ekonomisinde etkilerinin daha ziyade 2009'da görüldüğü Küresel Finansal Krizinin de bankaların takipteki alacaklar kalemini artırdığı sonucuna varılmıştır. Makroekonomik faktörlerin ise bankaların kredi riski üzerinde farklı etkilerinin olduğu görülmüştür. Gayri safi yurtiçi hasıladaki (GSYİH) ve sermaye piyasası varlık fiyatlarındaki (BIST 100 endeksi) artışın takipteki alacakları azalttığı işsizlik, faiz oranları ve dolar kurundaki artışların ise takipteki kredileri artırdığı sonucuna ulaşılmıştır.

Anahtar Kelimeler: Kredi riski, Teknik etkinlik, Makroekonomik faktörler, Panel veri analizi.

To My Dad and Family

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1 INTRODUCTION

The recent global financial crisis, which is also known as the sub-prime mortgage crisis, has shown that the stability of financial system is crucial for the stability of real economy and sustainable development. A great amount of literature has accumulated on regulating and monitoring the financial institutions, predicting financial crisis and determining the underlying factors behind financial crisis. The studies that concentrate on the determinants of financial crises found that deterioration in banks' loan quality (i.e., the degree of credit risk they are exposed to) is one of the major causes of financial fragility (Bofondi & Ropele, 2011). In other words, when the financial crises and bank failures was examined it is found that failing banks have large proportions of non-performing loan (i.e., high degree of credit risk) prior to collapse, and asset quality is statistically significant with probability of bankruptcy (Berger & DeYoung, 1997).

Accordingly, credit risk in banking refers to the risk that a borrower will default on any type of debt by failing to make required payments (Principles for the Management of Credit Risk, 2000). Considering one of the primary function of the banking business, that is financial intermediation, it becomes evident just how important precisely to manage its loan portfolios (i.e., credit risk). In this context, the chief factors that affect the credit risk plays significant role on predicting bank failures and financial crises.

The sources of credit risk in the banking sector is very large and diverse. On the one hand, it can arise from the external sources such as macroeconomic and political environment, borrowers-specific and natural factors. On the other hand, internal factors (size, efficiency, risk profile and capital etc.), which are idiosyncratic to the bank(s), might have impact on the level of credit risk.

The concept of efficiency is also another major topic which received great attention in the banking studies over the last several decades. Efficiency literature in banking briefly examines the relationship between inputs (total deposits, capital, and labor) and outputs (loans, securities) of the banking business. Given the production technology, if a bank can reduce its inputs with causing minimum decrease in its outputs it is called efficient bank. However, if a bank achieves the current performance using higher number of inputs than other similar banks, this indicates that the bank does not use its resources efficiently. These inefficiencies may be arising from mismanagement, inappropriate sizes of banks and

external factors. One of the major factor that relies on the inefficiency in banks is the inadequate management practices. The empirical studies on the efficiency found strong evidence between management quality and inefficiency. In other words, high levels of cost efficient or technical efficient institutions are found to display successful management quality and *vice versa* (Williams, 2004).

Although at the first glance these two blocks of literature (credit risk and efficiency) reasonably seem unrelated, recent developments on both theoretical literature and empirical evidence have proved that these two strands of literature are closely related (Berger & DeYoung, 1997). To understand the underlying factors behind financial stability, it is vitally important to account for the linkages and interactions among these variables in empirical studies. Particularly the subject matter is important for policy makers, regulators and bank managers.

As explained by Berger and De Young (1997) the issue of risk (specifically the credit risk) and efficiency are related by the following ways. First there are numerous studies (Berger and Humphrey 1992; Barr and Siems 1994; De Young and Whalen 1994; Weelock and Wilson, 1995) found that most of unsuccessful banks located far from the efficient frontier. Second, Peristiani (1996) and DeYoung (1997) both found measured cost efficiency to be positively related to examiners' ratings of bank management quality. Moreover, the latter study found that banks' management ratings were more strongly related to their asset quality ratings than to any of their other examination ratings. A relationship between asset quality and cost efficiency (via management quality) is consistent with the failed bank data cited above, and suggests that the negative relationship between problem loans and cost efficiency holds for the population of banks as well as for the subset of failing banks (Berger & DeYoung, 1997).

The first theoretical link and empirical study that explain the interaction between efficiency and credit risk was introduced by Allen Berger and Robert De Young in 1997. The authors examined the relationship between non-performing loans (i.e., ex-post credit risk) and cost efficiency for the US commercial banks and developed four hypotheses namely bad management, skimping, bad luck and moral hazard. The first two hypotheses directly explain how inefficiency (cost inefficiency) in banks could affect the bad loans in banks' loan portfolio. The studies until Berger and De Young (1997) that focus on determinants credit risk usually assumed that banks operate fully efficient and therefore did not consider that

efficiency could be an important factor for examining the determinants of credit risk. Berger and De-Young (1997) however, indicate that banks that are not operating on the efficient frontier could have high level of credit risk. The majority of the empirical studies that continue in this line have found strong evidence between efficiency and credit risk in commercial banks.

The objective of this thesis is to examine the bank-specific and macroeconomic determinants of credit risk in the Turkish commercial banking sector over the period 2002 and 2015. To the best of our knowledge there are limited studies that investigate the relationship between credit risk and efficiency in Turkey. Isık & Hassan, (2003) and Yıldırım (2002) examined the relationship between credit risk efficiency for Turkish banking sector[1]. They rather measured various types of efficiency and explained what factors (risk, ownership, corporate control etc.) effect the efficiency scores. As result of comprehensive literature review, we noticed that there is a gap on the credit risk side. The subject of determinants of credit risk has not been examined from the efficiency perspective for the Turkish banking sector. To fill the gap we examine the subject from the credit risk perspective by using efficiency scores (technical efficiency scores) as an important factor (variable) that affects the default risk.

In addition, we also recognized that the majority of the studies in this topic for Turkish banking sector usually focus on how macroeconomic environment affect the level of credit or default risk. They usually employ time series methodology and use aggregated data that is suitable to time series approach. Therefore, there are some lack of studies that examine this topic by using micro level data. This study (thesis) uses bank-specific (microeconomic) data to analyze the determinants of credit risk for Turkish commercial banks. For this purpose the thesis is structured as follows:

The first chapter introduces the objective of this thesis. The second chapter of this study aims at reviewing both theoretical and empirical literature on determinants of credit risk in banking sector. In this chapter, we first explain the models that measure the credit risk. Each models here are separated based on the type of variables they use to measure the default risk. In the second part of this chapter we outlined the empirical studies on the determinants of

[1] Setiwan et al. (2013) investigated the inter-temporal relationships between bank efficiency and problem loans both for conventional and Islamic banks in the Organization of Islamic Cooperation (including Turkey) during the period 1993 and 2007. The authors examined the bank efficiency and risk for whole sample including 25 different countries (Setiwan, Hassan, Hassan, & Mohamad, 2013). We investigate the same topic solely for Turkey not only from the bank-specific but also from macroeconomic perspective.

credit risk. As mentioned above, the sources of credit risk is very large and diverse yet it can arise from borrower-specific, political and macroeconomic, bank-specific (lender) and natural factors. The empirical studies here are reviewed by the factors (borrower-specific, macroeconomic and bank specific) they employ to investigate the determinants of credit risk.

The focal point of the third chapter will be the efficiency in Turkish commercial banking sector. In this chapter we measure the technical efficiency scores of commercial banks by employing data envelopment analysis (DEA) over the period December 2002 and September 2015. The efficiency scores of each commercial banks in this chapter are measured in two distinct panels and they are used as an independent variables that affect credit risk in the chapter four below.

In the chapter 4 we examine the determinants of credit risk for Turkish commercial banking sector between December 2002 and September 2015. We first analyze how bank-specific (internal) factors might have impact on the level of credit risk. We used ratio of non-performing loans to total loans as a proxy for credit risk. The variables here are technical efficiency scores, profitability, lending rate (loan growth), and loan type, size and capital structure. Secondly we investigate the effects of macroeconomic factors on the credit risk. The macroeconomic (external) factors are gross domestic product GDP, unemployment, inflation, stock market index and exchange rates.

2 A LITERATURE REVIEW ON THE DETERMINANTS OF CREDIT RISK

2.1 Introduction

The main aim of this chapter is to review the theoretical studies on the credit risk, including the models that measure credit risk, and summarize the empirical findings on the determinants of credit risk. In economics and finance credit risk is a consequence of contracted and/or contingent financial transaction between the providers and users of funds. (Caouette, Altman, Narayanan, & Nimmo, 2008) Accordingly, parties such as individuals, firms and governments, who take part in a financial transaction (either as providers or users of funds) directly or indirectly involve in credit risk. Although manufacturing firms, service companies and individuals that are part of a financial transaction directly related to credit risk, financial institutions specifically commercial banks are more profoundly concerned with management of credit risk. Considering the main objective of commercial banks, which is to channel funds from savers to borrowers, it becomes evident just how important to measure and control the credit risk accurately.

According to the classification by Altıntaş (2006), the factors that determine the level of credit risk in banks can be simply grouped as internal and external factors. The internal factors are usually under the control of the bank's managers whereas the external factors generally originate out of the control of the banks. Political, economic (macroeconomic), natural and borrower-specific factors are considered as the external factors and whereas the bank-specific factors are internal factors that affect the credit risk. As indicated by Altıntaş (2012), the bank-specific factors (i.e., the quality of management) affect the credit risk considerably. In other words, managers can reduce the credit risk with good risk management practices such as adequate intelligence, correct financial analysis and assessment, accurate collateral valuation and credit monitoring (Altıntaş A. , 2012). The credit risk that arise from the external factors are more diverse and large compared to the internal factors. The adverse macroeconomic conditions usually have negative impact on the credit risk. For example, low level of growth in gross domestic product (GDP) high unemployment and tight monetary policy generally results in increases on the non-performing loans (i.e., credit risk) in banks. Likewise, the natural factors such as earthquake, floods, storms and droughts can also increase the credit risk in bank's loan portfolio due to their negative effect on the income level of households and firms.

The borrower-specific factors (the quality of produced goods or services, management skills, reputation, leverage, volatility of earnings, collateral etc.) are idiosyncratic to the commercial or individual borrowers and affect the level of credit risk in banks. Although there are numerous borrower-specific factors that affect the credit risk level the common factors are summarized as 4 C's namely Character, Capacity, Capital and Collateral[2]. (i) Character is the indicator of reputation of the borrower and its history of repayment. Based on the empirical findings it is agreed that firm's age is good indicator of its repayment reputation (Saunders & Allen, Credit Risk Management, 2002). (ii) Capital is the measure of contribution of the owners (shareholders) and also indicator of the debt level in the firm. The high level of debt (i.e., financial risk) is regarded as greater probability of default. (iii) Capacity indicates the variability of the earnings of the firms or individuals. High volatile revenue increases the chance that borrower cannot pay fixed interest and principal charges for any given capital structure (Saunders & Cornett, Financial Institutions Management, 2011). (iv) Collateral is the asset pledged by borrower which can be claimed by the lender in the event of default. Adequate level of collateral reduces the losses at the default.

The remaining of this chapter is organized as follows: The section 2.2 reviews credit risk measurement models based on the type of factors (borrower-specific, macroeconomic and bank-specific) they employ. In section 2.3 we summarize the empirical studies on the determinants of credit risk in banking sector. We separate the empirical findings according to the same order in section 2.2.

[2] The similar approach is called as CAMELS (Capital, Assets, Management, Earning and Liquidity)

2.2 Review of the Theoretical Literature on the Determinants of Credit Risk

2.2.1 Borrower-specific Factors

The factors in this group that influence the credit risk arise from the users of funds (i.e., borrowers) who either issued financial assets or borrowed money from banks to finance their investments or spending. Here we will review the models that employ the borrower-specific factors to measure the credit risk. The initial model that measure the credit risk is called structural models which are also known as *firm-value models* since a borrower's (usually firm) inability to meet the contractual obligations is assumed to be determined by its asset value (Zhang, 2009)[3]. These models use the evolution of firm's structural variables, such as asset's value, equity (i.e., capital structure) and debt values to measure the probability of default (Elizalde, 2006). They measure the default risk primarily for the larger (corporate) borrowers by using firm-specific factors.

The initial study in structural-form models begun with Merton's (1974) seminal work which measure the price of the credit risk on a risky debt. The model is based on Black and Scholes (1973) option pricing model and assumes equity in a levered firm as a *call option* on firm's assets with a strike price equal to debt repayment (Allen, 2004). Before we review the Merton model, it will be practical to briefly outline the Black-Scholes option pricing model. The Black-Scholes formula for the European call option on non-dividend paying stocks are (Black & Scholes, 1973)[4];

$$c = S_o\, N\,(\mathrm{d}_1) - K e^{-r\,T}\, N\,(\mathrm{d}_2) \tag{1}$$

$$(\mathrm{d}_1) = \frac{ln\left(\frac{S_0}{K}\right) + \left(r + \frac{\sigma^2}{2}\right) T}{\sigma\sqrt{T}}$$

$$(\mathrm{d}_2) = \frac{ln\left(\frac{S_0}{K}\right) + \left(r - \frac{\sigma^2}{2}\right) T}{\sigma\sqrt{T}}$$

where:

The variables c is the European call option price. S_o is the current price of the stock and K is the strike (exercise) price, r is the risk free interest rate, T is the time to maturity and σ is the

[3] The structural models are also called option models.
[4] Since the Merton approach uses the call option the put option formula is not included.

volatility of the stock price. The function N (d_1) and N (d_2) are the cumulative probability function for a standardized normal variable. In other words, it is the probability that a variable with standard normal distribution, will be less than (d_1) or (d_2) (Hull, 2008). As seen on the Equation 1 value of the call option is equivalent to the probability of stock prices that will be equal or less than its current value minus the present value (continuously discounted at risk free rate) of strike price times N(d) value.

The Black and Scholes call option pricing model in the Equation 1 is modified by the Merton and applied to the credit risk pricing. In other words, Merton (1974) formulated how to calculate the default risk premium for a risky debt. He used some strict assumptions listed below.

i. There are no transaction costs and taxes.
ii. There are adequate number of investors who can buy and sell as much as of an asset as they want at the market price.
iii. There is an exchange market that one can borrow and lend at the same interest rates.
iv. Short sales of assets are allowed.
v. Trading assets take place continuously in time.
vi. The Modigliani-Miller theorem is valid hence the value of the firm is not affected from capital structure.
vii. The term structure of interest rate is constant and known.
viii. The value of the firm(s) follow (V) diffusion-type stochastic process with stochastic differential equation.

The parameters (variables) in the Black-Sholes (1973) model altered in the Merton model as follows; the stock price becomes the firm value (V), the strike price is considered as the debt value (B) at the maturity and the call option price (value) becomes the equity value (f) which is provided by the owners of the firm. Accordingly, if the market value of assets of a firm is higher than its market value of debt at the maturity then the firm's shareholders will exercise the option and repay the debt which is a zero-coupon bond in the model. On the other hand if the market value of debt is higher than the market value of assets then the shareholders will not make any payment and therefore debt holders will acquire the firm (Merton, 1974). According to this specification Merton (1974) indicates that the probability of default depends on the market value of a firm and level of the debt at the maturity. After defining

the parameters above Merton (1974) developed the formula that yield the return difference between risky and risk-free asset. The original Black-Sholes formula in the Equation 1 was modified as;

$$f\ (V,\tau) = V\ N\ (\mathrm{d}_1) - Be^{-r\,\tau}\ N\ (\mathrm{d}_2) \tag{2}$$

$$(\mathrm{d}_1) = \frac{ln\left(\frac{V}{B}\right) + \left(r + \frac{\sigma^2}{2}\right) T}{\sigma\ \sqrt{T}}$$

$$(\mathrm{d}_2) = \frac{ln\left(\frac{V}{B}\right) + \left(r - \frac{\sigma^2}{2}\right) T}{\sigma\ \sqrt{T}}$$

where:

f is the value of equity and is the function of value of the firm. V and B are the value of firm's assets and value of firm's debt at the maturity respectively. τ is the time to maturity and r is the risk free rate. σ represents the volatility of the firm's assets. From the Equation 2 the value of debt is equal to V – f and can be rewritten as;

$$V - f\ (V,\tau) = Be^{-r\,\tau}\ [\ N\ (\mathrm{h}_2) + \frac{1}{d}\ N\ (\mathrm{h}_1)] \tag{3}$$

where:

d = $\frac{Be^{-r\,\tau}}{V}$ and

$$(h_1) = -\frac{\frac{1}{2}\ \sigma^2\ \tau - ln\left(\frac{Be^{-r\,\tau}}{V}\right)}{\sigma\ \sqrt{\tau}}$$

$$(h_2) = -\frac{\frac{1}{2}\ \sigma^2\ \tau + ln\left(\frac{Be^{-r\,\tau}}{V}\right)}{\sigma\ \sqrt{\tau}}$$

If the Equation 3 is written in terms of yield spread rather than debt value, we obtain the equation 4 which reflects an equilibrium default risk premium that the borrower should be charged (Saunders & Cornett, Financial Institutions Management, 2011).

$$R(\tau) - i = \left(-\frac{1}{\tau}\right) ln\ [\ N\ (\mathrm{h}_2) + \frac{1}{d}\ N\ (\mathrm{h}_1)] \tag{4}$$

R (τ) represents the required return on the risky debt and i is the risk-free rate hence, the difference $R(\tau) - i$ between return on risky debt and risk free rate is called credit (default) risk premium. As seen on the Merton approach, as firm-specific factors such as leverage (d) and assets risk (denoted by σ) changes so does the risk premium changes.

Besides formulating the credit risk premium, Merton (1974) made a remarkable contribution to the measurement of credit risk which relies on the Equation 2. The market value of the debt which is continuously discounted at the risk free rate and denoted by $Be^{-r\tau}$ was multiplied by$N(\mathrm{d}_2)$. In the equation, (d_2) value represents the *probability of default* of the firm's debt. Basically, the (d_2) in the original Black-Scholes model becomes probability of default (PD) in the Merton approach. The (d_2) formula is shown as follows;

$$N(\mathrm{d}_2) = \frac{ln\left(\frac{V}{B}\right) + \left(r - \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}} \quad (5)$$

where:

V: Market value of the firm

B: Market value of firm's debt

ln: Natural logarithm

r: Return on the firm's assets

σ: Standard deviation of the firm's assets

N: The value calculated from the standardized normal distribution statistical table.

T: Time to maturity

As seen on the Equation 5 the probability of default (i.e., credit risk) depends on the firm-specific factors such as volatility (σ) of firm's assets, the ratio of market value of the firm to market value of debt, time to maturity and return on the firm's assets.

Other studies that might be considered as structural models (first generation structural models) that follow the Merton approach included Black & Cox (1976), Geske (1977) and Vasicek (1984). These studies modify and improve the Merton model by slackening the impractical assumptions. One of the assumptions in the original Merton approach indicates

that the capital structure of the firm does not have any impact on the firm value thus; only one set of capital structure (equity and zero-coupon bond) was used in the model. Black and Cox (1976) introduce the possibility of complex capital structure by including subordinated debt (Altman, Resti, & Sironi, 2004). Geske (1977) change the Merton approach by assuming that there are separate interest payments for debt (bond) until maturity. In his influential work, which later becomes Moody's KMV, Vasiceks (1984) try to answer how the short-term and long-term debt (i.e., debt with different maturities in the capital structure) will affect the credit valuation and price of the bond.

The first generation structural-form models have two disadvantages in pricing and measuring the credit risk. First they assume that the default occurs at the maturity of the debt where it is not always the case in reality. Second the models do not consider influence of the interest rate risk on the market value of corporate debt instead they assume that the term structure of interest rate is flat over the time (Baykal, 2010). In response to such drawbacks the second generation structural-form models have been developed, which still follow the Merton approach. The models here assume that default may occur any time between the issuance and maturity of the debt (Altman, Resti, & Sironi, 2004). Second generation structural-form models are indicated as follow Longstaff, Francis A; Schwartz, Eduardo S;, (1995) and In Joon, Kim; Ramaswamy, Krishna; Sundaresan, Suresh;, (1993).

Kim et al. (1993) made two contributions to the structural-form models in credit risk measurement literature. They first examined the effects of the dividend payment and call provision on the zero coupon bond. Later they prove that the yield spread in the model is consistent with the practice. Longstaff and Schwartz (1995) developed a simple approach to value the risky debt by improving Black and Cox model. First they construct a model that includes both default risk and interest rate risk for fixed-rate and floating rate debt. Second the assumption of strict absolute priority is removed where senior debt holders have the priority to claim assets at the event of default. An important feature of their approach is that the model can be applied directly to value risky debt when there are many coupon payment dates or when the capital structure of the firm is very complex (Longstaff & Schwartz, 1995). Moreover the findings of Longstaff and Schwartz (1995) indicate that, the correlation of a firm's assets with changes in the level of the interest rate can have important effects on the value of risky fixed-income securities. In addition, the model indicates that credit spreads are negatively related to the level of interest rates.

KMV's Credit Portfolio Manager: Although Merton opened a significant path on the pricing of credit risk and measurement of probability of default there are some limitations for implementing the model to the real world. For example, the market value of firm's assets and its volatility are not directly observable. To overcome this problem as well as to improve the Merton approach the KMV model was developed by Stephen Kealhofer, John McQuown and Oldrich Vasicek in 1989 and later in 2002 was acquired by Moody's Analytics. The KMV model estimate the market value of the assets and its' volatility by using the firm's equity value. Since the data on firm's share price (as well as the total market value) and volatility are obtainable, the unknown values σ_A and V_A (volatility of firm's assets and market value) can be extracted by simultaneously resolving (using Excel solver function) the equation 6 with the equation 2 (Altıntaş A. , 2012).

$$\sigma_E * V_E = N\,(d_1)\,\sigma_A * V_A \qquad (6)$$

The default in KMV is defined as failure to make scheduled payment of interest or principle. The probability of default in KMV model depends on the capital structure, assets value and volatility of assets returns. As mentioned above, KMV model applies structural models (Merton Approach) of default to its substantial credit history database in order to determine an empirical Expected Default Frequency (EDF) by examining the historical likelihood of default for any given Distance to Default (DD) level (Saunders & Allen, Credit Risk Management, 2002). KMV best applies to publicly traded companies for which the market value of equity and debt easily determined. It is more suitable for corporate borrowers and use financial market data rather than employing accounting data for estimating the probability of default.

The model uses three distinct steps to measure the probability of default of a firm. First, the value firm's assets and volatility are estimated based on a standard geometric Brownian motion as indicated in the Merton framework and the Equation 2 and 6. Second the index that is called distance to default (DD) is calculated. Distance to Default (DD) is the number of standard deviation between the average value of assets and the default point which is defined as short term liabilities plus half of the long term debt. The distance to default can be formulated as follows:

STD: Short-term debt,

LTD: Long-term debt,

DP: Default Point = STD+LTD/2

DD: Distance to default in 1 year = $\frac{E(V_1)-DP}{\sigma_A}$ (7)

Default point is firm specific and function of the firm's liability structure (Analytics, 2014). The distance to default, i.e., probability of value of assets falling below critical debt level prior to certain time period, which is usually 1 or 5 years, is measured with the formula in Merton model. The last step involves converting distance to default (DD) into a probability of default. In this step KMV uses Expected Default Frequency (EDF) which is a database of historical default rates[5]. For example, historical evidence indicates that firms with DD equal to 4 have an average historical default rate of 1 % and KMV assigns EDF of 1 % to firms that have DD score equal to 4 (Allen, 2004). Since KMV uses equity prices to determine the EDF the probability of default (i.e. EDF score) is more sensitive to the financial changes than other models that predominately use accounting data.

So far we reviewed the primary theoretical study conducted by Merton (1974) and the studies follow Merton's approach. Although Merton explains that default risk may arise from value of firm's assets, the standard deviation of those assets and the value of debt at the maturity, the recent studies claim that other firm-specific (especially efficiency) and external factors (macroeconomic environment) might also trigger the default risk.

2.2.2 Macroeconomic Factors

Besides the borrower-specific factors, external factors specifically the macroeconomic environment also affect the level of credit risk (i.e., non-performing loans) in the banking system. Adverse economic conditions where growth is low or negative, with high levels of unemployment, high interest rates and high inflation are favorable to low level of asset quality as well as high level of credit risk (Castro, 2013). In this part we will first shortly explain how some certain macroeconomic factors (the state of the economy, unemployment, interest rate, inflation etc.) affect the credit risk level and later review the Credit Portfolio View, a model that measure portfolio credit risk with macroeconomic factors. The main macroeconomic factors that affect the level of credit risk are summarized as follow;

Business Cycle (State of the Economy): The position of the economy in the business cycle phase is enormously important to a financial institution in assessing the probability of

[5] Instead of cumulative normal probability function, KMV uses Expected Default Frequency.

borrower default. For example, during recessions, firms in the consumer durable goods sector that produce autos, refrigerators, or houses do badly compared with those in the non-durable goods sector producing clothing and foods. People cut back on luxuries during a recession but are less likely to cut back on necessities such as foods. Thus corporate in the consumer durable goods sector of the economy are especially prone to default risk (Saunders & Cornett, Financial Institutions Management, 2011). Likewise, in individual lending the state of the economy significantly affects the degree of probability of default. When the economy performs well (e.g., high GDP and low unemployment) the individual borrowers could afford the loan payments, during the recession or economic downturns however, the large-scale layoffs (unemployment) along with declining wages causes individuals to become insolvent and default on their loans. The empirical findings on the relationship between the macroeconomic conditions and the quality of loans in the banking system is enormous and diverse. Common findings of these studies indicate that the interaction between asset quality (i.e., level of non-performing loans) and economic growth is positive (Beck, Jakubik, & Piloiu, 2013).

Interest Rates: The lending rates may also affect the level of credit risk in the banking sector. High interest rates indicate restrictive monetary policy actions by the central banks. Financial institutions not only find funds to finance their lending decision scarcer and more expensive but also must recognize that high interest rates are correlated with higher credit risk in general since the higher cost of debt worsen the financial situation of debtors (Caporale, Colli, & Lopez, 2014). High interest rate levels may also encourage borrowers to take excessive risk and or encourage only the most risky customers (Saunders & Cornett, Financial Institutions Management, 2011).

Unemployment: The unemployment rate effect the level of non-performing loans in commercial banks. An increase in the unemployment rate influence the level of non-performing negatively since the cash flow to the households (individuals) decreases. With regards to firms, increases in unemployment may signal a decrease in production as a consequences of drop in effective demand. All those cause to a decrease in revenues and increase in debt burden (Castro, 2013).

Inflation: Price stability is another factor that might be effective on the level credit risk. The views in the effect of inflation on the credit risk is not straight forward. On the one hand it is argued that the increase in overall price of services and goods may weaken borrower's

ability to service debt by reducing their real income. On the other it is assumed that inflation might can make debt servicing easier by reducing the real value of outstanding loans. Thus, the relationship between inflation and credit risk can be in both directions (Castro, 2013).

Stock market index: The stock market also may affect the credit risk. In general the growth of the stock indexes indicates improvements in the current and future conditions of the listed companies even including the companies are not listed on the index (Caporale, Colli, & Lopez, 2014). In other words, the increase in overall prices of stocks in the market is usually regarded as a positive sign for the economy's itself and it may contribute a reduction in the credit defaults. Therefore there is usually negative relationship between increase in stock market index (i.e., increase in share prices of major firms in the economy) and credit risk (Castro, 2013).

Exchange rate: Exchange rate is defined as the prices of a nation's home currency against the foreign currency and it might affect the level of the credit risk in banks. When the value of home currency increases against the foreign currency (i.e., home currency appreciates) the price of the goods and services becomes more expensive for the importer in other countries. This decreases the demand for the home products and services and unfavorably affect the competitiveness of the local export-oriented firms. All these adverse conditions reduce the ability of debt servicing of the firms (Nkusu, 2011) (Castro, 2013). After briefly explaining how some major macroeconomic indicators could affect the default risk in banks, we review a credit risk measurement model, Credit Portfolio View, that employ macroeconomic factors to measure the default risk.

Credit Portfolio View: Credit Portfolio View is an econometric model which measure the credit risk (default rates) with macroeconomic factors. It was introduced by Wilson (1997a, 1997b and 1998) and proposed by McKinsey. Wilson has systematically analyzed the impacts of macroeconomic factors on the *portfolio credit risk* and described a recent attempt to analyze portfolio risk and return through econometrics and Monte Carlo simulation. He recognizes that the loss distributions in the credit portfolios are conditional on the state of the economy and demonstrated the relationship between defaults rates and macroeconomic factors in certain countries. In other words, Wilson argue that the default probabilities are strongly associated with business cycle. Table 2 shows the chief macroeconomic factors that affect the portfolio credit risk in different countries (Altıntaş A. , 2012).

Table 1: Macroeconomic factors that affect the default rate in developed countries.

Country	Macroeconomic Variables	R^2
Germany	Unemployment, GDP Growth, Government Disbursements	95.7
France	Unemployment, Long-Term Interest Rates, Exchange Rates	89.7
Spain	Unemployment, Government Disbursements, Long-Term Interest Rates	95.7
UK	Unemployment, Government Disbursements, Gross Savings	65.5
USA	Unemployment, GDP Growth, Long-Term Interest Rates	82.6

The Credit Portfolio View model measures not only the probability of default but also the probability of credit migration, i.e., probability of change in the credit quality (Baykal, 2010). Credit Portfolio View provides a single joint distribution for default and migration risk. The variables that might affect the probability of default and migration probability are macroeconomics factors such as GDP growth rate, unemployment rate, foreign exchange rates, interest rates and gross industrial production. Accordingly, the model assumes that since there is strong and positive relationship between business and credit cycle, the default and migration probability are significantly affected from the macroeconomic conditions. The probability of default is measured by the logit function where it (probability) is bounded between 1 and 0. The model can be presented as follow;

$$P_{j,t} = \frac{1}{1+e^{-Y_{j,t}}} \tag{8}$$

where

$P_{j,t}$: Conditional probability of default in period *t* and in country/industry *j*

$Y_{j,t}$: The index value obtained from multi factor model.

The macroeconomic index ($Y_{j,t}$), which is the indicator of the economic cycle, is measured through the following multi-factor model.

$$Y_{j,t} = \beta_{j,0} + \beta_{j,1}X_{j,1,t} + \beta_{j,2}X_{j,2,t} + \ldots\ldots + \beta_{j,n}X_{j,n,t} + v_{j,t} \tag{9}$$

where

$Y_{j,t}$: The index value in period *t* for the industry or country *j*

β_j : The coefficients to be estimated for *j*th industry or country

$X_{j,t}$: The macroeconomic variables in period *t* for the industry or country *j*

$v_{j,t}$: The error term.

As seen on the equation above based on the historical macroeconomic variables and an average default rate time series, credit portfolio view approach builds a multifactor model for different country (Caouette, Altman, Narayanan, & Nimmo, 2008). The macroeconomic variables in the model are country specific and if sufficient data is provided, industry specific model can also be constructed. To implement the Equation 8 for estimating the default probabilities of the credit portfolio, the future value of the macroeconomic variables must be also forecasted. In this regard Wilson indicate that each macroeconomic variables is assumed to follow a univariate, autoregressive model of order 2 (AR2) and could be estimated as (Altıntaş A. , 2012);

$$X_{j,1,t} = k_{j,0} + k_{j,1} X_{j,\,t-1} + k_{j,2} X_{j,\,t-2} + \varepsilon_{j,t} \qquad (10)$$

where $X_{j,\,t-1}$ and $X_{j,\,t-2}$ are the lagged values of the macroeconomic variable which influence the credit risk, $k_{j,0}$, $k_{j,1}$, $k_{j,2}$ denotes the coefficients to be estimated, $\varepsilon_{j,t}$ is the error term which assumed to independent and identically distributed (Crouhy, Galai, & Mark, 2000).

2.2.3 Bank-specific Factors

In the previous sections we briefly described the models that measure the credit risk (usually the probability of default) using borrower specific and macroeconomic factors. In this part we will summarize the bank-specific factors that determine the credit risk and in banks. Theories in here are developed by different scholar under different assumptions. First Allen Berger and Robert De Young (1997) in their study "Problem Loans and Cost Efficiency in Commercial Banks" explain the relationship between non-performing loans and cost efficiency by introducing the Bad Management, Bad Luck and Skimping hypotheses. Second, Jeitschko, D. et al (2005) describe how moral hazard problem may influence the risk taking behavior of the shareholders by referring the study of Green and Talmor (1986). Berger and De-Young (1997) also use the same theory (moral hazard) to explain the relationship between non-performing loans and cost efficiency. Third, the diversification hypothesis explains whether or not the diversification opportunities reduce the level nonperforming loans (NPL) in the financial institutions.

Bad Management Hypothesis: The bad management hypothesis implies that low level of cost efficiency in a bank is a sign of poor management quality and it causes to the higher

non-performing loans (i.e., higher credit risk level) in bank's loan portfolio[6]. The main intuition behind this hypothesis relies on the low management quality that is result of bad managers. Accordingly, bad managers in banks typically have the following characteristics. First they have low capability in credit scoring and tend to issue (select) loans that have higher probability of default. Second, bad managers have deficiencies in appraising the true value collateral that is pledged by the borrowers. Finally they insufficiently monitor and control the borrowers after the loan (credit) issued to ensure the compliance with the loan contract. As a result of high bad management practices (i.e., low efficiency) the loan portfolio of a bank deteriorates by time and causes non-performing loans to increase. Thus in this hypothesis low cost efficiency is expected to occur before non-performing loans and there is negative relationship between cost efficiency and credit risk or non-performing loans (Berger & DeYoung, 1997).

Skimping Hypothesis: Similar with bad management hypothesis, the skimping hypothesis also examines the relationship between cost efficiency and non-performing loans under different assumption. According to the hypothesis, banks reduce the operating costs (expenditure) in the short-term to increase the profitability in the long-run by skimping (saving) on the resources allocated for issuing and controlling loans. Therefore managers postpone dealing with the deteriorating assets quality until an unspecified future date (Williams, 2004). The consequences of short-term cost efficiency lead to higher non-performing loans in the long-term due to inadequate loan management. Moreover the reduced effort allocated for underwriting, valuing collateral and monitoring and controlling borrower makes banks appear to be cost efficient in the short-term since fewer operating expenses supports the same quantity of loans. The level of non-performing loans in the short-term does not change but increases in the long-term because of insufficient loan supervision. The main difference between the bad management and skimping hypothesis is that in bad management there is negative relationship between cost efficiency and nonperforming loans. In skimping hypothesis however, there is a positive relationship between cost efficiency and future non-performing loans.

Moral Hazard Hypothesis: Moral Hazard is the asymmetric information problem between two parties after a financial transaction take place (Mishkin & Eakins, 2012). It involves

[6] The ex-post of credit risk takes the form of non-performing loans (NPL) (Louzis, Vouldis, & Metaxas, 2012)

when one party takes excessive risk if the consequences of that risk taking is borne by the second party. In other words, moral hazard occurs when the party with superior information about its actions has a tendency or incentives to act improperly from the perspective of the other party that have less information. Moral hazard problem may arise in equity and debt contracts. In equity contracts the moral hazard problem takes the form of principal-agent or the agency problem. Accordingly, when principals (owners) and agents (managers) are not the same people in a firm (i.e., the control and ownership is separated) managers in control may not act in the interest of owners since the consequences (both positive and negative) of their actions are mainly borne by the owners. In debt contract the moral hazard problem usually occurs between lenders and borrowers. Because a debt contract requires the borrowers to pay out a fixed amount and lets them keep any profits above this amount, the borrowers have incentive to take on investment projects that are riskier than lenders would like (Mishkin & Eakins, 2012).

In banking the moral hazard problem arises between various parties such as borrowers, shareholders (owners), debtholders (depositors) and managers (agents) in different forms. The risk taking behavior of each parties in a bank (owners, agents and depositors) may differ based on their incentives. According to Green and Talmor (1986) if the bank's investment opportunity set is ranked by strict mean–variance, then the shareholder prefer risky assets as capitalization decreases. In other words, the owners of a weakly capitalized bank will prefer a riskier investment project than the shareholder of a well-capitalized bank. The main intuition behind is that because thinly capitalized banks have little amount of capital to lose by bankruptcy, so they maximize the option value of deposit insurance by gambling in riskier assets. On the other hand, the shareholder of a well-capitalized bank prefers a less risky investment project, because he has more to lose in case of bankruptcy (Jeitschko, D. Thomas; Jeung, Shin D.;, 2005).

Diversification Hypothesis: In finance literature diversification involves investing in different assets to reduce the non-systematic risk. The concept was first introduced by Harry Markowitz in 1950s in his seminal work of Modern Portfolio Theory (MPT). According to the theory as a portfolio manager or individual investor adds more assets to his portfolio the additional stocks diversify the portfolio if they do not move perfectly too much with the other assets in the portfolio. Because stocks from similar geographic regions and industries tent to move together, a portfolio is diversified if it contains assets from different sectors and

regions. Similarly, firms often prefer to diversify, selecting investment projects in different industries to reduce the overall risk of the firm (Grinblatt & Titman, 2004).

Diversification in banking takes various formats. It involves the spread of lending over different types of borrowers, different economic sectors and different geographical regions (Machiraju, 2008). Largely, Mercieca et al. (2007) classify banks' diversification opportunities by 3 groups; (i) financial products and services diversification, (ii) geographic diversification, and (iii) a combination of geographic and business line diversification (Mercieca, Schaeck, & Wolfe, 2007). In addition, banks also diversify its earning by promoting non-traditional banking practices that is called income diversification. In banking income diversification refers to increasing share of fees, net trading profits and other non-interest income (commission etc.) within net operating income of a bank (Gürbüz, Yanık, & Aytürk, 2013).

The traditional portfolio theory (conventional wisdom) in the banking literature indicates that banks should diversify their products and services in different locations[7]. The main rationale behind the theory is that first banks could reduce their chances and/or expected costs of financial distress/bankruptcy by spreading operations across different products and economic locations. Second, diversification makes it cheaper for institutions to achieve credibility in their role as screeners or monitors of borrowers (Berger, Hasan, Korhonen, & Zhou, 2010). In addition to product and geographical diversification, diversification of income sources in a bank should lead to a lower risk level and a higher risk-adjusted performance. Since service fees, net trading profits and other non-interest income are uncorrelated or imperfectly correlated with net interest income, diversification of income sources should make net operating income of a bank more stable (Gürbüz, Yanık, & Aytürk, 2013).

[7] There is also counter theory in the corporate literature which argue that banks should focus on a single line of business to benefit the management's expertise and reduce agency problems, leaving investors to diversify on their own.

2.3 Review of the Empirical Literature on the Determinants of Credit Risk

2.3.1 Borrower-specific Findings

The empirical studies that follow the Merton (1974) approach usually examine the power of the Merton model on the prediction of probability of default (PD) of the firms. Although Moody's KMV provides sophisticated methodology on measuring the probability of default of firms, there are also other empirical studies on the Merton approach to predict the future defaults. Falkenstein and Boral (2001) examines the Merton model on its power for predicting default, and its sensitivity to refinements. They use Moody's proprietary U.S. dataset of 14,500 nonfinancial firms from 1980-2000, and 1,450 defaulting companies. The results of the authors indicate that the Merton model is a powerful measure of default risk, refinements add only marginally to its power, and outside-the-box augmentations make it significantly better (Falkenstein & Boral, 2001).

Another empirical study on the Merton approach was conducted by Tudela and Young (2003). The authors first employ a Merton-style approach to estimate default risk for public non-financial UK companies and later evaluate the reliability of these estimates using a range of different techniques. The probability of default is estimated for a sample of UK non-financial quoted companies. The sample date includes 7,459 financial statements from 1990 to 2001, 65 of which correspond to firm defaults. The accuracy ratio for the first and second year is recorded as 76.75% and 53.39% respectively. The results of the study also suggests that PDs are successful in discriminating between failing and non-failing firms (Tudela & Young, 2003).

The empirical studies that directly investigate the determinants of credit risk with borrower-specific factors are quite limited compared to those that use macroeconomic and bank-specific factors. The possible reason for that is because there are inadequate data to be used for in the analyses. Although it is very easy to obtain macroeconomic (i.e., GDP, unemployment, inflation, etc.) and bank-specific (financial statements, surveys and reports etc.) data there limited source that one can excess for borrower-specific data.

Jimenez and Saurina (2004) examined the determinants of the probability of default (PD) of bank loans in Spain. The authors used very large data set which comprise all loan (over 3 million loans) transactions carried out by Spanish credit institutions during the year 1988 and 2000. The database was obtained from Spanish Credit Register and covers all the banks

operating in Spain during the time period analyzed. Jimenez and Saurina (2004) used non-performing loans as proxy for credit risk. They marked 1 (defaulted) for the loans which either principal or interest has not paid over 90 days and 0 otherwise. The authors analyzed the interaction between credit risk and following variables; collateral, type of lender, relationship banking some other explanatory factors such as the macroeconomic environment, characteristics of the borrowers (industry and region) and the loan characteristics (instrument, currency, maturity and size). By employing logit model the authors found that collateralized loans have a higher PD, loans granted by savings banks are riskier and, finally, that a close bank–borrower relationship increases the willingness to take more risk.

2.3.2 Macroeconomic Findings

The empirical studies that examine the determinants of credit risk with macroeconomic (external) variables are summarized in Table 2. Accordingly, Berge and Boye (2007) analyzed the driving forces behind the household and enterprise sector for Norges banks, the central bank of Norway, during the years 1993 and 2005. By using non-performing loans as a measure of credit risk and employing ordinary least square (OLS) method, the authors conclude that the reduction in problem loans in the enterprise sector is largely driven by higher domestic demand, lower real interest rates and high oil prices. They also found that falling real interest rates and a strong rise in house prices in recent years have made positive contributions to a further reduction in problem loans in the household sector (Berge & Boye, 2007).

Table 2: The list of the studies that analyze the macroeconomic determinants of credit risk.

NO	AUTHOR(S)	TITLE	MACROECONOMIC VARIABLES
1	Tor Oddvar Berge, Katrine Godding Boye (2007).	An analysis of banks' problem loans.	Price deflator for GDP, banks' lending to households and non-financial enterprises, real exchange rate, oil price, consumer price index, real interest rate, unemployment, disposable income, price index for existing dwellings.
2	Asghar Ali, Kevin Daly (2010).	Macroeconomic determinants of credit risk: Recent evidence from a cross country study.	GDP, interest rates, industrial production and debt to GDP ratio.

3	Grigori Fainstein, Igor Novikov (2011).	The Comparative Analysis of Credit Risk Determinants In the Banking Sector of the Baltic States.	Growth rate of real GDP, unemployment rate, growth rate of real estate market and aggregate debt.
4	Vítor Castro (2013).	Macroeconomic determinants of the credit risk in the banking system: The case of the GIPSI.	Growth rate of real GDP, unemployment rate, interest rates, the credit growth, stock market index, housing prices, real exchange rates.
5	Petr Jakubík, Thomas Reininger (2013).	Determinants of Nonperforming Loans in Central, Eastern and Southeastern Europe.	Real GDP, private sector credit to GDP, national stock index, exchange rates, real domestic demand and real exports.
6	Guglielmo Maria Caporale, Stefano Di Colli, Juan Sergio Lopez (2014).	Bank lending procyclicality and credit quality during financial crises.	Industrial production, unemployment, consumer price index, retail sales, housing pricing, short-term and long-term interest rates, interest rates slope, stock market index and the yield spread between German and Italian 10 year bonds.

Ali and Daly (2010) in their comparative study, investigated the credit risk determinants for USA and Australia banking to answer which macroeconomic variables are important for both countries for the years between 1995 and 2009. The authors used ratio of non-performing loans to total loan as a dependent variable and four macroeconomic factors (GDP, interest rates, industrial production and debt to GDP ratio) as an independent variables. They found that the same set of macroeconomic variables display different default rates for the two counties. For example, the GDP is found a significant factor that has negative impact on the level of non-performing loans for both countries. The interest rates for both countries are found negative but statistically insignificant. The ratio debt level (the sum of loans and leases provided by commercial banks) is also found statistically significant and negatively effects the non-performing loans in USA and Australia. Additionally, the results of the study indicate that compared to Australia, the US economy is much more vulnerable to the adverse macroeconomic shocks (Asghar & Daly, 2010).

Fainstein and Novikov (2011) examined the influence of macroeconomic variables (growth rate of real GDP, unemployment rate, growth rate of real estate market and aggregate debt) on the level of non-performing (i.e. credit risk) by comparing the three Baltic States (Estonia,

Latvia and Lithuania). The authors used quarterly data with different time periods depending on each country. They employed vector error correction (VEC) model in the study and found that the most significant reason for the growth of non-performing loans was caused by the changes in the real GDP in all the three Baltic States. Rapid growth of the real estate market also played an important role in Latvia and Lithuania, but it was not as crucial as it has been previously assumed in Estonia (Fainstein & Novikov, 2011). In parallel with these studies, Castro (2013) examined the link between macroeconomic developments and credit risk in particular group of European countries (Greece, Ireland, Portugal, Spain and Italy) by using quarterly panel data over the period 1997q1 and 2011q. The measure of credit risk is determined as the ratio of non-performing loans to the total gross loans. Castro (2013) employed different econometric techniques (pooled OLS, random effect, fixed effect and dynamic panel data approaches) and found negative relationship between non-performing loans and GDP, share price index and housing prices. In addition, he found positive link between credit risk (non-performing loans) and unemployment rate, long-term interest rate, real exchange rates and credit growth (Castro, 2013). Another study to measure the determinants of credit risk using macroeconomic variables is conducted by Jakubík, and Reininger (2013). The study was applied to the central, eastern and southern European countries (Bulgaria, Croatia, the Czech Republic, Hungary, Poland, Romania, Russia, Slovakia and Ukraine) over the period between 1993 and 2012. In line with the current literature, the authors confirms that economic growth is the main driver that has negative effect on non-performing loans (Jakubik & Reininger, 2013).

Caporale, Colli and Lopez (2014) have investigated the macroeconomic factors and the bad loans (non-performing loans) for the Italian banking system over period 2008 to 2012 by using monthly data. In addition to the prior literature, the authors divided the bad loans into three groups (bad loans to firms, to households and to cooperative credit banks) and examined how macroeconomic factor impact each type of bad loans. By employing SVAR approach, the authors found that unemployment, interest rates slope and yield spread between German and Italian 10 year bonds have significant and positive effect on bad loans. They also conclude that there is negative relationship between industrial production, consumer price index, retail sales, housing pricing, short-term and long-term interest rate and stock market index and bad loans (Caporale, Colli, & Lopez, 2014). Other studies that

focus on determinants of credit risk from macroeconomic perspective are indicated as follow; (Nkusu, 2011), (Rinaldi & Arellano, 2006).

2.3.3 Bank-specific Findings

The empirical studies on the bank-specific determinates of credit risk is presented in the Table 3. All these studies investigate the relationship between risk and efficiency. They use non-performing loans as proxy for credit risk –there are some studies that employ different variables (expected default frequency EDF or loan loss provision ratio) as measure of credit risk- and examine how different types of efficiency (cost, revenue, technical) and capital structure affect the level of credit risk (i.e., non-performing loans).

Table 3: The list of the studies that examine the relationship between risk and efficiency.

NO	AUTHOR(S)	YEAR	TITLE
1	Allen N. Berger, Robert De Young.	1997	Problem loans and cost efficiency in commercial banks.
2	Jonathan Williams.	2004	Determining management behavior in European banking.
3	Yener Altunbas, Santiago Carbo, Edward P.M. Gardener, Philip Molyneux.	2007	Examining the relationships between capital, risk and efficiency in European banking.
4	Franco Fiordelisi, David Marques-Ibanez, Philip Molyneux.	2011	Efficiency and risk in European banking.
5	Adnan Kasman, Oscar Carvallo.	2013	Efficiency and risk in Latin American banking: explaining resilience.
6	Yong Tan, Christos Floros.	2013	Risk, capital and efficiency in Chinese banking.
7	Momna Saeed, Marwan Izzeldin.	2014	Examining the relationship between default risk and efficiency in Islamic and conventional banks.

The initial study that theoretically and empirically analyzes the relationship between credit risk (i.e., non-performing loans) and efficiency, which is one the major bank-specific factor that influence the level of credit risk in banks, is done by Berger and De Young in 1997. They developed three hypotheses namely 'bad management', 'skimping' and 'moral hazard' that might have different effect on non-performing loans[8]. They examine a sample of US banks during the period 1985 and 1994 by employing Granger-causality techniques and

[8] The study originally develops 4 hypotheses (bad management, bad luck, skimping and moral hazard) but we indicated only three since bad luck hypothesis explain determinants of efficiency rather than credit risk.

concluded that cost efficiency is a significant factor that affects non-performing loans. Their findings also indicate that decreases in measured cost efficiency are generally followed by increases by non-performing loans. In addition, it is also found that thinly capitalized banks may respond to moral hazard incentives by taking increased risk (Berger & DeYoung, 1997). Williams (2004) analyzes the management behavior of European savings banks between 1990 and 1998 following the similar theories and approaches in Berger and De Young (1997). The sample in the study includes the savings banks from the following European countries; Germany, United Kingdom, France, Italy, Spain and Denmark. The author employed loan loss provisions as measure of credit risk and used cost efficiency as measure of efficiency. By employing Granger-causality technique Williams found that there is a strong statistical evidence to support the bad management hypothesis. In other words, weakly managed banks (i.e., inefficient banks) in the sample tend to have high level of non-performing loans. Contrary to the bad management hypothesis, the author did not find any strong evidence on the skimping and moral hazard hypotheses and concluded that in general, the results for the European saving banks are inconsistent with the findings of Berger and De Young (1997) for US commercial banks (Williams, 2004).

Another empirical study that examine the intertemporal relationship between efficiency capital and risk in European banking system is conducted by Franco Fiordelisi, David Marques-Ibanez and Philip Molyneux in 2011 using the same hypotheses developed by Berger and De Young (1997). The sample data includes the commercial banks that operate in European Union countries (26 EU countries) over the period 1995 and 2007. The authors used Granger-causality method and two-step system Generalized Method of Moments (GMM) to estimate the results. Besides the non-performing loans, which is the most frequently used variable as an indicator of the credit risk by the previous studies, Fiordelisi et al (2011) employed both non-performing loans and Expected Default Frequency (EDF is a forward-looking measure calculated by Moody's KMV for each bank for 1 and 5 years.) as a proxy for credit risk. Their results indicates that lower bank efficiency (both cost and revenue efficiency) Granger-causes higher bank risk and thus confirm the bad management hypothesis. They found limited evidence on the skimping hypothesis and the relationship between bank capital and risk.

A similar study was conducted for Chinese banking by Yong Tan, Christos Floros in 2013. They assessed the relationship between bank efficiency, capital and risk for Chinese commercial banks during the period 2003 and 2009. The authors used the ratio between loan-

loss provision and total assets as an indicator of the banks' credit risk. To have the robust results, they also used three alternative measures of banks risk which are volatility of ROA, volatility of ROE and Z score. Although the previous studies (Berger and De Young, 1997), (Williams, 2004) and (Fiordelisi, Marques-Ibanez and Molyneux, 2011) employed parametric methods (stochastic frontier approach) to estimate the efficiency of banks Tan and Floros (2013) used data envelopment analysis (DEA), a non-parametric method, for measuring the efficiency of the commercial banks in their sample. Contrary to the previous findings the authors found that there is positive and significant relationship between bank's technical efficiency and risk.

The other studies and their findings that specifically focus on the determinants of non-performing loans with bank-specific variables are summarized as follow. Podpiera and Weill (2007) continued in this line of study and investigated the relationship between problem loans and efficiency in Czech banking sector during 1994 -2005 by employing Generalized Method of Moments (GMM) approach. The findings of the authors support the bad management hypothesis which indicates that deteriorations in cost efficiency precede increases in non-performing loans (Podpiera & Weill, 2007).

Ahmad and Ariff (2007) also examined the determinants of credit risk with bank-specific variables for developed and emerging economies. The authors selected Australia, France, Japan and the US as the developed economies; and chose India, Korea, Malaysia, Mexico and Thailand as the developing economies. By employing ordinary least square (OLS) for the cross-section data, Ahmad and Ariff (2007) concluded that anywhere from two to four factors are significant determinants of credit risk of any one banking system. Contrary to the theory and some earlier studies, they found that leverage is irrelevant to credit risk of banks in several economies during their test period (Ahmad & Ariff, 2007).

Although there are numerous studies that separately examine the relationship between non-performing loans and macroeconomic or microeconomic variables, there are some recent studies that analyze the determinants of non-performing loans (credit risk) using both factors (bank-specific and macroeconomic) at the same time. One of the prominent study that use bank-specific and macroeconomic variables to analyze the credit risk determinants is conducted by Salas and Saurina (2002). They used panel data to compare the determinants of non-performing loans of Spanish Saving and Commercial banks during the period 1985 and 1997 using both macroeconomic and bank-specific variables. All the variables chosen by the authors can be classified as follows; The GDP growth rate, firms, and family

indebtedness, rapid past credit or branch expansion, inefficiency, portfolio composition, size, net interest margin, capital ratio, and market power. By employing dynamic panel data (Arellano and Bond, 1989; 1991) approach the authors concluded that bank level variables can be used as early warning indicator in the future NLP (Salas & Saurina, 2002).

Louzis Vouldis and Metaxas (2011) investigated the determinants of non-performing loans (NPLs) in the Greek banking sector for different loan categories including consumer, business and mortgages loans. The authors used GDP growth, the unemployment rate and the lending rates as the macroeconomic variables. Efficiency ratio, capital structure, ratio of total assets in the banking sector, performance, collateral are selected as the bank-specific variables. They employed Generalized Method of Moments as proposed by Arellano and Bond (1991) and developed by Arellano and Bover (1995), Blundell and Bond (1998) comprising nine Greek commercial banks over 2003 and 2009. The authors found that macroeconomic variables, especially the real GDP growth rate, the lending rates, the unemployment rate and public debt have a strong effect on the level of NPLs of consumer mortgage and business loans. In addition, bank level variables such as performance and efficiency have additional explanatory power when added in to model (Louzis, Vouldis, & Metaxas, 2012).

As a comparative study, Chaibi and Ftiti (2015) examined the determinants of non-performing loans (NPLs) of commercial banks of France and Germany for the period 2005-2011. The authors used loan loss provisions as the measure of credit risk and the following variables as the bank specific factors; inefficiency, leverage, solvency ratio, non-interest income, size and bank profitability. The macroeconomic variables in the study are listed as follows; inflation, GDP growth, interest rate, exchange rates. They found that all macroeconomic variables, particularly GDP growth, interest rate, unemployment rate, and exchange rate, have a significant and strong effect on both economies. Only two bank-specific variables (size and profitability) were significant factors on the NPL for both economies (Chaibi & Ftiti, 2015). Similar studies that examine NPL with bank-specific and macroeconomic factors are shown as; (Messai & Jouini, 2013), (Zribi & Boujelbène, 2011).

To this end, after providing a review of both theoretical and empirical literature on determinants of credit risk in banking, in the next chapter we will measure the technical efficiency of the Turkish commercial banks for the period of 2003 to 2013.

3 EFFICIENCY ANALYSIS OF TURKISH COMMERCIAL BANKING SECTOR.

3.1 Introduction

The objective of this chapter is to measure the technical efficiency scores of commercial banks in Turkey by employing data envelopment analysis (DEA) for the period 2002 and 2015 with quarterly data. In banking, efficiency studies involve analyzing the relationship between inputs and outputs of banks. Given the production technology, if a bank can reduce its inputs with causing minimum decrease in its outputs it is called efficient bank. However, if a bank achieves the current performance using higher number of inputs than its peers, this indicates that the bank does not use its resources efficiently.

The concept of efficiency is one of the internal (bank-specific) factor that affect the default rates in a loan portfolio. Accordingly, the studies over the last several decades that examine the relationship between credit risk and efficiency proved that the level of credit risk in banks could be reduced by improving the overall efficiency of the banking system. Berger and De Young (1997) theorized the relationship between credit risk and efficiency in commercial banks with bad management, skimping and bad luck hypotheses and found that the cost efficient banks usually have low level of non-performing loans. Moreover, the studies that continue in this line concluded that the banks that operate on the efficient frontier or have higher efficiency scores usually display low level of credit risk.

In this study we measure the technical efficiency of commercial banks that operate in Turkey. The main focus in efficiency measurement of financial institutions involves estimating an efficient frontier and measuring the average differences between observed institutions and the institutions (bank, insurance companies) on the frontier. The time period includes the post-crises (the twin crises) period as well as the global financial crises. The sample data includes the 23 commercial banks. We follow the intermediation approach and employ two inputs and five output items both from balance sheet and income statement. The set of input items are non-interest expenses and interest expenses whereas the total output variables are non-interest income, interest income total deposits, total loans and total securities.

The findings of the study indicate that the overall technical efficiency in the Turkish commercial banking sector has improved during the years 2004 and 2007. Later 2008, the

efficiency of the commercial banking sector in Turkey has deteriorated. In addition, state banks are found more technical efficient than foreign and domestic banks contrary to the international literature.

The remaining part of this chapter is organized as follow. Section 3.2 provides a summary on empirical literature of efficiency in Turkish banking sector. Section 3.3 describes the methodology and data. Section 3.4 provides the empirical results and finally, Section 3.5 concludes the study.

3.2 Previous Studies on Efficiency in Turkish Banking Sector

The empirical findings in the efficiency of financial institutions are very large and diverse. The concept of efficiency was applied to the wide range of financial institutions including commercial banks, investment banks, credit unions and insurance firms. Berger and Humphrey (1997) exceptionally reviewed 130 studies that employ all types of frontier analysis (both parametric and non-parametric approaches) to measure the efficiency of financial institution from 21 different countries. The authors found that compared to the parametric approaches, non-parametric approaches suggests a greater dispersion in estimated efficiency ratios. In addition, they concluded that there is greater similarity in bank efficiency rankings when, instead of comparing non-parametric with parametric techniques, the comparison is between different techniques within one of these categories (Berger & Humphrey, 1997).

There is also great amount of empirical findings in the literature that examine the efficiency of financial institutions in Turkey. The Table 4 and Table 5 below exhibits the studies that was conducted to measure the efficiency of financial institution (commercial banks, insurance companies, and brokerage firms) in Turkey based on the methods employed. Table 4 presents the studies that follow non-parametric approach and Table 5 covers the studies that use parametric methods specifically the stochastic frontier approach (SFA). There are also some studies (Isik and Hassan, 2002) which used both methods simultaneously. As seen on the both tables the input and output combination indicate that the intermediation approach is commonly used to for selecting the input and output variables. The common input factors are labor (labor is measured usually with number of employees or personnel expenses), deposits, and equity capital where the main output factors are loans (corporate and individual) and financial securities.

Table 4: Efficiency studies with data envelopment analysis (DEA) approach in Turkish banking sector.

No	Author(s)	Year	Method	Inputs	Outputs
1	Osman Zaim	1995	DEA	Number of employees, interest expenses, depreciation expenses and expenditures on materials	Time deposits, demand deposits, short term loans and long term loans,
2	Reha Yolalan	1996	DEA	Non-performing loans and non-interest expenses.	Net income plus capital, non-interest expenses and short term securities.
3	Canan Yıldırım	2002	DEA	Demand deposit, time deposit, interest expenses and non-interest expenses.	Total loans, interest income and non-interest income.
4	Ihsan Isik and M. Kabir Hassan	2002	DEA and SFA	Number of total employees, capital and funds (deposits and non-deposit funds).	Short term loans, long term loans, risk-adjusted off-balance sheet items and other earning assets.
5	Ihsan Isik and M. Kabir Hassan	2003	DEA	The number of full-time employees, physical capital, the sum of deposit (demand and time) and non-deposit funds including inter-bank loans.	Short-term loans, long-term loans, risk-adjusted off-balance sheet items and loans to special sectors (inter-bank funds sold and investment securities)
6	Nur Ozkan-Gunay, Arzu Tektas	2006	DEA	Personnel expenses, administrative expenses and interest expenses.	Total deposits, total loans, total securities, total interest income and total non-interest income.
7	Cevdet A. Denizer, Mustafa Dinç and Murat Tarimcilar	2007	DEA	Total operational expenses for production and intermediation, total own resources of the bank for production and intermediation and total deposits.	Total loans, non-interest income, interest income and total deposits.
8	Muhttin Kaplan, Tuncay Celik	2007	DEA *(*insurance firms)*	Operating expenses, total assets, provisions and debt.	Total insurance premiums, net profit/loss.
9	Hirofumi Fukuyama, Roman Matousek	2011	DEA	Labor (the number of employees) and capital (the book value of premises and fixed assets).	Total loans, total securities and total deposits.

Zaim (1995) is the only study on the list that used production approach for measuring efficiency in the Turkish commercial banking. Yolalan (1996) analyzed the efficiency of Turkish commercial banks during the period of 1988 – 1995 by employing data envelopment analysis. He used non-performing loans and non-interest expenses as the inputs and net income plus capital, non-interest expenses and short term securities as the outputs. The author found that foreign banks are the most efficient banks compared to the private (domestic) and state banks. Yıldırım (2002), analyzed the efficiency performance of the Turkish banking sector over the period 1988 and 1999, a period that characterized by increasing macroeconomic instability. The technical and scale efficiencies of Turkish commercial banks are measured by using data envelopment analysis. Yıldırım found that the banking industry in Turkey suffers mainly from the scale inefficiency which is mainly due to decreasing returns to scale. In addition, the author also investigated the relationship between profitability, asset quality, size and the two different types of efficiency. The findings of the author indicates that efficient banks are more profitable, and pure technical and scale inefficiencies are positively related to size.

Isik and Hassan (2003) in their comprehensive study examined the two aspects of the efficiency of the Turkish banking sector. In the first part they measured the 5 different efficiency scores namely technical, allocative, cost, pure technical and scale efficiency over the period 1988 and 1996 by using data-envelopment analysis. The authors used the following set of inputs: the number of full-time employees, physical capital, sum of deposit (demand and time) and non-deposit funds including inter-bank loans. The price of the inputs are total expenditures on employees divided by total number of employees, total expenditures on fixed assets divided by total fixed assets and total interest expenses on deposit divided by total deposits. The outputs used in the study can be classified as follows: short-term loans, long-term loans, risk-adjusted off-balance sheet items and loans to special sectors (inter-bank funds sold and investment securities). In the second part they examined the differences in measured efficiency across various forms of banks operating in Turkey. The authors tested the market power, market discipline, agency cost, moral hazard, bad luck hypothesis, bad management and skimping hypothesis in the context of different type of efficiency by employing generalized least square (GLS) and tobit multiple regression models. Isik and Hassan (2003) found that public and foreign banks are more cost and technical efficient than private banks whereas public banks dominated both type of banks

(private and foreign) in terms of allocative efficiency. They also concluded that banks whose shares are publicly traded in the Istanbul Stock Exchange are technically more efficient. As for bank size, the authors did not have any results on the relationship between efficiency and bank size and conclude that banks in different size might have the same efficiency scores. In addition, they found that efficient banks are relatively good at originating and monitoring loans and have much more quality loan portfolio. Their results also suggests that banks that have more educated employees are more cost efficient (Isık & Hassan, 2003).

Denizer, Dinç and Tarimcilar (2007) investigated the banking efficiency in a pre- and post-liberalization environment in Turkey over the long period between 1970 and 1994 by employing data envelopment analysis. The authors used the following inputs total operational expenses for production and intermediation, total own resources of the bank for production and intermediation and total deposits and the following outputs total loans, non-interest income, interest income and total deposits. The results of the Denizer, Dinç and Tarimcilar (2007) show that liberalization did not provide the expected efficiency improvements for the Turkish banking industry. Finally, they also analyzed whether the macro economic variables (high and variable inflation and unstable growth patterns) affected bank efficiency. Their results indicate that volatile inflation and growth rates have reduced bank efficiency in Turkey.

Kaplan and Celik (2007) measured the efficiency of insurance firms operating in Turkey and estimated the factors that determine the efficiency of those firms. The results of the authors suggest that the significant number of insurance firms use their resources inefficiently. In addition, increasing the amount of investment in human capital, firm sizes, the control over management and specialization in a particular branch other than in accident branch play an important role in reducing the efficiency differences among insurance firms (Kaplan & Celik, 2007).

Table 5: Efficiency studies with stochastic frontier approach (SFA) approach in Turkish banking sector.

No	Author(s)	Year	Method	Inputs	Outputs
1	Ömer Faruk Çolak and Serdar Kiliçkaplan	1999	SFA	Total costs (interest expenses and personnel expenses).	Total loans, total securities, total interest expenses over total deposits and personnel expense over total number of personnel.
2	Burak Günalp and Tuncay Çelik	2004	SFA	Labor, physical capital and deposits.	Total loans.
3	Mahmoud A. El-Gamal and Hulusi Inanoglu	2005	SFA	Labor, physical capital and interest expense.	Total loans.
4	Nazmi Demir, Syed F. Mahmud and Senol Babuscu	2005	SFA	Labor, deposits, borrowed funds, and equity.	Sum of total loans and securities.
5	Adnan Kasman	2005	SFA	Total employment, interest expense and physical capital.	Total loans, total deposits and total securities.
6	Dervis Ahmet Akinci, Roman Matousek, Nemanja Radic, Chris Stewart	2013	SFA	Labor, capital and funds.	Loans, securities and off balance sheet items.
7	A. George Assaf Roman Matousek Efthymios G. Tsionas	2013	Bayesian SFA	Number of employees, bank capital, fixed assets and deposits.	Loans, securities, and off-balance sheet assets.

Colak and Kılıçkapan (1999) examined the cost functions in Turkish commercial banking sector. The sample data includes the 29 commercial banks that operate in Turkey. The authors follow the intermediation approach. The input item is the total cost that is sum of interest and non-interest expense. The set of outputs are total loans, total securities, the price of the deposits (total interest expenses over total deposits) and the cost of each personnel (personnel expense over total number of personnel). By employing parametric approach (translog cost function) Colak and Kılıçkapan found that there is constant return to scale in the Turkish banking sector (Çolak & Kılıçkapan, 1999).

Günalp and Çelik (2004) analyzed the relationship between market structure, performance and efficiency for the Turkish banking sector during the period 1990 and 2000. They employed stochastic efficient frontier approach to estimate the bank's efficiency scores and used the total loans as output and labor, physical capital and deposits as input items. The estimated efficiency scores are later used as an independent variable in the profitability equation. The result of the study supports the efficient structure hypothesis. The authors concluded that high profitability in the banking sector do not seem to have as a result of the cooperation between banks or market power of the large banks have (Günalp & Çelik, 2004).

El-Gamal and İnanoğlu (2005) performed two types of efficiency analyses for the Turkish commercial banking system. They first estimated the traditional cost efficiency and later measured a labor efficiency cost function. The authors used 49 conventional banks in their sample which account more than 93 % of total assets the commercial banking sector in Turkey. By employing stochastic efficient frontier method, a parametric approach, El-Gamal and İnanoğlu (2005) found that state banks are not particularly inefficient overall, but that they do utilize labor inefficiently which supports recent calls for privatization in the Turkish banking system. They also conclude that special finance houses (or Islamic banks) utilize the same technology as conventional domestic banks, and do so relatively efficiently. This suggests that they do not cause harm to the financial system. Finally, the authors found that foreign banks utilize a different technology from domestic ones. This suggests that one should not overstate their value to the financial sector (El-Gamal & Inanoglu, 2005).

Demir et al. (2005) estimated the stochastic frontier production model with the TIE model for commercial banks in Turkey during the pre-liberalization period (1981–1984) and post-liberalization period (1995–1998). They employ parametric approach, translog stochastic production frontier, with the TIEs of Turkish banks for the sample period. The authors used

the ratio of loans to assets to proxy the investment behavior of banks. The findings of the authors indicate that banks with a higher loans to assets ratio are more technically efficient as opposed to the securities-oriented banks, both in the pre- and post-liberalization periods. Second, the bank size is also found significant determinant of technical efficiency in the post-liberalization period. Third, private and foreign banks are found to be technically more efficient compared to state-owned banks. Finally, Demir et al. (2005) conclude that banks with higher rates of profitability are also more efficient, implying that profitability can be compatible with technical efficiency (Demir, Mahmud, & Babuscu, 2005).

The other findings that examine the efficiency in Turkish banking industry can be summarized as follows: The studies that compare the efficiency of domestic and foreign banks in Turkey have relatively mixed results. Yolalan (1996), Isik and Hassan (2002) and El-Gamal and Inanoglu (2005) found that foreign banks operating in Turkey are more efficient than domestic banks. Dervis et al. (2013) and Fukuyama and Matousek (2011) however, found that foreign banks have lower efficiency compared to the domestic banks based on the both profit and cost efficiency measures. Onis (1995) and Ertuğrul and Zaim (1999) examined the effect of financial liberalization on the efficiency of Turkish banking sector. Both authors concluded that the financial liberalization that was started in early 1980s has improved the overall bank efficiency in Turkey.

Ozkan-Gunay and Tektas (2006), Fukuyama and Matousek (2011) investigated the impact of financial and economic crises on the bank efficiency in Turkey by employing data envelopment analysis and Bayesian stochastic frontier approach respectively. All data in these studies cover the 2 major crises period (the currency crisis in 1994 and the twin crises in late 2000 and early 2001) that erupted after the financial liberalization. Their results suggest that the crises periods reduce the average efficiency in Turkish banking industry.

3.3 Methodology and Data

Methodology:

The concept of efficiency can be defined as a measure of deviation between actual performance and desired performance. Therefore, efficiency must be measured relative to an objective function (Mester, 2008). The objective function could be the best practicing firm(s) operating either at maximum output given the level of input or minimum input given the level of output. The simple way of measuring efficiency of the firms as well as financial

institutions is the ratio analysis. In this method efficiency is measured by comparing one input with another output. Although it is easy to measure and analyze the efficiencies of firms with ratio analysis approach, there are some drawbacks of this method. First, most of firms especially financial institutions (specifically commercial banks) have multiple inputs and outputs therefore, measuring efficiency of financial instructions solely with ratio analysis is not adequate. Second, using multiple ratios will not give a single measure to compare the firm with others in an industry or the sample (İnan, 2000). Thus measuring efficiency for financial institutions requires methods beyond the ratio analysis.

In this regard, the frontier approaches were introduced by the researchers. In frontier approaches a single efficient frontier is constructed by using inputs and outputs of firms in a sample and the efficiency (productivity) of each firm in the sample is found by measuring the distance between each firm in the sample and efficient firm(s) on the frontier. The frontier analysis provides an overall, objectively determined, numerical efficiency value and ranking of firms (banks) that is not otherwise available (Berger & Humphrey, 1997). In the efficiency literature there are two major type of methods (parametric and non-parametric) to measure the FI's efficiency. The parametric methods can be divided into deterministic and stochastic models. The deterministic models is also called "full frontiers" models. The models here first construct the efficient frontier by enveloping all observation (firms) and later identify the distance between efficient frontier and actual production for each firm. The deterministic models assume that all deviations from the efficient frontier are under the control of the decision making unit which is not always the case. There are some conditions such as competition, regulation, weather disasters, luck, uncertainty etc. that might not be fully controlled by the firms or DMUs. The stochastic models can eliminate the problem above. They procedures model both specification failures and uncontrollable factors independently of the technical inefficiency component by introducing a double-sided random error into the specification of the frontier model (Murillo-Zamorano, 2004). The common parametric techniques that estimate the efficiency are; stochastic frontier approach (SFA), distribution free approach (DFA) and thick frontier approach (TFA).

The non-parametric approaches is the second type of methods that is used to measure the efficiency. The aim of these non-parametric techniques to the measurement of efficiency is to define a frontier envelopment surface for all observations in the sample. This surface is determined by those observations that lie on it, which are considered the efficient

observations (decision making units). The units which do not stay on the frontier are regarded as inefficient and individual inefficiency score is calculated for each of them (Murillo-Zamorano, 2004). The non-parametric approaches can be classified by two methods; data envelopment analysis (DEA) and free disposal hull (FDH).

The main differences between parametric and non-parametric approaches are summarized as follow: The parametric models employ econometric techniques to solve the equations for efficiency. In these models there are usually multiple independent variables and one dependent variable where the dependent variable could be either an input or an output. Contrary to the parametric models, non-parametric models can use multiple inputs and outputs at the same time to measure the efficiency of DMUs. They employ mathematical programming rather than using econometric techniques used by parametric approaches and therefore do not take account the random error in the sample. Since the true level of efficiency is unknown, it is not possible to determine which of the two major approaches dominate the other (Berger & Humphrey, 1997).

In this study we used data envelopment analysis (DEA) for measuring the efficiency of commercial banks. Data envelopment analysis is a mathematical non-parametric method which was developed by Charnes, Cooper and Rhodes in 1978 to measure the efficiency of similar decision making units. The theoretical foundation of DEA goes back to Farrell 1957. Farrell (1957) defined efficiency, given the technology, as a distance to empirical production frontier. Production frontier represents the highest possible performance that can be achieved using available technology. Each Decision Making Unit's (DMU) efficiency is measured by comparing the efficiency score of this unit with banks that constructs the frontier. To this end, Farrell used one input and output combination to measure the efficiency (Celik, Kaplan, & Sahin, 2015). The single-input/output efficiency measure of Farrell is improved to the multiple input/output case and reformulated as a mathematical programming problem by Charnes, Cooper and Rhodes (1978) (Murillo-Zamorano, 2004) (Charnes, Cooper, & Rhodes, 1978) .

The Figure 1 below illustrates the efficiency that was calculated with DEA for a decision making unit –in this case a bank- that use only single input and output. Accordingly, A, B, C, D, E, are the banks where their input is specified on the X axis and output is given on the Y axis.

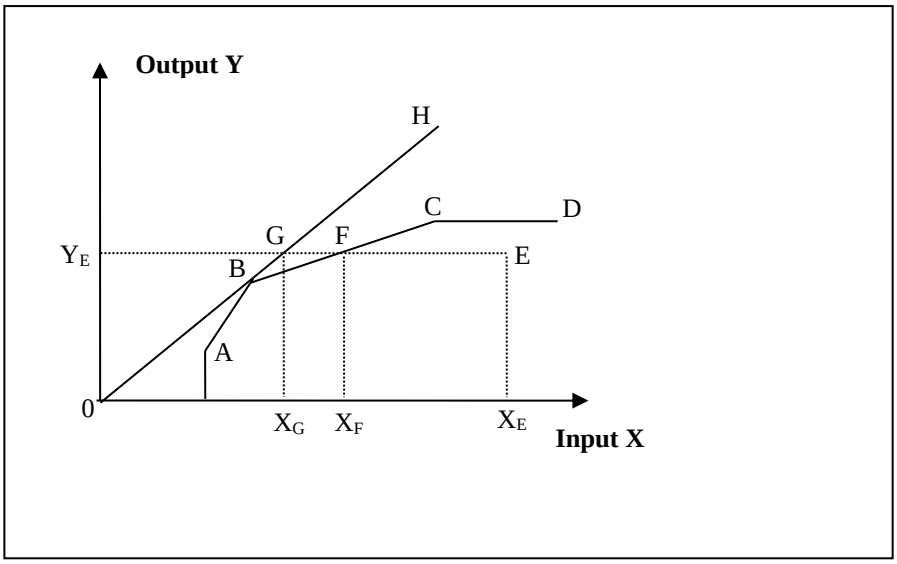

Figure 1: Data Envelopment Analysis

Under the assumption of constant returns to scale, the most efficient bank(s) is/are the one/those that has the highest output-input ratio if there is single input and output. On the diagram the linear OH line represents the constant return to scale and the bank(s) on the line are the most efficient banks where their efficiency is 1. All the banks (points) under this line is considered as inefficient banks. The efficiency score of inefficient banks are measured as follows. Assuming that the observation on the efficiency line (in our example this is shown by point B) is efficient, the efficiency score corresponding to this point is one (or 100 percent). Banks which are under the efficiency line are inefficient and the level of inefficiency of these banks is related to their distance to line H. The efficiency score for bank E is determined by the ratio of X_G / X_E (Celik, Kaplan, & Sahin, 2015)[9].

The mathematical representation of DEA model can be written as follow (Lovell, 1993)

DEA Model;

$$\max\ h_c = \frac{\sum_{r=1}^{s} u_r y_{rc}}{\sum_{i=1}^{m} v_i x_{ic}} \tag{11}$$

[9] The mathematical specification of data envelopment analysis (DEA) is written from study Efficiency, Concentration and Competition in the Turkish Banking Sector conducted by Çelik, Kaplan and Şahin (2015).

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1$$

$$u_r, v_i \geq 0$$

$$r = 1,2...,s; i = 1,2,...,m; j = 1,2,..,n$$

where c, represent the DMU (which is the commercial bank in this study) that its efficiency level will be evaluated, y_{rj} is the bank j's r^{th} output, x_{ij} is bank j's i^{th} input, u_r and v_i are the weights that will be obtained from solving the model corresponding to input r's and output i's respectively. Equation 11, involves the maximization of objective function h_c's, DMU c's weighted output to weighted inputs ratio, including itself under the restriction of no one DMU ratio is greater than one. The weights of u_r and v_i in the model is obtained with optimization. To solve the optimization problem given in equation 11 we equate h_c's denominator to one thereby turning the problem into linear programming. Corresponding model suitable to linear programming can be written as:

$$\max_{u,v} h_c = \sum_{r=1}^{s} u_r y_{rc} \qquad (12)$$

$$\sum_{i=1}^{m} v_i x_{ic} = 1$$

$$\sum_{r=1}^{s} u_{rc} y_{rj} - \sum_{i=1}^{m} v_{ic} x_{ij} \leq 0$$

$$u_r, v_i \geq 0 \; r = 1,....,s; i = 1,.....,m \text{ and } j = 1,.....,n$$

In equation 12, it is assumed that constant returns technology is employed in the optimization problem. In addition, as seen from the equation 12, the weighted average of inputs is equal to one and outputs are maximized. This formulation of the DEA model is called input oriented efficiency measurement and indicates that banks try to minimize inputs given the outputs. The dual of the Primal Linear Programming Model given in equation 12, can be written by defining the input weights of banks as θ_c and output weights as λ_j :

Dual Model;

$$\min h_c = \theta_c \tag{13}$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} - s_i^+ = y_{rc}$$

$$\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = \theta_c x_{ic}$$

$$\lambda_j, s_i^-, s_i^+ \geq 0 \qquad j = 1,2,..,n$$

The values of θ_c scores obtained solving the model is equal to one and the slacks s_i^+ and s_i^- is equal to zero, bank c is called efficient. The efficiency bank implies that it is impossible for the bank to achieve the given output level with using less inputs. If θ_c is smaller than one, these banks are called less efficient than the benchmark reference banks and the value of θ_c indicates the extent that bank c needs to reduce input usage to reach efficient frontier. For inefficient reference banks are obtained using the optimum values of λ_j's. To consider the variable returns to scale (VRS) in the production, an extra restriction of $\sum_{j=1}^{n} \lambda_j = 1$ needs to be added to the equation 13 (Banker, 1984).

Data Description:

The data employed in the empirical part of this chapter is obtained from Banks Association of Turkey (BAT) over the period from the fourth quarter of 2002 and third quarter of 2015. Banks Association of Turkey exceptionally provides the information about independent audit reports, financial statements, surveys, financial ratios and other fundamental information related to banking sector in Turkey. The initial sample data in this study includes 26 commercial (deposit) banks that operate in Turkey. The banks in the sample are grouped as state, domestic and foreign banks and comprise the 90% (ranked by total assets) of the total banking sector between 2003 and 2013. We measured quarterly efficiency score for 23 commercial banks (3 state-owned, 10 domestic and 10 foreign banks) and excluded 3 banks due to availability and consistency of the data.

Although non-financial firms (manufacturing firms) use certain inputs to produce outputs, the input and output mix of financial institutions is quite controversial. In the banking literature there are two views (production approach and intermediation approach) that describe the input and output combination of financial institutions (Berger & Humphrey, 1997). Under the production approach financial institutions are thought of as primarily producing services for accountholders. Basically, they carry out the following tasks such as processing loan application, accepting deposits, preparing credit reports etc. In this approach the outputs of financial institutions are considered as the total number of deposits and loan accounts or the number of insurance policies. The input items however, are usually physical capital and labor.

In the intermediation approaches financial institutions are regarded as an intermediary which channel funds from savers to borrowers. Here, the outputs of financial institutions are all types of loans and the inputs are the total funds (primarily deposits), labor and physical capital. There is a controversy on the treatment of deposits whether to count it as an input or output. In the intermediation approach it is considered as input where it is counted as output in the production approach (Berger & Humphrey, 1997). There are some studies (Bauer & Hancock, 1993) that use deposits both as an input and output. Berger and Humphrey (1997) suggest that the intermediation approach is appropriate for examining bank efficiency, where the production approach is suitable for investigating the efficiency of branches of financial institutions.

To be consistent with the majority of literature, we follow the intermediation approach to measure the technical efficiency and prefer the similar input and output variables that were used in the studies (Berger & DeYoung, 1997 and Williams, 2004) which examine the relationship between the efficiency and credit risk. The set of input items are non-interest expenses and interest expenses. Non-interest expense is the sum of personnel expenses (total wages and benefits of the employees) and administrative expenses which include the depreciation expenses, rental expenses, advertisement expenditures and other operating expenses. Interest expenses is the total interest paid to depositors, money market instruments and other funds. The output set is separated by two groups where in the first group we use balance sheet items and in the second group income statement items are employed. The output variables from the balance sheet are total deposits, total loans and total securities. The definition of these variables are indicated as follows; deposits are the aggregate level of

deposits from individuals and firms. Total loans include sum of consumer and corporate loans. Securities are defined as all financial assets that held both in the trading book and banking book (the securities that are held until maturity). The second group of output variables are non-interest income and interest income. The same input and output mix in this study are also used by Ozkan-Gunay and Tektas (2006). Both inputs and outputs in the sample are given in ratios so all variables are divided by total assets. Yolalan (1996) and Demir et al. (2005) employed financial ratios as inputs and output to measure the efficiency in Turkish banking industry.

We included the total loans and total securities as output because the asset, user cost and value-added methods of assigning financial goods to input and output categories all agree that major assets such as loans and securities should be considered as output. However, there is a disagreement about the deposits whether or not they should count as input or output. On the one hand deposits are input because they are collected by financial institutions as funds to invest in financial assets. On the other hand deposits are treated as output because they are associated with a substantial amount of liquidity, safekeeping, and payment services provided to depositors (Berger & Humphrey, 1997). The controversy on deposit is resolved by dual-approach that count deposit as both input and output. Accordingly, the total interest paid on deposits is regarded as input and the quantity of deposits used as output. We follow the same approach and used interest expenses as input and total deposits as output. Moreover, interest expenses is an important expense item for Turkish commercial banking sector. According to the data of Banks Association of Turkey, the interest expenses comprise the 66.4% of the total expenses of the commercial banks over the period 2002 and 2015 and the remaining part of the expenses are the non-interest expenses.

Table 6: Descriptive statistics of the employed variables for the different banking groups.

	State Banks		Domestic Banks		Foreign Banks	
Inputs:	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Interest expense	0.04543	0.03333	0.03611	0.02227	0.03548	0.02665
Noninterest expense	0.01928	0.01088	0.02854	0.01779	0.03516	0.02132
Outputs:						
Interest income	0.07204	0.04583	0.06216	0.03380	0.06738	0.03949
Noninterest income	0.01031	0.00734	0.01408	0.01144	0.01635	0.01862
Deposit	0.72199	0.06811	0.62921	0.07507	0.59366	0.14181
Securities	0.36490	0.17404	0.19892	0.10517	0.17314	0.11263
Loans	0.43989	0.17487	0.53521	0.15831	0.55016	0.15906
Obs.	151		500		473	

The descriptive statistics for inputs and outputs based on the different banking types are provided in Table 6. According to the table, during the sample period state-owned banks, which comprise the 31.9 % of the Turkish commercial banking sector in terms of total assets, have lower non-interest expenses per asset than foreign and domestic banks. One of the reason for that is because domestic and foreign banks pay salaries and benefits to their employees much more than state-owned banks do (Isık & Hassan, 2003). Interest expenses per asset however, was found the highest for state-owned banks and lowest for foreign banks.

As we look at to the outputs, state banks have the highest total deposits to total assets ratio (72.20 %) whereas foreign banks have the lowest ratio. One of the reason why the ratio is very high for state-owned banks is because they (specifically the Ziraat Bank) have higher number of branches in all over the Turkey compared to the other banks. Surprisingly, the ratio of total loans to the total assets in the sample is the highest (55.02%) for foreign banks. The ratio total securities over total assets for state-owned, domestic and foreign banks are recorded as 36.49 %, 19.89 %, and 17.31% respectively. As seen on the table interest income, which is the output variable from the income statement, is quite higher for the state banks compared to the two other banking groups. Non-interest income however is recorded the lowest for the state banks.

3.4 Empirical Findings

We calculated technical efficiency scores for each year rather than measuring a common efficiency scores over the time. The technical efficiency scores are measured by using two different group of variables. In the first group (EFFA) the input variables are interest and non-interest expenses and output variables are interest and non-interest income. The efficiency scores in the second group (EFFB) are measured with the same inputs as in the first group, output variables however, are total loans, deposits and securities held by commercial banks. While measuring the efficiency scores using DEA approach, we followed input approach where the efficiency score 1 indicates an efficient bank and any score less than 1 represent the inefficiency or deviation from the efficient frontier. By selecting the constant return to scale (CRS) we calculated the total technical efficiency using the efficiency measurement system (EMS) 1.3.0 software package. The full efficiency scores of panel A and B obtained from DEA model are presented in the appendix section.

Table 7: Mean technical efficiency scores of the commercial banks in the sample.

Banks	Mean Efficiency Scores for Panel A	Mean Efficiency Scores for Panel B
Akbank	0.967074	0.982423
Alternatifbank	0.850526	0.791021
Anadolubank	0.898545	0.847266
Arap Türk Bankası	0.981382	1.000000
Burganbank	0.772964	0.703250
Citibank	0.934615	0.787221
Denizbank	0.842281	0.803758
Fibabanka	0.752406	0.961703
Finansbank	0.878998	0.810204
Garanti	0.922332	0.927172
Halkbank	0.982774	0.979940
HSBC Bank	0.858228	0.778563
ING Bank	0.821644	0.848047
İşbank	0.881063	0.874563
Odeabank	0.786997	0.999125
Sekerbank	0.806618	0.682598
Tekstilbank	0.777652	0.844016
Turkishbank	0.791848	0.784902
Turklandbank	0.802011	0.784374
Türk Ekonomi Bankası	0.823142	0.852739
Vakıfbank	0.847716	0.875652
Yapı Kredi	0.834489	0.863817
Ziraat Bankası	0.998871	0.998523
Mean	0.861486	0.860038

The Table 7 presents the average technical efficiency scores of the commercial banks in the sample. The efficiency scores for each bank vary from one period to another. A bank that is found efficient in one quarter could be inefficient in another quarter. Only Arap Türk Bankası A.Ş. (in Panel B) is found efficient for each quarter during the sample period. The mean technical efficiency scores both for panel A and B for Turkish commercial banking sector during the sample period is found 0.8615 and 0.86 respectively.

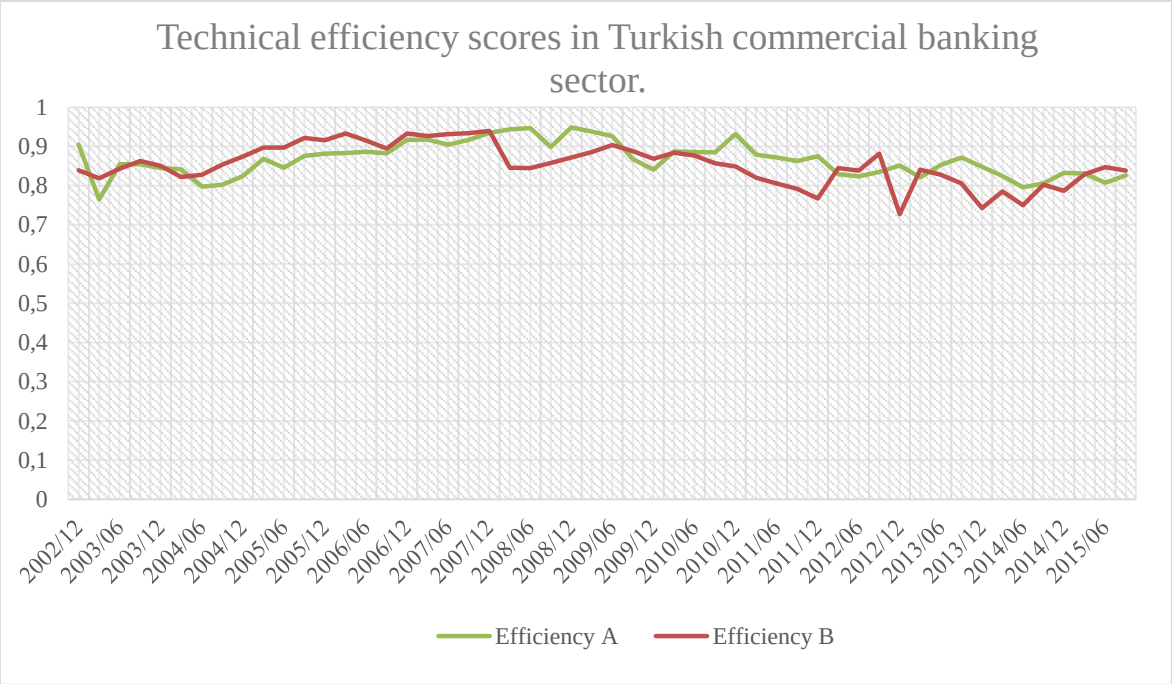

Figure 2: Mean technical efficiency scores of the commercial banks between 2002 4th quarter and 2015 3rd quarter.

The average efficiency score for each quarter during sample period is given in the Figure 2 above. As seen on the figure, the efficiency scores of the Turkish commercial banking sector were relatively higher for the early years, 2004, 2005, 2006 and 2007, probably due to positive effects of the restructuring program that was implemented in early 2000s. Early in 2009, the percentage and number of efficient banks in the sample declined considerably possibly because of the global financial crisis (GFC).

The Table 8 presents the descriptive statistics for efficiency scores of the different banking groups operating Turkey. Based on the type of ownership, the commercial banks in Turkey can be categorized by state-owned banks, domestic banks and foreign banks where the last two is also called private banks. At the beginning of 2014, the portion of each banking segment in the commercial banking sector is recorded as; the state banks comprise the 30.85 % of the total commercial banking sector in terms of total assets. Domestic and foreign banks constitute the 53.11 % and 15.98 % of the total assets in the sector respectively. The minimum efficiency scores for both panels (EFFA and EFFB) in the Turkish commercial banking sector for the period December 2002 and September 2015 recorded as 0.36 and 0.45 where the maximum score is 1. The mean efficiency scores for state banks is 94.27% for panel A and 95.11% for panel B. Apparently, similar with the Dervis et al. (2013) and

Fukuyama and Matousek (2011), the state-owned banks are found more technical efficient (including for both panels) than other types of banking group. Foreign banks are found least technical efficient banking group in the sample.

Table 8: Descriptive statistics of the efficiency scores of the different banking groups.

Variable	Obs.	Mean	Std. Dev.	Min	Max
State Banks:					
Efficiency (A)	151	0.9427018	0.0871409	0.5539485	1
Efficiency (B)	151	0.9511164	0.0793989	0.6728511	1
Domestic Banks:					
Efficiency (A)	500	0.8475636	0.1133262	0.5434321	1
Efficiency (B)	500	0.8597194	0.1261064	0.458299	1
Foreign Banks:					
Efficiency (A)	473	0.8571533	0.1201909	0.4538851	1
Efficiency (B)	473	0.8146096	0.1619133	0.3674028	1

3.5 Conclusion

In this section we analyzed the total technical efficiency of the Turkish commercial banks during the period December 2001 and September 2015. Our sample on the average include 90% of the total assets in the Turkish banking system. We employed data envelopment analysis (DEA), a non-parametric approach, to measure the efficiency by following intermediation approach for selecting the input and output mix. Later, we provided evidence on the possible improvements to attain the full efficiency for the inefficient banks.

The results of the study indicate that the overall technical efficiency scores for both panel A and B in the Turkish commercial banking sector has improved during the years 2004 and 2007. This is the period where consolidation and restructuring program was introduced. Later 2008, the efficiency of the commercial banking sector in Turkey has deteriorated. The decreases in the efficiency of commercial banks could result from strict regulatory rules imposed by Banking Regulation and Supervision Agency (BRSA) (Fukuyama & Matousek, 2011).

Second state banks are found more technical efficient than foreign and domestic banks contrary to the international literature. The majority of empirical findings in the efficiency studies Yolalan (1996), Isik and Hassan (2002) and El-Gamal and Inanoglu (2005) indicate that foreign banks are more efficient than domestic peers. Remarkably, we found domestic

banks (including state-owned and private banks) more efficient than foreign and domestic banks.

4 THE DETERMINANTS OF CREDIT RISK IN TURKISH COMMERCIAL BANKING

4.1 Introduction

The aim of this chapter is to examine the bank-specific and macroeconomic determinants of credit risk (i.e., non-performing loans) in the Turkish commercial banking sector by using quarterly data over the period 2002 and 2015. Credit risk in banking refers to the risk that a borrower will default on any type of debt by failing to make required payments (Principles for the Management of Credit Risk, 2000). The role of increasing level of credit risk (i.e., non-performing loans) on the recent global financial crisis was enormous. High rates of defaults on the mortgage loans in 2006 and 2007 caused a collapse in the mortgage-backed security market. The collapse set off a chain of events resulting in the most severe international financial crisis since the Great Depression (Lang & Jagtiani, 2010).

The rapid growth in commercial and consumer credit markets in the last decade in Turkey has also raised some concern about the level of non-performing loans in the banking sector. The recent data show that the degree of non-performing loans in the Turkish banking sector increased considerably during the time period between 2011 and 2015. The ratio of nonperforming loans to gross domestic product (GDP) has increased from 1.44 % in 2011 to 2.42 % in 2015. Likewise, the ratio of non-performing loans to total loans in the Turkish banking sector has increased recently. The ratio was recorded 2.71 % in 2011 and increased to 3.17 % in 2015.

The level of credit risk (i.e., non-performing loans) in commercial banks could originate from different factors. On the one hand, external sources such as macroeconomic environment, changes on the borrower's ability to service their debt and natural disasters might influence the level of default rates in a loan portfolio. On the other hand, internal factors, which arises directly from the lenders, might affect the degree of default risk. In this study we analyze how both bank-specific and macroeconomic factors impact the level of credit risk in Turkish commercial banking sector. The time period includes the last quarter in 2002 and the third quarter in 2015. This time period covers the late post-crises (the twin crises) period and the global financial crises. The sample data includes the 23 commercial banks that include 95 % of the commercial banking sector during the sample period. We used the ratio of non-performing loan total loans as an indicator of credit risk. The set of internal (bank specific) factors are technical efficiency scores, growth rate of loans,

profitability, capital structure, size, and non-interest income. The macroeconomic factors are the growth rate of gross domestic products (GDP), unemployment rate, interest rates, inflation, stock market index and exchange rates. We employed traditional panel data approach (fixed affect and random affect) to estimate the level of non-performing loans. The result of the study indicate that both internal and external factors can have significant impact on the credit risk in Turkish commercial banks.

The remaining part of this chapter is organized as follow. Section 4.2 provides a summary on previous studies in the determinants of credit risk in Turkish banking sector. Section 4.3 presents a brief overview of Turkish banking system from early 1980s and until late 2015. Section 4.4 describes the methodology and data. Section 4.5 provides the empirical results and finally, we discuss the results and some policy implications in the next chapter.

4.2 Previous Studies in Determinants of Credit Risk in Turkish Banking Sector.

The empirical literature on the determinants of credit risk in the banking literature has developed as two separate paths. The first path of the studies tries to explain the determinants of credit risk with external factors (macroeconomic and political and borrower-specific) where the second paths of the studies analyze it with internal (bank-specific) factors. There are also recent studies that use both variables to explain the determinants of credit risk. Here, we will review the studies on the determinants of credit risk for Turkish banking sector. We first outline the studies that explain the default risk through external factors, the second category presents the studies that use internal (bank-level) factors and the third group includes studies that use both factors to examine the determinants of credit risk for Turkish banking industry[10].

Karabulut et al. (2007) examined the impact of the unlimited deposit insurance on credit risk and market discipline for the Turkish banking system during the period 1987 and 2002. The authors used non-performing loans as a measure of credit risk and employed ordinary least square (OLS) technique. The findings of Karabulut et al. (2007) show that there is a strong structural change in non-performing loans in 1994 where the full coverage deposit insurance system was introduced. The result of the study indicate that unlimited deposit insurance system of Turkey triggered non-performing loans (NPL) by damaging efficiency of

[10] Possibly there are further studies in the literature that examine the determinants of credit risk of Turkish financial institutions. We were able to include studies that were available we are sorry from those authors that we missed.

allocation of deposits. With this new legal framework of deposit insurance, insolvency risk of a bank became less important for depositors since full coverage exists (Karabulut & Bilgin, 2007).

Cifter et al. (2009) examined the relationship between sectoral credit default cycle and industrial production over the period January 2001 and November 2007 in Turkey. The authors used the non-performing loans ratio (non-performing loans / (performing + nonperforming loans) as the sectoral default cycle. By employing wavelet (neural) network method, they found that industrial production cycle affects the sectoral credit default cycle at different time scale. In addition, the results of the study show that three sectors' default cycles, leather and leather products, textile, and hotel and restaurants are affected by industrial production cycle between 2–8 months later where agriculture's default cycle is affected 16 months later and construction sector's default cycle is affected 32–64 months later (Cifter, Yilmazer, & Cifter, 2009).

Altıntaş (2012) investigated the determinants credit risk of Turkish banking sector by using macroeconomic factors over the period 2003 and 2012. The author used non-performing loans for different sectors as the dependent variable and growth rate of real gross domestic product (GDP), interest rates, inflation rate, exchange rates, unemployment rate and money supply are the independent variables. By using the Credit Portfolio View approach developed by Thompson Wilson in 1997 and vector auto regressive (VAR) model Altıntaş estimated level of credit risk and applied the stress test for Turkish banking sector. The author found significant relationship between macroeconomic factors and credit risk in Turkish banking sector (Altıntaş A. , 2012).

Eren (2013) examined the dynamic relationship between Turkish banking sector's non-performing loans (NPL) and the macroeconomic indicators during the period of 2004-2010 by using vector autoregressive (VAR) methodology. The author used the following variables; Non-performing loans to total banking sector loans ratio, real effective exchange rate, gross domestic product, nominal interest rates, consumer price index and foreign trade import volume index. All of the variables in the sample consist of quarterly data. The findings of the study suggests that it takes at least 8 quarters to see the impact of unexpected changes in the gross domestic product growth rate, the real exchange rate, and the import volume on the non-performing loans while unexpected changes in the nominal interest rate (the policy rate) impact the non-performing loans within six quarters. In addition, the author

found that solely based on macroeconomic indicators, may not give sufficiently early warning signals about the potential upcoming credit crisis and that most powerful predictor of the banking sector non-performing loan ratio is the previous values of the ratio itself (Eren, 2103)

Yurdakul (2014) investigated the macroeconomic determinants of credit risk over the period 1998 and 2013 with monthly data. The author used the aggregate level of non-performing loans that represent the credit risk and included the following macroeconomic variables; inflation rate, GDP growth rate, exchange rate, stock market index (BIST-100), unemployment rate, nominal deposit interest rates and percentage change in MS money supply. By employing two methods namely Engle-Granger (1987) and Gregory Hansen (1996) Yurdakul found that an increase in money supply, exchange rate, unemployment rate, inflation rate and interest rates increases bank's non-performing loans as well as credit risk. Contrary to the previous variables, ISE index is found to have negative influence in non-performing loans (Yurdakul, 2014).

Masood et al. (2010) comparatively analyzed factors that explain the non-performing loans in Turkey and Pakistan using bank level data. The authors conducted survey (face to face interview with credit managers) method and applied ordered probit model. All explanatory and dependent variables are obtained from the survey. The findings of the authors for the Turkish banking industry indicate that government intervention is the major determinants of non-performing loans and the loans that are granted for insiders or insider connected firms are poorly significant determinant of non-performing loans. Their results also show loans that are poorly evaluated and weak capital structure influence the non-performing loans. Finally they conclude that loans often made using personal judgement rather than specialized lending techniques (Masood, Bellalah, Mansour, & Teulon, 2010).

Vatansever and Hepşen (2013), examined whether there is a significant relationship between macroeconomic indicators, bank-level factors and non-performing loan ratio in Turkey over the period 2007 and 2013. The authors used ordinary least square estimation approach with cointegration analysis namely Engle-Granger (EG) or Augmented Engle-Granger (AEG) test and Cointegrating Regression Durbin Watson (CRDW). The bank level factor are inefficiency, debt ratio, profitability, loans to total assets ratio, and capital adequacy ratio. The macroeconomic variables can be summarized as follows: Confidence Index-Real Sector, Consumer Price Index, Exchange rates (both for USD and EURO), Industrial Production

Index, Istanbul Stock Exchange100 Index, M3Y Money Supply Change, Unemployment Rate, Interest Rate and Gross National Product Growth. The authors also included two global factors, the Euro Zone's GDP growth rate and volatility of the Standard & Poor's 500 Stock Market Index, in to the analysis. The empirical findings show that that debt ratio, loan to asset ratio, confidence index-real sector, consumer price index, EURO/ Turkish lira rate, USD/ Turkish lira rate, money supply change, interest rate, GDP growth, the Euro Zone's GDP growth and volatility of the Standard & Poor's 500 stock market index are insignificant to explain non-performing loans on multivariate perspective. On the other hand, industrial production index (IPI), Istanbul Stock Exchange 100 Index, Inefficiency ratio of all banks negatively, Unemployment rate, return on equity, capital adequacy ratio positively affect NPL ratio in Turkish banking sector (Vatansever & Hepşen, 2013).

What this study contributes to the credit risk literature is that first it examines determinants of credit risk with bank-specific factors for Turkish commercial banks. As summarized above, there are considerable amount of study that analyze the determinants of credit risk using macroeconomic factors. However, to the best of our knowledge, there are limited studies in the literature that analyze the determinants of credit risk in Turkish banking sector by using bank-level data. Işık and Hassan (2003) examined the different types of efficiency measures in Turkish banking sector and investigated the factors that determine the level of efficiency. They used non-performing loans as a variable that is expected to effect the efficiency level in the banks. In this study we the use the efficiency (technical efficiency) as an independent variable that effect the level of credit risk in Turkish commercial banks. Setiwan et al. (2013) also investigated the inter-temporal relationships between bank efficiency and problem loans both for conventional and Islamic banks in the Organization of Islamic Cooperation (including Turkey) during the period 1993 and 2007. The authors examined the bank efficiency and risk for whole sample including 25 different countries (Setiwan, Hassan, Hassan, & Mohamad, 2013). We investigate the same topic solely for Turkey by adding some country-specific and bank-specific variables in to our study.

Second, as seen on the literature the majority of the studies use aggregated data and employ time series methods (VAR, SVAR etc.) to examine the macroeconomic determinants of credit risk. Based on our comprehensive literature review we could not find any study that examine the level of credit risk using bank-level panel data. Thus, in order to fill the gap, in

this study we use macroeconomic variables with bank-level data rather than applying time series approach to explain the changes in the credit risk Turkish banks.

4.3 Overview of Turkish Banking System

In order to analyze the determinants of non-performing loans in Turkish banking thoroughly it will be helpful to have a general overview on Turkish banking system. The milestone developments in Turkish economy as well as in Turkish banking system took place in 1980s where the financial liberalization and deregulation was achieved. The initial reforms began in 1981 when controls on interest rates were removed. In 1984 foreign exchange trade was relaxed. In 1986 Istanbul Stock Exchange was reopened. In 1987 the central bank began open market operations. The benchmark date for financial liberalization is 1989 when controls on capital movements were removed entirely and Turkish currency became convertible (Arin, 1998). After the financial liberalization in late 1980s both Turkish economy and banking sector strongly incorporated with global financial system.

Although one of the main purpose of financial liberalization was to promote savings and channelize them to real investment, in the short-term it caused speculative trading in Turkish financial markets. As a result, the fragility of the Turkish financial system as well as economy had increased (Savrul, Ozekicioglu, & Ozel, 2013).

When it comes to 1994, one of the major financial crisis, *the currency crisis*, erupted in Turkish banking system and adversely affected the whole economy. The Turkish Lira devaluated by almost 70 percent against the US dollar in the first quarter of 1994 and the operations of 3 banks that have excessive foreign exchange open position were cancelled. The Central Bank seriously intervened in the foreign exchange market, and as a result, lost more than half of its foreign reserves. Overnight interest rates jumped to the unprecedented level, such as 700 percent, which was around 70 percent before the crisis. The economic growth (GDP) declined by 6 percent (Ozatay, 2000). The recovery plan was implemented after the crisis and towards end of the 1990s the Turkish banking sector had rapidly developed and total number of commercial banks increased from 55 in 1995 to 61 in 1999.

In late 2000 and early 2001, Turkish banking sector experienced another financial crisis that is also called *twin crisis.* The main reasons behind the crisis were deteriorating economic conditions, heavy reliance on short-term financing, fragile and weakly regulated banking system and political instabilities. The first turmoil had started with liquidity shortage in the banking sector and peaked with the second crisis due to political dispute in February 2001.

The consequences of the crisis on the Turkish banking system were catastrophic. The total assets of the banking sector decreased by almost half and interbank over-night interest rates in Turkey increased to 7.000%. Banks that had a maturity mismatch position incurred immense losses and market value of their securities declined enormously (Celik, Kaplan, & Sahin, 2015). Immediately after the twin crisis a comprehensive restructuring program was implemented by Banking Regulation and Supervision Agency (BRSA) for sound and stable banking system. Under this program state banks were privatized. The capital adequacy ratio of Turkish banks increased to 12% while Basel required 8%. The debt of private sector specifically 6 billion dollars of corporate loans was extended. Improvements in the Turkish banking system and economy became effective hence total assets along with total loans increased rapidly.

4.4 Methodology and Data

Data Description:

We obtained the data from various sources. The bank specific data is obtained from Banks Association of Turkey (BAT). Banks Association of Turkey (BAT) online present the independent audit reports, financial statements, financial ratios, surveys and other fundamental information related to banking sector in Turkey. We gathered the macroeconomic data from Central Bank of Turkey (CBT) and Organization for Economic Cooperation and Development (OECD). In this study, the sample consists of 26 commercial banks which in average constitutes the 90% (ranked by total assets) of the total banking sector between 2002 and 2015.[11] We included 23 banks in to the analysis due to availability and consistency of data. The definition of each hypotheses to be tested as well as the related variables are provided below.

We use non-performing loans (NPL) as the measure of the credit risk.[12] The ratio of non-performing loans to the total loans will be used as a dependent variable in the study. According to the banking regulation in Turkey banks, including their overseas branches, have to classify and monitor their loans and other receivables in five different groups based

[11] The rest of the sector consists of development, investment banking (4%) and participation (interest-free) banking which comprise the 5.5% of the total banking sector.

[12] The other type of variables that can be used as a proxy for credit risk are the EDF and the ratio of loan loss provision. Expected Default Frequency (EDF) is a forward-looking measure calculated by Moody's KMV for each firm (bank) for 1 and 5 years. The ratio of loan loss provision is a backward-looking measure and calculated by dividing total loan loss provision by total loans.

on respective recovery capabilities and debtor's creditworthiness levels (Resmi Gazete, 2006).

The first group of loans is *standard loans and other receivables*. In this group the payments of the loans are made on terms, no repayment problems are expected in the future and all receivables are totally collectable. The second group loans are classified as *loans and other receivables under close monitoring*. The repayment of the loans in the second group is highly likely but also the collection of capital and interest payments is delayed for more than thirty days (up to 90 days) as of the day of their payment dates for several reasons. The loans in the first and second group is also called performing loans and banks must allocate provision of 1 % for standard loans and 2 % for loans under close monitoring. The provision rate for the non-cash loans (banks acceptance, letter of credit etc.) for each type is 0.2 % and 0.4 % respectively.

Loans and other receivables with limited recovery is the third type of loans based on asset quality classification. In this group, the payment of principal and interest or both are passed due more than ninety (90) days but no more than 180 days. The fourth type of loans includes the *doubtful loans and other receivables*. These repayments loans are due for one hundred eighty (180) days but not longer than one (1) year. *Loans and other receivables at loss* is the last group. The principal and interest payment of these loans are unpaid for more than one (1) year. All the loans classified in the group of 3, 4 and 5 are considered as non-performing loans which either principal or interest or both have not been repaid at least ninety (90) days. Banks must allocate *special provision* for the non-performing loans. The rate of special provision for non-performing loans depends on the number of days (term) which the loan is outstanding as unpaid. As presented in Table 9, banks must allocate 20% provision for the loans and other receivables with limited recovery. For the 4^{th} and 5^{th} group of loans (loans that have outstanding balance more than180 days and 1 year) banks required to allocate 50 % and 100 % provision respectively.

Table 9: Loan loss provision rates (special provision) for non-performing loans.

Loan Type	Loan Loss Provision
Loans and other receivables with limited recovery.	20 %
Doubtful loans and other receivables.	50 %
Loans and other receivables at loss.	100 %

The higher a bank incurs non-performing loans the higher a bank have realized credit risk as well as the lower asset quality. The ratio of non-performing loans (NPL) to total loans for Turkish banking sector between 2002 and 2015 is provided in Table 10. In accordance with, the average NPL to total loans ratio for state, domestic and foreign banks are recorded as 9.78 %, 4.09 %, and 4.10 % respectively. During the same period, the average NPL to total loans ratio for the Turkish commercial banking sector is recorded as 5.47 percent. The ratio is obviously very high for 2002 and 2003 compared to the other years. The reason for that because Turkey has faced a severe financial crisis (that is also known as twin crisis) and it negatively affected the credit portfolio of the commercial banking sector. In addition, the global financial crisis (GFC) also adversely affected the financial system in Turkey. As seen on the table the ratio of non-performing loans increased considerably in 2009 where the effects of crisis has felt deeply.

Table 10: Ratio of non-performing loans to total loans in Turkish commercial banking.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
State Banks	48.57	33.77	11.12	7.97	5.11	4.06	3.80	4.47	3.33	2.53	3.28	2.90	3.12	2.84
Domestic Banks	9.06	6.81	5.04	4.18	3.59	3.60	3.49	5.39	3.31	2.38	2.24	2.27	2.93	2.90
Foreign Banks	4.03	2.77	2.58	3.68	2.67	2.82	4.07	7.86	6.15	4.38	4.90	4.34	3.48	3.73
Turkish Banking Sector	18.50	12.33	6.16	4.90	3.75	3.50	3.60	5.43	3.71	2.67	2.85	2.69	3.19	3.25

The bank-specific factors that can influence the non-performing loans are indicated as follows. Berger and De Young (1997) examine the relationship between non-performing and cost efficiency through bad management, skimping and moral hazard hypotheses and we initially refer to their study for investigating the determinants of credit risk.

Bad Management Hypothesis: According to this hypothesis banks operating with low levels of efficiency have higher costs mostly due to insufficient credit scoring, monitoring, and inadequate control of operating expenses. Because of the credit, operational, market and reputational problems, declines in efficiency will temporarily lead to increases in banks non-performing loans (Tan & Floros, 2013). The hypothesis is tested with the technical efficiency scores of commercial banks in the sample which is measured by employing efficiency frontier approach. In chapter 3, we used data envelopment analysis (DEA) to measure the

technical efficiency of each bank during the period of 2002 fourth quarter and 2015 third quarter. We used technical efficiency scores because poor management is the chief source of technical inefficiency or vice versa (Isık & Hassan, 2003)[13]. Thus the efficiency scores (EFFA and EFFB) in chapter 3 for each bank also reflects the quality of banks' management over the period 2002 and 2015. We expect negative relationship between non-performing loans and technical efficiency scores.

In addition to the technical efficiency scores, we use profitability in banks as a proxy for efficiency. The main intuition behind that is because performance of banks regarded as an indicator quality of management. Accordingly, higher performance, (i.e., returns) indicates superior management quality. Demir et al. (2005) found that that banks with higher rates of profitability are also more efficient, implying that profitability can be compatible with technical efficiency. Therefore we also test the bad management hypothesis with financial ratio of return on equity (ROE) and expect negative relationship between performance and non-performing loans.

Skimping Hypothesis: The hypothesis explains the relationship between efficiency and risk by examining short-term operating cost and future loan performance problem. Accordingly, a bank targeting to maximize the profitability in the long-run may choose to lower cost in the short run by skimping (saving) on the resources allocated to underwriting and monitoring loans, but accept the consequences of greater loan performance problems and possible costs of dealing with these problems in the future (Berger & DeYoung, 1997). Thus under skimping hypothesis there is a positive relationship between non-performing loans and lagged technical efficiency scores ($EFFA_{t-1, t-2, t-3, t-4}$) ($EFFB_{t-1, t-2, t-3, t-4}$) and performance ($ROE_{t-1, t-2, t-3, t-4}$).

Moral Hazard Hypothesis: The moral hazard problem exists (occurs) between bank managers and owners (i.e. shareholders). Accordingly, managers are likely to take more risk if the risk entirely borne by the shareholders. In other words, bank managers have incentives to take on more risk especially if the level of bank capital is decreasing (Fiordelisi, Marques-Ibanez, & Molyneux, 2011). In this hypothesis it is assumed that there is a negative

[13] According to Isik and Hassan (2003), although the main source of technical inefficiency is the poor quality of management, the major causes of the allocative inefficiency is the weak regulation. The combination of both efficiencies gives the cost efficiency which is also known as X-inefficiency.

relationship between bank capital level (CAPITAL) and non-performing loans. The bank capital is (CAPITAL) proxied by total equity to total assets ratio.

In addition to these hypotheses developed by Berger and De Young, the other bank-specific factors and several control variables that may affect the non-performing loans are added to the model as follows;

Diversification Hypothesis: As a primary financial theory, diversification reduces the unsystematic (firm specific) risk and larger banks are usually expected to hold more diversified loan portfolio. The empirical findings that examine the relationship between income diversification and risk have mixed results. For example, Saunders and Walters (1994) reviewed the 18 studies that investigate whether nonbank activities decrease banks' risk, and found that 9 answer yes, 6 answer no, and 3 provide mixed results. (Stiroh, 2002) Further studies also indicated that bank size presents an advantage in diversification because large banks can diversify by industry as well as region (Demsetz & Strahab, 1995). So in this hypothesis we assume that there is negative relationship between bank size (SIZE), which is proxied by share of each bank's total assets in the banking system. Diversification opportunities can also be measured by non-interest income (NIN) as a share of total income which implies the bank's ability to generate more diverse income rather than interest income (Louzis, Vouldis, & Metaxas, 2012). So the hypothesis will also be tested with the ratio of non-interest income (NIN) to total income ratio.

The growth of loans: Here we will measure whether or not the growth of loan portfolio over total assets has any influence on the credit risk in the commercial banking sector in Turkey. This is a specific and important issue for the Turkish banking sector because, the commercial and consumer credit markets in Turkey have grown very rapidly over the last decade. According to the data of the Banks Association of Turkey (BAT), the compounded annual growth rate of the total loans made by commercial banks between 2002 and 2015 was recorded as 30.94 %. During the same period, total assets of the banking sector have grown only by 19.37 % annually. In other words, as illustrated on the Figure 3, the share of total loans in total assets in the Turkish commercial banking sector increased from 19.78 % in 2002 to 72.21 % in 2015[14]. In order to examine impact of the growth of loans on the credit

[14] The main reason behind the high rise in loan market, that was higher than the growth rate of total assets, was mostly due to decreases in crowding out effect in the banking system. The commercial banking sector in Turkey before 2000s was predominantly funding the government budget deficit by investing in T-bill and Notes and

risk in the Turkish commercial banking sector we used the ratio of total loans to total assets (LOANS).

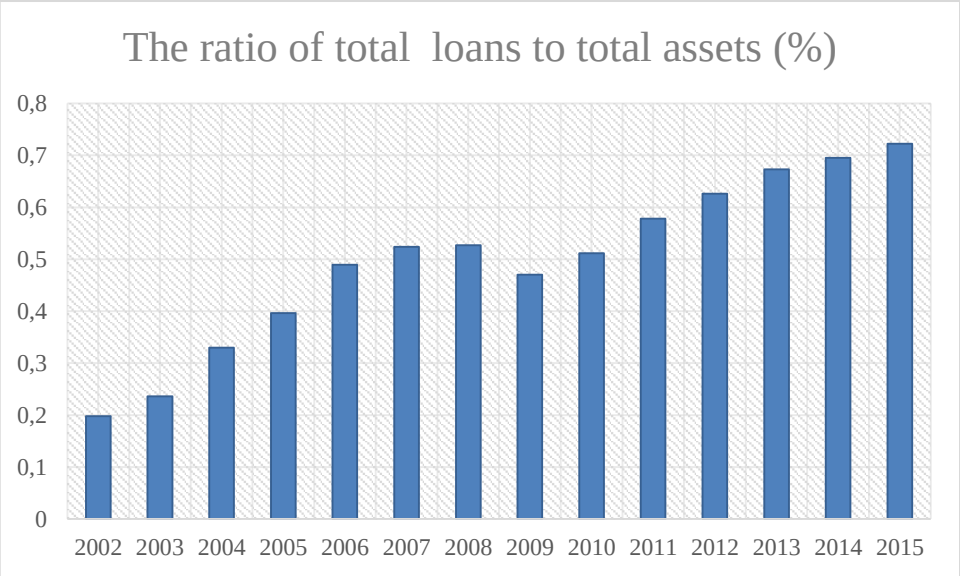

Figure 3: The ratio of total loans to total assets in Turkish commercial banking sector.

Type of lender: Type of lender is also assumed to be effective on the level of non-performing loans. We used dummy variable and assigned 1 if the bank is owned by the state (STATEBANK) and 0 if it is privately held. We expect positive relationship between non-performing loans and state banks (STATEBANK) because the decision making in the state banks highly influenced by political factors (Ozkan-Gunay & Tektas, 2006).

The crisis period: As indicated in section 3.3 over the last decade there was a major financial crisis (global financial crises) in Turkish economy as well as in the banking system. To investigate the effects of crises period on non-performing loans we assigned dummy 1 (Y2009) for 2009. Although the global financial crises was in 2008 the major impact of the crises was felt in Turkey in 2009. Since during the deteriorating economic conditions borrowers feel more difficulties to pay their loans, we expect positive effect of the year 2009 on the level of non-performing loans. The definition of each bank-specific variables and their expected sign are given in Table 11.

receding from its fundamental financial intermediation function (BRSA, 2010). The financial and economic reforms along with structural improvements in early 2000s resulted in banking sector to channel the funds to finance public spending and real investment.

Table 11: Definition of bank-specific variables and expected sign used to test the various hypotheses.

Variables	Definition	Expected Sign
Credit Risk	Total non-performing loans $_{(it)}$ / Total Loans $_{(it)}$	NA
Bad Management	Technical efficiency scores of each bank measured by DEA using non-interest income and interest income as output items (EFFA).	(-)
	Technical efficiency scores of each bank measured by DEA using deposits, loans and securities as output items (EFFB).	(-)
	ROE -Net Income$_{(it)}$ / Total Equity$_{(it)}$	(-)
Skimping	Lagged technical efficiency scores of each bank measured by DEA	(+)
	ROE -Net Income / Total Equity	(+)
Moral Hazard	Total Equity$_{(it)}$ / Total Assets$_{(it)}$	(-)
Diversification	Total Assets$_{(it)}$ / Total Assets $_{(Turkish\ Banking,\ t)}$	(-)
	Non-interest income$_{(it)}$ / Total Income$_{(it)}$	(-)
Loans	Total Loans$_{(it)}$ / Total Assets$_{(it)}$	(-/+)
Type of Lender	Dummy 1 for state-owned banks , 0 for other banks	(+)
The Crisis Period	Dummy 1 for year 2009, 0 for other years	(+)

So far, we described the bank-specific variables and the related hypotheses including the expected sign for each variable. We also aim to examine how macroeconomic environment could affect the credit risk in commercial banks. For this purpose, the macroeconomic variables and their expected impact on the level of non-performing loans summarized as follows:

Business Cycle (State of the Economy): The position of the economy in the business cycle phase is enormously important to a financial institution in assessing the probability of borrower default. The majority studies found negative relationship between credit risk and economic growth (Beck, Jakubik, & Piloiu, 2013). We used the GDP (during the period, Q1 2003 – Q3 2015) as a proxy for the business cycle and expect negative relationship between credit risk and economic growth. This indicator is seasonally adjusted and it is measured in percentage change from previous quarter and from same quarter previous year (OECD, 2016).

Unemployment: The unemployment rate also effect the level of non-performing loans in commercial banks. An increase in the unemployment rate influence the level of non-performing negatively since the cash flow to the households (individuals) decreases. With

regards to firms, increases in unemployment may signal a decrease in production as a consequences of drop in effective demand. All those cause to a decrease in revenues and increase in debt burden (Castro, 2013). The unemployment was proxied by the quarterly unemployment rate for Turkey during the period, Q1 2003 – Q3 2015 and we assume positive link between credit risk and unemployment. The Figure 4 below illustrates percentage change in GDP and Unemployment rate in Turkey between March 2003 and September 2015[15].

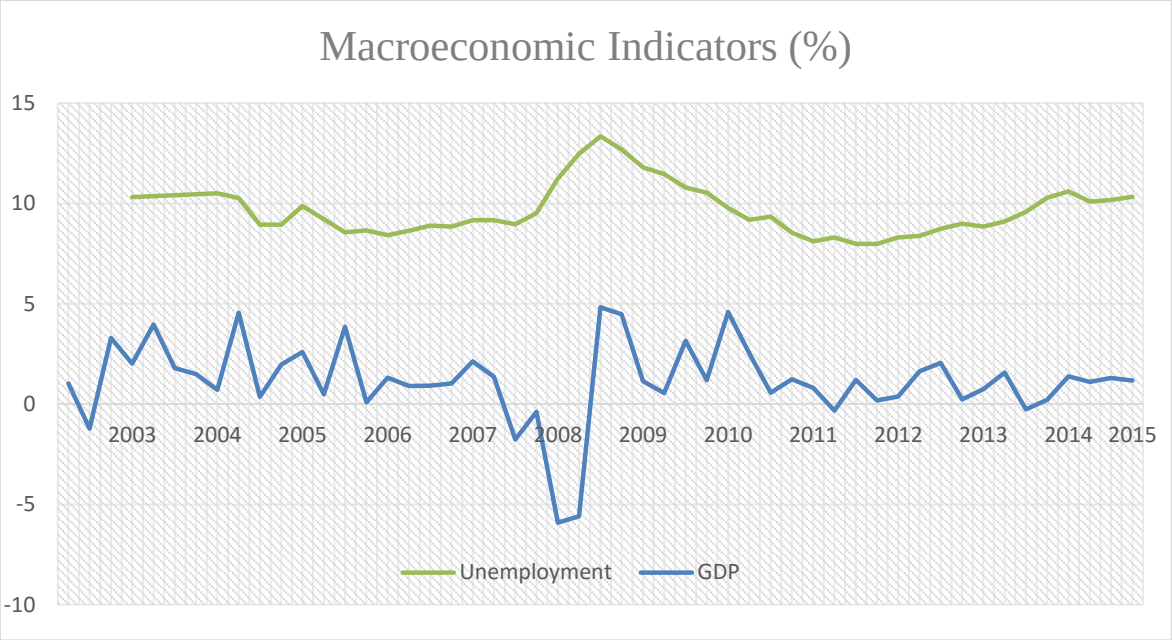

Figure 4: Macroeconomic indicators in Turkey between 2003 and 2015.

Interest rates: The lending rates may also affect the level credit risk in the banking sector. High interest rates indicate restrictive monetary policy actions by the central banks. Financial institutions not only find funds to finance their lending decision scarcer and more expensive but also must recognize that high interest rates are correlated with higher credit risk in general since the higher cost of debt worsen the financial situation of debtors (Caporale, Colli, & Lopez, 2014). High interest rate levels may also encourage borrowers to take excessive risk and or encourage only the most risky customers (Saunders & Cornett, Financial Institutions Management, 2011). We expect positive relationship between interest rates and credit risk.

[15] Unemployment rate is the number of unemployed people as a percentage of the labor force, where the latter consists of the unemployed plus those in paid or self-employment.

To test the effect of the interest rates on the credit risk we used average nominal interest rates charged for consumer or individual (IRI) and commercial (corporate) borrowers (IRC) respectively. The interest rates for individual borrowers include the rates charged for car, mortgage and consumer loans. The interest rates for commercial loans include the weighted average annual rates charged for firms. The figure below demonstrates the nominal interest rates both for consumer and commercial loans during the sample period. As seen from the figure below, the interest rates for bank loans decreased radically from 55-60 % in early 2003s to 15 % in 2015. Obviously, the commercial loan rates are recorded lower than consumer loan rates.

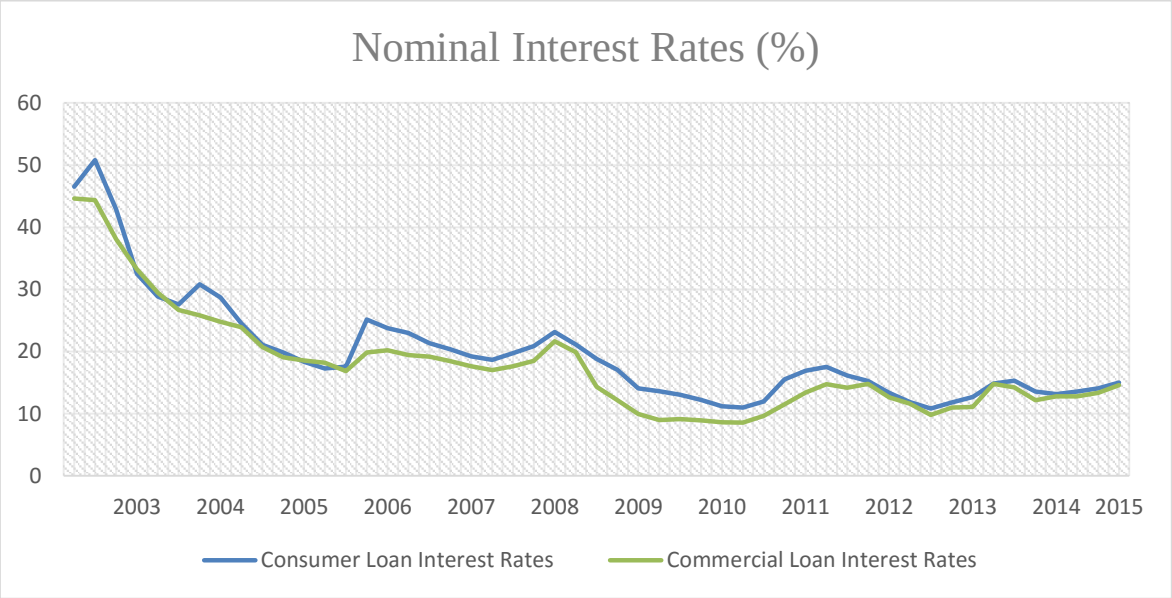

Figure 5: Consumer and commercial loan interest rates in Turkish deposit banks between 2003q1 and 2015q3.

Inflation: Price stability is another factor that might be effective on the level credit risk. The views in the effect of inflation on the credit risk is not straight forward. On the one hand it is argued that the increase in overall price of services and goods may weaken borrower's ability to service debt by reducing their real income. On the other it is assumed that inflation might can make debt servicing easier by reducing the real value of outstanding loans. Thus, the relationship between inflation and credit risk can be in both directions (Castro, 2013). Inflation measured by consumer price index (CPI) based on the quarterly price changes.

Stock market index: The stock market also may affect the credit risk. In general the growth of the stock indexes indicates improvements in the current and future conditions of the listed companies even including the companies are not listed on the index (Caporale, Colli, &

Lopez, 2014). In other word, the increase in overall prices of stocks in the market is usually regarded as a positive sign for the economy's itself and it may contribute a reduction in the credit defaults. Therefore there is usually negative relationship between increase in stock market index (i.e., increase in share prices of major firms in the economy) and credit risk (Castro, 2013). The quarterly percentage return on the BIST 100 index, which is a capitalization-weighted index composed of national market companies except investment trusts, is employed as an indicator of the stock market in Turkey. The quarterly price changes in inflation (CPI) and stock market (BIST100) are given in the Figure 6.

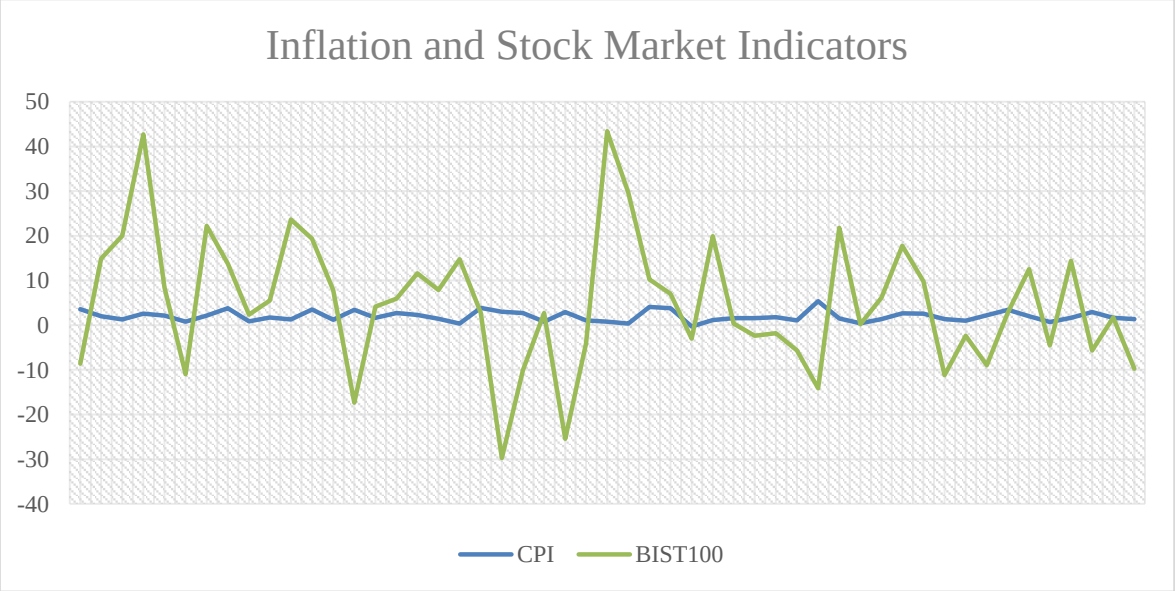

Figure 6: Percentage changes in CPI and BIST100 index in Turkey between 2003q1 and 2015q3.

Exchange rate: Exchange rate is defined as the prices of a nation's home currency against the foreign currency and it might affect the level of the credit risk in banks. On the one hand, depreciation in foreign currency might increase the level of non-performing loans in banks. For example, when the value of home currency increases against the foreign currency (i.e., home currency appreciates) the price of the goods and services becomes more expensive for the importer in other countries. This decreases the demand for the home products and services and unfavorably affect the competitiveness of the local export-oriented firms. All these adverse conditions reduce the ability of debt servicing of the firms (Nkusu, 2011) (Castro, 2013). On the other hand, the falling foreign currency prices can decrease the default rates on the foreign currency dominated loans. In Turkish commercial banking system foreign currency dominated loans roughly accounts 30 % of the total loans. Thus the effect

of the exchange rates on the non-performing loans can be both directions. We use the quarterly price changes per 1 USD and EURO against the Turkish Lira. The Figure 7 illustrates the percentage changes in foreign currency during the sample period.

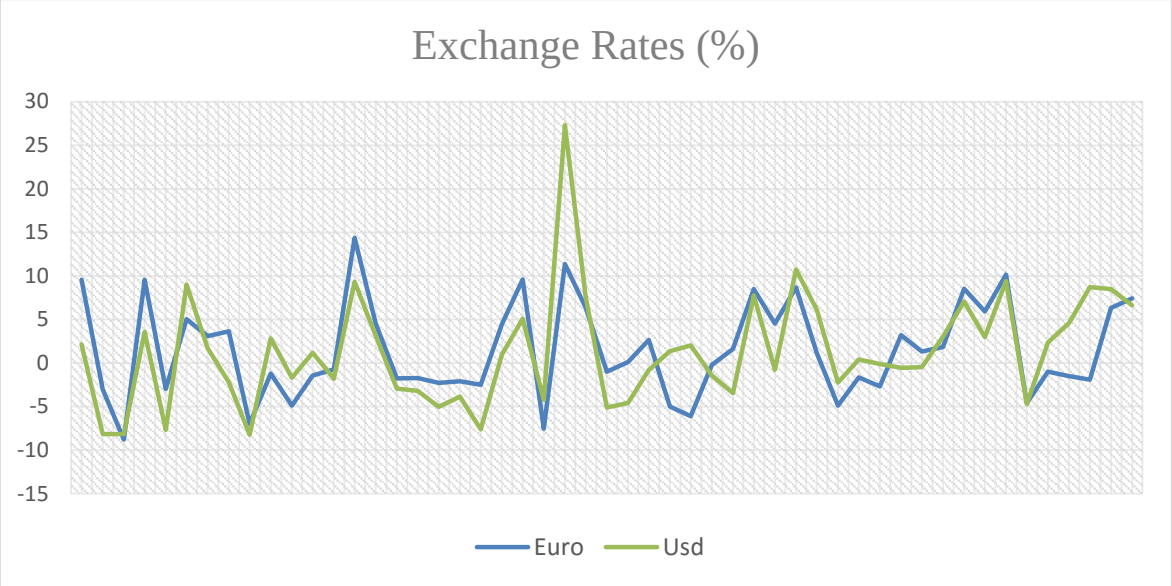

Figure 7: Percentage changes in foreign currency rates between 2003q1 and 2015q3.

The definition of each macroeconomic variable and their expected sign on the credit risk is summarized in the table below.

Table 12: Definition of macroeconomic variables and expected sign on the non-performing loans.

Variables	Definition	Expected Sign
Business cycle	Growth rate of gross domestic product (GDP) $_{(t)}$	(-)
Unemployment	Quarterly unemployment rate $_{(t)}$	(+)
Interest rates	Weighted average nominal interest rates for consumer and commercial loans $_{(t)}$	(+)
Inflation	Consumer price index$_{(t)}$	(+)/(-)
Stock market index	Quarterly return on the BIST 100 index $_{(t)}$	(-)
Exchange rate	Quarterly price changes per 1 USD$_{(t)}$ and EURO$_{(t)}$	(+)/(-)

Table 13 provides the information about the descriptive statistics for bank-specific and macroeconomic variables during the sample period. We have 1124 total number of observations in the sample for bank specific variables. All bank-specific variables (including ratios and efficiency scores) take value between 0 and 1. The proxy variables for profitability (ROE) and diversification (NIN) variables may also take negative values for some banks.

As seen from the table, the average technical efficiency scores both for EFFB and EEFA are recorded as 0.85301 and 0.86438 respectively.

Macroeconomic variables below are given as ratio and percentage change. Except UNEMPLOYMENT and interest rates (both IRI and IRC) all other macroeconomic variables, (GDP, CPI, BIST100 USD and EURO) presents the percentage changes in respect to the previous quarter. The stock market index (BIST-100) has the highest volatility rate (standard deviation 14.45) compared to the other macroeconomic indicators.

Table 13: Descriptive statistics of the bank-specific and macroeconomic variables.

	Obs.	Mean	Std. Dev.	Min	Max
NPL	1124	0.04831	0.05547	0.00000	0.51894
Bank-Specific Variables:					
EFFB	1124	0.85301	0.14444	0.36740	1.00000
EFFA	1124	0.86438	0.11733	0.45389	1.00000
ROE	1124	0.07491	0.07508	-0.39352	0.35268
CAPITAL	1124	0.12645	0.04198	0.03265	0.38751
LOANS	1124	0.52870	0.16471	0.03644	0.87841
NIN	1124	0.17268	0.08745	-0.14140	0.45039
SIZE	1124	0.04363	0.05122	0.00062	0.21469
Macroeconomic Variables:					
GDP	1112	1.151255	1.971799	-5.91428	4.82037
UNEMPLOYMENT	989	9.630323	1.26007	7.97748	13.34247
CPI	1112	1.973242	1.15842	-0.32761	5.35723
BIST100	1112	4.843885	14.44573	-29.75017	43.40945
IRI	1112	19.50445	8.445041	10.84385	50.79385
IRC	1112	17.47477	8.110629	8.53917	44.61154
EURO	1112	1.487854	5.412423	-8.78929	14.37845
USD	1112	1.363149	6.271554	-8.23238	27.31477

Correlation among the variables for bank-specific variables is provided in Table 14. Accordingly, the maximum correlation score (0.4845) for the bank-level variables is found between efficiency and profitability ratios. The rest of the correlation scores for this group of variables indicate that our empirical model does not seriously suffer from multicollinearity problem.

Table 14: Correlation matrix for the bank–specific variables.

	NPL	EFFB	EFFA	ROE	CAPITAL	LOANS	NIN	SIZE
NPL	1							
EFFB	-0.108	1						
EFFA	0.035	0.467	1					
ROE	0.008	0.218	0.484	1				
CAPITAL	0.100	0.017	0.128	-0.125	1			
LOANS	-0.420	-0.075	-0.149	-0.153	-0.196	1		
NIN	0.064	0.008	0.098	0.102	0.354	-0.204	1	
SIZE	0.081	0.337	0.355	0.405	-0.212	-0.190	0.046	1

Table 15 presents the correlation scores among the macroeconomic variables including non-performing loans. According to the scores on the table, there is no significant correlation between non-performing loans and all macroeconomic factors in the sample. There is however, quite higher negative correlation between USD and stock market indices (-0.535) and GDP (-0.485) compared to other variables. The correlation scores between USD and EURO and consumer and commercial interest rates are obviously found moderately high. To eliminate such multicollinearity problem we will use these variables separately while estimating the coefficients.

Table 15: Correlation matrix for the macroeconomic variables.

	NPL	GDP	UN	CPI	BIST100	IRI	IRC	EURO	USD
NPL	1								
GDP	0.091	1							
UN	0.204	0.020	1						
CPI	0.002	-0.111	-0.128	1					
BIST100	0.213	0.332	0.286	-0.188	1				
IRI	0.146	-0.167	0.063	0.132	0.252	1			
IRC	0.126	-0.194	-0.023	0.132	0.214	0.950	1		
EURO	-0.010	-0.212	-0.033	0.269	-0.368	-0.007	0.042	1	
USD	-0.050	-0.485	0.035	0.201	-0.535	-0.107	-0.045	0.696	1

After providing descriptive statistic and correlation scores among the variables we performed the unit root test both for bank-specific and macroeconomic variables. In order to test the unit root for bank-specific variables we use the Fisher type tests since our panels are unbalanced. Im–Pesaran–Shin (IPS) test is also applicable for the unbalanced panel data but the missing values within panel data does not allow to employ IPS test. Fisher-type test

performs either the Augmented Dickey–Fuller or Phillips–Perron unit-root tests. We selected the Fisher-type ADF test which perform a unit-root test on each panel's series separately, then combine the p-values to obtain an overall test of whether the panel series contains a unit root. The null hypothesis being tested by fisher-type ADF is that all panels contain a unit root whereas the alternative is that at least one panel is stationary. The panel unit root test results for bank-specific variables are given in the Table 16. The fisher-type ADF yields four different results namely; inverse chi-squared, inverse normal, inverse logit and modified inv. chi-squared. Choi (2001) recommends to use inverse normal (Z) statistics since it offers the best trade-off between size and power (Choi, 2001).

Table 16: Fisher-type ADF unit root test for bank-specific variables.

Variables		No Trend		Trend		Trend (Lag 1)	
		Statistic	p-value	Statistic	p-value	Statistic	p-value
NPL	Inv. chi-squared	237.8643	*0.0000*	108.0473	*0.0000*	108.4563	*0.0000*
	Inv. Normal	-7.2467	*0.0000*	-2.5228	*0.0058*	-3.7544	*0.0001*
	Inv. logit t	-12.1346	*0.0000*	-3.6675	*0.0002*	-4.7754	*0.0000*
	Mod. inv. chi-squared	20.0032	*0.0000*	6.4689	*0.0000*	6.5115	*0.0000*
EFFB	Inv. chi-squared	165.9286	*0.0000*	167.5934	*0.0000*	106.2287	*0.0000*
	Inv. Normal	-8.6072	*0.0000*	-8.8109	*0.0000*	-5.4102	*0.0000*
	Inv. logit t	-9.6957	*0.0000*	-9.8197	*0.0000*	-5.7119	*0.0000*
	Mod. inv. chi-squared	12.5034	*0.0000*	12.677	*0.0000*	6.2793	*0.0000*
EFFA	Inv. chi-squared	145.4078	*0.0000*	158.8244	*0.0000*	73.714	*0.0059*
	Inv. Normal	-7.5134	*0.0000*	-7.2064	*0.0000*	-3.0795	*0.0010*
	Inv. logit t	-8.155	*0.0000*	-8.8039	*0.0000*	-3.0156	*0.0016*
	Mod. inv. chi-squared	10.364	*0.0000*	11.7628	*0.0000*	2.8894	*0.0019*
ROE	Inv. chi-squared	576.7666	*0.0000*	584.3996	*0.0000*	572.8484	*0.0000*
	Inv. Normal	-19.3527	*0.0000*	-20.2	*0.0000*	-19.2674	*0.0000*
	Inv. logit t	-33.0193	*0.0000*	-33.7197	*0.0000*	-32.9386	*0.0000*
	Mod. inv. chi-squared	55.3362	*0.0000*	56.132	*0.0000*	54.9277	*0.0000*
CAPITAL	Inv. chi-squared	118.1553	*0.0000*	140.3835	*0.0000*	54.1864	*0.1905*
	Inv. Normal	-5.5547	*0.0000*	-3.873	*0.0001*	-1.3445	*0.0894*
	Inv. logit t	-5.9739	*0.0000*	-6.3372	*0.0000*	-1.2636	*0.1044*
	Mod. inv. chi-squared	7.5227	*0.0000*	9.8402	*0.0000*	0.8535	*0.1967*
LOANS	Inv. chi-squared	110.7398	*0.0000*	76.5152	*0.0031*	56.1615	*0.1449*
	Inv. Normal	-4.2525	*0.0000*	-1.3715	*0.0851*	-1.1355	*0.1281*
	Inv. logit t	-4.5625	*0.0000*	-1.7846	*0.0384*	-1.0869	*0.1396*
	Mod. inv. chi-squared	6.7496	*0.0000*	3.1814	*0.0007*	1.0594	*0.1447*
NIN	Inv. chi-squared	212.998	*0.0000*	231.3071	*0.0000*	151.3861	*0.0000*
	Inv. Normal	-9.9606	*0.0000*	-10.3323	*0.0000*	-7.1569	*0.0000*

	Inv. logit t	-11.9653	*0.0000*	-13.1145	*0.0000*	-8.0787	*0.0000*
	Mod. inv. chi-squared	17.4107	*0.0000*	19.3196	*0.0000*	10.9873	*0.0000*
SIZE	Inv. chi-squared	67.8883	*0.0195*	78.0506	*0.0022*	59.1797	*0.0919*
	Inv. Normal	-1.2779	*0.1007*	-1.2918	*0.0982*	-0.7535	*0.2256*
	Inv. logit t	-1.7115	*0.0448*	-1.664	*0.0494*	-0.8997	*0.1851*
	Mod. inv. chi-squared	2.282	*0.0112*	3.3415	*0.0004*	1.3741	*0.0847*

As seen from Table 16 all four of the tests strongly reject the null hypothesis (i.e., all the panels contain unit roots) for non-performing loans, (NPL), technical efficiency scores (EFFA and EFFB) return on assets (ROE) and non-interest income (NIN). The variables CAPITAL, LOANS and SIZE however, are not found stationary when we run the test with trend and Lag-1 option. To overcome the unit root problem in these variables we take first difference (Δ indicates the first difference operator) and perform for the panel unit root test again. As presented in Table 17 in all four test results we reject the null hypothesis for ΔCAPITAL, ΔLOANS and ΔSIZE variables.

Table 17: Fisher-type ADF unit root test for nonstationary bank-specific variables.

Variables		No Trend		Trend		Trend (Lag 1)	
		Statistic	p-value	Statistic	p-value	Statistic	p-value
ΔCAPITAL	Inv. chi-squared	992.687	*0.0000*	888.5169	*0.0000*	400.6767	*0.0000*
	Inv. Normal	-28.4546	*0.0000*	-26.5884	*0.0000*	-16.306	*0.0000*
	Inv. logit t	-57.3012	*0.0000*	-51.2863	*0.0000*	-23.0936	*0.0000*
	Mod. inv. chi-squared	98.6989	*0.0000*	87.8385	*0.0000*	36.9776	*0.0000*
ΔLOANS	Inv. chi-squared	966.2767	*0.0000*	921.6169	*0.0000*	398.9946	*0.0000*
	Inv. Normal	-27.7409	*0.0000*	-27.3316	*0.0000*	-16.0091	*0.0000*
	Inv. logit t	-55.7262	*0.0000*	-53.2001	*0.0000*	-22.8756	*0.0000*
	Mod. inv. chi-squared	95.9455	*0.0000*	91.2894	*0.0000*	36.8022	*0.0000*
ΔSIZE	Inv. chi-squared	1143.296	*0.0000*	1017.197	*0.0000*	457.9095	*0.0000*
	Inv. Normal	-31.4359	*0.0000*	-29.39	*0.0000*	-18.1761	*0.0000*
	Inv. logit t	-65.9969	*0.0000*	-58.7178	*0.0000*	-26.4111	*0.0000*
	Mod. inv. chi-squared	114.401	*0.0000*	101.2543	*0.0000*	42.9445	*0.0000*

We also performed unit root test for macroeconomic variables. Since macroeconomic data is not in the panel format (i.e., we have only time dimension for each bank in the sample), we employed the traditional Augmented Dickey–Fuller test (Dickey & Fuller, 1979). The null hypothesis in ADF test is that series contain a unit root, and the alternative is that the variable was generated by a stationary process.

Table 18: Augmented Dickey-Fuller (ADF) unit root test for macroeconomic variables.

Variables	No-Trend	Trend	Trend (Lag1)
GDP	-5.427	-5.714	-3.694
	(0)	(0)	(0.0228)
ΔUNEMPLOYMENT	-4.266	-4.24	-4.371
	(0.0005)	(0.0039)	(0.0024)
CPI	-7.986	-7.931	-7.652
	(0)	(0)	(0)
BIST100	-6.673	-7.284	-5.349
	(0)	(0)	(0)
Δ*IRI*	-4.85	-5.061	-4.523
	(0)	(0.0002)	(0.0014)
Δ*IRC*	-4.672	-5.043	-3.901
	(0.0001)	(0.0002)	(0.0121)
EURO	-6.186	-6.102	-4.628
	(0)	(0)	(0.0009)
USD	-6.124	-6.071	-4.288
	(0)	(0)	(0.0033)

**MacKinnon p-value for Z (t) are given in parenthesis.*

Table 18 presents the ADF test results, here we can reject the null hypothesis for the CPI, BIST100, EURO and USD variables at all common significance levels. Because the data in Figure 5 show a strong downward trend, both commercial and consumer interest rates are found non-stationary at the trend level. Unemployment variable is found non-stationary for all trend structures. In order to transform the unemployment and interest rates to stationary process, we take percentage change (denominated by Δ) of each variable in respect previous quarter[16]. As seen from the table, the null hypothesis is rejected at all levels for the ΔUNEMPLOYMENT, ΔIRI and ΔIRC variables.

[16] The alternative way for transforming variables to the stationary process is to take the first difference. Since the other variables in the sample are in the percentage format we prefer to have unemployment and interest rates to be in the same format.

***Methodology*:**

We employ the traditional panel data estimators: pooled OLS, fixed-effects (FE) and random effects (RE) to measure the level of credit risk in commercial banks. The model specification is given in the equation below (Castro, 2013).

$$Y_{i,t} = \beta_0 + \beta_1 X_{1,i,t} + \beta_2 X_{2,i,t} + \cdots \beta_n X_{n,i,t} + n_i + \varepsilon_{i,t}$$

where

$Y_{(i,t)}$: is the level of credit risk.

β_1: is the vector of coefficient.

$X_{(1,i,t)}$: is the vector of explanatory variables.

n_i : are the unobserved bank-specific effects.

$\varepsilon_{(i,t)}$: is the error term.

the i subscript represents the cross-sectional dimension across banks, and t represents the time dimension.

The econometric models for bank specific data are presented below;

Model 1:

$$NPL_{i,t} = \beta_0 + \beta_1 EFFA_{i,t} + \beta_2 EFFA_{i,t-1} + \beta_3 EFFA_{i,t-2} + \beta_4 EFFA_{i,t-3} + \beta_5 EFFA_{i,t-4} + \beta_6 CAPITAL_{i,t} + \beta_7 LOANS_{i,t} + \beta_8 NIN_{i,t} + \alpha_1 STATEBANK_t + \gamma\, 2009 + \varepsilon_{i,t}$$

Model 2:

$$NPL_{i,t} = \beta_0 + \beta_1 EFFB_{i,t} + \beta_2 EFFB_{i,t-1} + \beta_3 EFFB_{i,t-2} + \beta_4 EFFB_{i,t-3} + \beta_5 EFFB_{i,t-4} + \beta_6 CAPITAL_{i,t} + \beta_7 LOANS_{i,t} + \beta_8 NIN_{i,t} + \alpha_1 STATEBANK_t + \gamma\, 2009 + \varepsilon_{i,t}$$

We test the "bad management" and "skimping" hypotheses with an alternative proxy variable, the performance ratio return on equity (ROE), also the diversification hypothesis is examined with size variable. The econometric model including the profitability ratio and

size, the ration total assets of bank i over the total assets in the commercial banking sector, is given as;

Model 3:

$$NPL_{i,t} = \beta_0 + \beta_1 ROE_{i,t} + \beta_2 ROE_{i,t-1} + \beta_3 ROE_{i,t-2} + \beta_4 ROE_{i,t-3} + \beta_5 ROE_{i,t-4} + \beta_6 CAPITAL_{i,t} + \beta_7 LOANS_{i,t} + \beta_8 SIZE_{i,t} + \alpha_1 STATEBANK_t + \gamma\ 2009 + \varepsilon_{i,t}$$

The econometric models for macroeconomic variables are given in the Model 4 and 5.

Model 4:

$$\Delta NPL_{i,t} = \beta_0 + \beta_1 GDP_t + \beta_2 \Delta IRC_{t-2} + \beta_3 BIST\ 100_t + \beta_4 EURO_t + \varepsilon_{i,t}$$

Model 5:

$$\Delta NPL_{i,t} = \beta_0 + \beta_1 \Delta UNEMPLOYMENT_{t-2} + \beta_2 \Delta IRI_{t-2} + \beta_3 CPI_t + \beta_4 USD_t + \varepsilon_{i,t}$$

4.5 Empirical Findings

The empirical analyses in this study are presented in two separate parts. We first discuss the empirical findings for bank-specific factors and provide some evidence about how macroeconomic environment have impact on the credit risk of Turkish commercial banks.

4.5.1 Bank-specific Findings

The empirical results with bank-specific data are given in Table 19, Table 20 and Table 21. We first performed traditional pooled OLS, fixed effect (FE) and random effects (RE) estimators for Model 1, 2 and 3. Later, Breusch-Pagan Lagrange Multiplier and Hausman tests are performed to decide on the most appropriate estimators. Accordingly, Breusch-Pagan Lagrange Multiplier test decides between pooled OLS and random effect estimators. If the null hypothesis is rejected the pooled-OLS is not found as the proper estimator for this analysis (Breusch & Pagan, 1980). As seen from all tables we reject the null hypothesis at 1 % significance level for all models and conclude that random effect is more useful for this analysis.

To decide between fixed or random affect estimators we employed Hausman test to the model. The null hypothesis (H_o) in the Hausman test is "Difference in coefficients not systematic" which indicates that the preferred model is random effects vs. the alternative the fixed effects. The Hausman test results for both for models are given in the Table 19, Table

20 and Table 21. Accordingly, we reject the null hypothesis at 99 % confidence level and select the fixed affect (FE) model as the most appropriate estimator for all models in our analysis (Hausman, 1978).

Once the most appropriate estimator (fixed effect) is selected, we run the diagnostic tests for autocorrelation and heteroscedasticity problems in the fixed effect (FE) model. We first perform the Modified Wald statistics which tests the group-wise heteroscedasticity in fixed effect models. The test must be used in caution if the number of cross sections (i) are larger than the total number of times (t) in the panel. In our sample data we have 23 cross sections (banks) and 52 times (quarters). The null hypothesis in Modified Wald test assumes homoscedasticity in the model (Greene, 2002). The test results for all three models are given below. We reject the null hypothesis at 1 % significance level and conclude that all models (1, 2 and 3) are not homoscedastic. We also performed the Bhargava et al. Durbin-Watson and Baltagi-Wu LBI tests for autocorrelation problem in fixed effect (FE) model. The test results in exhibit that all models are serially correlated (Baltagi & Wu, 1999), (Bhargava, Franzini, & Narendranathan, 1982).

Finally, to control the heteroscedasticity and autocorrelation problem we added the vce cluster (bank) option in the Stata and run all models again. The cluster modifies the standard errors and variance–covariance matrix of the estimators but not the estimated coefficients. Clustering on the panel variable produces a consistent VCE estimator when the disturbances are not identically distributed over the panels or there is serial correlation in it (Stata Corp, 2013). We re-estimated fixed effect and random effect model with cluster option. The robust results for model 1, 2 and 3 are presented in Table 19, Table 20 and Table 21.

Although the Hausman test result specify that fixed effects (FE) model is the fitting model, we also added results of pooled-OLS and random effects (RE) model since each model has some advantages to each other. For example, the advantage of random effects is that we are able to include time invariant variables. In the fixed effects model these variables are absorbed by the intercept.

Table 19: Empirical results for Model-1 with bank-specific variables.

	(1) P-OLS	(2) RE	(3) FE	(4) P-OLS	(5) RE	(6) FE
EFFA	-0.0340	-0.0374*	-0.0378	-0.0309	-0.0321	-0.0324
	(-1.68)	(-1.97)	(-1.93)	(-1.44)	(-1.84)	(-1.74)
$EFFA_{(t-1)}$	-0.0125	-0.0125	-0.0122	-0.00848	-0.0130	-0.0140
	(-0.50)	(-1.74)	(-1.61)	(-0.32)	(-1.73)	(-1.92)
$EFFA_{(t-2)}$	0.00893	0.00817	0.00820	0.0127	0.0105	0.00976
	(0.36)	(1.58)	(1.52)	(0.48)	(1.44)	(1.30)
$EFFA_{(t-3)}$	0.00952	0.00477	0.00465	0.00918	0.00436	0.00223
	(0.40)	(0.49)	(0.46)	(0.36)	(0.42)	(0.22)
$EFFA_{(t-4)}$	-0.0144	-0.00945	-0.00831	-0.0103	-0.0156	-0.0175
	(-0.78)	(-0.63)	(-0.56)	(-0.53)	(-0.85)	(-0.97)
CAPITAL	0.133***	0.264**	0.284*			
	(3.84)	(2.75)	(2.82)			
LOANS	-0.0694***	-0.121**	-0.128**			
	(-8.91)	(-3.14)	(-3.13)			
NIN	0.0340*	-0.0303	-0.0351	0.0866***	0.0279	0.0144
	(2.22)	(-0.62)	(-0.71)	(5.69)	(0.87)	(0.39)
STATEBANK	0.0176***	0.0148		0.0217***	0.0219**	
	(4.72)	(1.16)		(5.94)	(2.68)	
Y2009	0.0176***	0.0147	0.0141	0.0193***	0.0211***	0.0215***
	(4.17)	(1.91)	(1.75)	(4.32)	(3.85)	(3.82)
ΔCAPITAL				0.118	0.109*	0.107
				(1.37)	(2.03)	(2.02)
ΔLOANS				-0.0766*	-0.0556***	-0.0519**
				(-2.30)	(-3.73)	(-3.52)
_cons	0.0914***	0.118***	0.122***	0.0483***	0.0730***	0.0840***
	(7.64)	(4.89)	(5.16)	(4.69)	(3.59)	(3.98)
N	1019	1019	1019	1019	1019	1019
adj. R^2	0.154		0.227	0.062		0.035
Breusch & Pagan LM test						1283.31
						(0.0000)
Hausman test						22.27
						(0.0081)
Modified Wald test						1.30E+05
						(0.0000)
Durbin-Watson						0.21158
Baltagi-Wu						0.4728

*Δ *is the first difference operator.*

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 20: Empirical results for Model-2 with bank-specific variables.

	(1) P-OLS	(2) RE	(3) FE	(4) P-OLS	(5) RE	(6) FE
EFFB	-0.0452**	-0.0365***	-0.0349***	-0.0445**	-0.0403***	-0.0389***
	(-3.21)	(-5.04)	(-4.57)	(-2.98)	(-4.60)	(-4.31)
$EFFB_{(t-1)}$	-0.0203	-0.0140**	-0.0128*	-0.0208	-0.0179**	-0.0171**
	(-1.23)	(-2.63)	(-2.46)	(-1.19)	(-2.93)	(-2.84)
$EFFB_{(t-2)}$	-0.00289	0.000285	0.000557	-0.00328	0.000562	0.00152
	(-0.17)	(0.06)	(0.13)	(-0.19)	(0.10)	(0.28)
$EFFB_{(t-3)}$	-0.00251	-0.00195	-0.00203	-0.00133	0.0000999	0.000583
	(-0.15)	(-0.31)	(-0.31)	(-0.08)	(0.01)	(0.07)
$EFFB_{(t-4)}$	-0.0128	-0.0107	-0.0102	-0.0120	-0.00873	-0.00810
	(-0.94)	(-0.89)	(-0.84)	(-0.82)	(-0.70)	(-0.64)
CAPITAL	0.131***	0.243*	0.274*			
	(3.95)	(2.52)	(2.66)			
LOANS	-0.0671***	-0.116**	-0.128**			
	(-8.98)	(-3.11)	(-3.20)			
NIN	0.0350*	-0.0252	-0.0314	0.0897***	0.0345	0.0177
	(2.40)	(-0.50)	(-0.61)	(6.24)	(1.14)	(0.47)
Y2009	0.0188***	0.0154*	0.0146	0.0215***	0.0218***	0.0217***
	(4.68)	(2.07)	(1.88)	(5.07)	(4.00)	(3.96)
STATEBANK	0.0239***	0.0175		0.0290***	0.0252**	
	(6.67)	(1.48)		(8.27)	(2.88)	
ΔCAPITAL				0.0688	0.0678	0.0677
				(0.83)	(1.07)	(1.09)
ΔLOANS				-0.0705*	-0.0487**	-0.0434*
				(-2.19)	(-3.12)	(-2.70)
_cons	0.124***	0.130***	0.133***	0.0922***	0.0885***	0.0911***
	(12.44)	(4.16)	(4.38)	(11.54)	(5.67)	(4.86)
N	1019	1019	1019	1019	1019	1019
adj. R^2	0.216		0.244	0.128		0.055
Breusch & Pagan LM test						811.13
						(0.0000)
Hausman test						37.85
						(0.0000)
Modified Wald test						8398.8
						(0.0000)
Durbin-Watson						0.2193
Baltagi-Wu						0.4865

*Δ *is the first difference operator*.
t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 21: Empirical results for Model-3 with bank-specific variables.

	(1) P-OLS	(2) RE	(3) FE	(4) P-OLS	(5) RE	(6) FE
ROE	-0.0451	-0.0505	-0.0522	-0.0415	-0.0401	-0.0397
	(-1.62)	(-1.17)	(-1.21)	(-1.40)	(-0.89)	(-0.87)
$ROE_{(t-1)}$	0.0101	-0.0261	-0.0296	0.0136	-0.00685	-0.0128
	(0.47)	(-1.38)	(-1.46)	(0.59)	(-0.49)	(-0.89)
$ROE_{(t-2)}$	-0.00626	-0.0364	-0.0390	0.0000654	-0.0181	-0.0237
	(-0.29)	(-1.74)	(-1.76)	(0.00)	(-1.12)	(-1.39)
$ROE_{(t-3)}$	-0.0297	-0.0543*	-0.0548*	-0.0395	-0.0570*	-0.0628*
	(-1.40)	(-2.26)	(-2.31)	(-1.75)	(-2.52)	(-2.65)
$ROE_{(t-4)}$	0.0155	-0.0146	-0.0160	0.00634	-0.0184	-0.0258
	(0.58)	(-0.34)	(-0.41)	(0.22)	(-0.33)	(-0.46)
CAPITAL	0.110**	0.213**	0.236**			
	(3.28)	(2.80)	(2.84)			
LOANS	-0.0764***	-0.127**	-0.134**			
	(-9.83)	(-3.25)	(-3.28)			
SIZE	-0.0788**	0.200	0.700			
	(-2.87)	(0.90)	(1.54)			
STATEBANK	0.0204***	0.00823		0.0196***	0.0269**	
	(5.29)	(0.31)		(5.26)	(3.00)	
Y2009	0.0172***	0.0161**	0.0156*	0.0184***	0.0206***	0.0209***
	(4.17)	(2.71)	(2.53)	(4.16)	(3.85)	(3.91)
ΔCAPITAL				0.123	0.125*	0.124
				(1.40)	(1.97)	(1.93)
ΔLOANS				-0.0508	-0.0429**	-0.0426**
				(-1.48)	(-2.92)	(-2.85)
ΔSIZE				0.703	0.700	0.720
				(1.32)	(0.76)	(0.80)
_cons	0.0744***	0.0884***	0.0694*	0.0436***	0.0474***	0.0543***
	(9.82)	(3.30)	(2.10)	(21.36)	(6.35)	(9.52)
N	1019	1019	1019	1019	1019	1019
adj. R^2	0.161		0.268	0.042		0.055
Breusch & Pagan LM test						1311.68
						(0.0000)
Hausman test						56.12
						(0.0000)
Modified Wald test						3945.98
						(0.0000)
Durbin-Watson test						0.2170
Baltagi-Wu test						0.4680

**Δ *is the first difference operator.*
t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The coefficient estimates and significance levels are given in tables above for model 1, 2 and 3. As indicated in the previous section some bank-specific variables (CAPITAL, LOANS and SIZE) are found non-stationary in different levels. We took the first difference of these variables and conduct our estimation both with non-stationary and stationary data. The coefficients of efficiency scores for panel B are found significant at 95 % and 99 % (even at 99.9 %) confidence level for all models including fixed effects, random effects and pooled OLS. Efficiency scores of panel A is found significant at 95 % confidence level in random effects models. Our results confirm the bad management hypothesis for the Turkish commercial banking sector. This suggest that lower efficient banks have higher level of non-performing loans. We also examined the bad management hypothesis with an alternative variable (profitability) and found negative but statistically insignificant link between return on equity and non-performing loans. On the third lags however, the coefficients of ROE is found significant at 5 % significance levels. The overall findings on the bad management hypothesis for Turkish commercial banking sector are consistent with the previous results of Berger & DeYoung (1997), Williams (2004) Fiordelisi, Marques-Ibanez, & Molyneux (2011), Louzis, Vouldis, & Metaxas (2012) and Setiwan, Hassan, Hassan, & Mohamad (2013).

In order to test the skimping hypothesis we take the four lags of efficiency scores and return on equity (ROE). As seen from Table 19 the second and third lagged coefficients of efficiency (EFFA) are found positive but insignificant at 1%, 5% and 10% significance level. Likewise, the second lagged coefficient of efficiency (EFFB) in Table 20 is recorded as positive but not significant. All coefficients for ROE in fixed effect and random effects are found negative. Although the coefficients of lagged ROE is found positive, they are not statistically significant at all levels. The positive coefficient estimated in pooled OLS estimator is positive but insignificant at all confidence level. Consequently, based on the all models and estimators we reject the validity of skimping hypothesis in the Turkish commercial banking sector.

As we look at to the moral hazard hypothesis, we could not find any evidence to support the moral hazard incentives in the commercial banking sector in Turkey. As given in the tables, we first performed our estimation with standard capital ratio and later take the first difference and re-estimated the models. For all models and estimators there is a positive link between bank capital (measured by total equity over total assets) and credit risk (NPL). However the

coefficients of capital (ΔCAPITAL) is found significant at 95% confidence level solely for random effects model in which we can weakly conclude that highly capitalized banks have more tendency on taking more risks. The results on moral hazard hypothesis in the international literature are quite controversial. Berger and De-Young (1997) and Williams (2004) found positive link between non-performing loans and bank capital for the whole population in their sample data. However, they found supporting evidence on moral hazard for the banks that have capital below the median in the whole sample.

As mentioned in the previous section, the consumer and commercial loan market in Turkish banking sector increased dramatically over the last decade. To investigate the effect of growth of loan we used ratio of total loans to total assets. As presented in the Table 19, Table 20 and Table 21 we found negative and very significant (at raging between 95% and 99.9% confidence level) relationship between loan ratio and non-performing loans. The findings of our study suggest that commercial banks with higher loan ratio have higher asset quality. The possible reason for that is because banks produce more and quality information about past consumer and commercial borrowers where this information is used in the future loan approval process which mitigate the level of ex-post credit risk (Williams, 2004).

In addition, we found no evidence on the diversification hypothesis. As shown in Table 19 and Table 20 when the ratio non-interest income to total income is used a proxy variable for diversification, the sign of the coefficients estimates are found both positive and negative depending on the different estimators. The results are similar even if we use size (ΔSIZE) as an alternative variable to test the diversification hypothesis. In Table 21, both the sign of the coefficients and their significance level (for clustered pooled OLS, FE and RE) does not support the diversification hypothesis in the Turkish commercial banking sector.

Finally, we used two dummy variables to examine the time and bank-specific factors on the credit risk. First, to investigate the effect of global financial crisis (GFC) on non-performing loans we assigned 1 for year 2009 and zero for other years. The coefficient of Y2009 is found positive and significant (ranging from 95% to 99.9%) for all models. Second, to examine the effect of lender type we assigned 1 for state-owned banks and 0 to other banks. The coefficient of state-owned banks is found as expected (positive) and significant between 99% and 99.9% confidence level for random effects and Pooled-OLS methods. The results indicate that the state-owned commercial banks, which comprise almost 30 % of the total

banking sector, highly influenced by political factors while making decision on loan approval process.

4.5.2 Macroeconomic Findings

The econometric model with macroeconomic variables was designed with two different alternatives to avoid the multicollinearity problem between the variables. The sign "Δ" in model 4 and 5 indicates the growth rate (percentage) for dependent and some explanatory variables. As seen from both equations, the macroeconomic models does not satisfy the requirement for panel data. Although the dependent variable (NPL) has both cross section and time dimension, the macroeconomic variables have only the time dimension.

The results with macroeconomic variables are given in Table 22 and Table 23. Accordingly, we performed the Breusch-Pagan Lagrange Multiplier (LM) decide between pooled-OLS and random effect (RE) estimators. If the null hypothesis is rejected the pooled-OLS is not found as the proper estimator for this analysis. As seen in both tables, we cannot reject the null hypothesis for model 4 and 5 and conclude that the basic pooled-OLS is more appropriate estimator for this analysis (Breusch & Pagan, 1980).

Once the most appropriate estimator (pooled-OLS) is selected, we run the diagnostic tests for autocorrelation and heteroscedasticity problems in the pooled-OLS models. We first perform the White and Breusch-Pagan statistics which tests the heteroscedasticity. The null hypothesis in White test assumes homoscedasticity in the model (Greene, 2002). The test results both for model 4 and 5 are presented below. We reject the null hypothesis at 1 % and 10 % significant levels for model 4 and 5 respectively and conclude that models are not homoscedastic. Breusch-Pagan tests results however, indicate that model 4 and 5 have constant variance.

We later performed the Bhargava et al. Durbin-Watson and Baltagi-Wu LBI tests for autocorrelation problem. The test results for all models is found very close to the critical value 2 which indicates that our model does not seriously suffer from autocorrelation problem (Baltagi & Wu, 1999) and (Bhargava, Franzini, & Narendranathan, 1982).

Finally, to control the heteroscedasticity problem we added the vce (robust) option to the pooled-OLS and run the models 4 and 5 again. The robust option, which is also known Huber/White/sandwich estimator, produces different standard errors and t statistics, yet the coefficients estimates does not change in both models (Huber, 1967) and (White, 1980).

Although Breusch-Pagan Lagrange Multiplier (LM) test result specify that the basic pooled-OLS is the most appropriate model, we also added robust estimation results obtained from fixed effects (FE) and random effects (RE) models.

Table 22: Empirical results for Model-4 with macroeconomic variables.

	1 P-OLS	2 P-OLS	3 P-OLS	4 P-OLS	5 FE	6 RE
GDP	-0.0303***		-0.0265**	-0.0262***	-0.0304**	-0.0303***
	(-3.46)		(-3.28)	(-3.38)	(-3.48)	(-3.48)
$GDP_{(t-1)}$		-0.0254***				
		(-5.67)				
$\Delta IRC_{(t-2)}$	0.163*	0.0682	0.0785	-0.00389	0.144	0.163**
	(2.48)	(0.89)	(0.92)	(-0.04)	(2.06)	(2.72)
BIST100	0.00101	0.0000109			0.00113*	0.00101
	(1.44)	(0.02)			(2.33)	(1.92)
$BIST100_{(t-2)}$			-0.00201**			
			(-2.87)			
$BIST100_{(t-3)}$				-0.00286***		
				(-3.36)		
EURO	0.00160	0.00418	0.00132	0.000439	0.00114	0.00160
	(0.58)	(1.56)	(0.42)	(0.14)	(0.43)	(0.57)
_cons	0.0490***	0.0430***	0.0591***	0.0634***	0.0489***	0.0490***
	(3.83)	(3.87)	(4.30)	(4.22)	(4.31)	(3.62)
N	1033	1033	1033	1033	1033	1033
adj. R^2	0.043	0.032	0.049	0.056	0.045	
Breusch & Pagan LM test						0.0000
						(1.0000)
White						32.74
						(0.0031)
Breusch-Pagan						2.02
						(0.1551)
Durbin-Watson test						1.8985
Baltagi-Wu test						1.9375

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 23: Empirical results for Model-5 with macroeconomic variables.

	1 P-OLS	2 P-OLS	3 P-OLS	4 FE	5 RE
$\Delta UNEMPLOYMENT_{(t-2)}$	0.676**	0.640**	0.669**	0.636***	0.676***
	(3.26)	(2.88)	(3.20)	(3.93)	(3.96)
$\Delta IRI_{(t-2)}$	0.226**	0.240**	0.195*	0.219**	0.226**
	(3.10)	(3.10)	(2.58)	(2.86)	(3.11)
CPI	-0.00424		0.00406	-0.00301	-0.00424
	(-0.59)		(0.50)	(-0.38)	(-0.54)
USD	0.00726*	0.00703*		0.00644*	0.00726*
	(2.42)	(2.34)		(2.12)	(2.36)
$CPI_{(t-1)}$		-0.00555			
		(-0.82)			
$USD_{(t-1)}$			0.00332*		
			(2.14)		
_cons	0.0257	0.0289	0.0175	0.0249	0.0257
	(1.85)	(1.83)	(1.35)	(1.56)	(1.81)
N	889	889	889	889	889
adj. R^2	0.040	0.040	0.024	0.037	
Breusch & Pagan LM test					0.0000
					(1.00)
White					23.01
					(0.06)
Breusch-Pagan					410.69
					(0.00)
Durbin-Watson test					1.8750
Baltagi-Wu test					1.9132

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

As indicated in the Table 22 the coefficients of GDP (growth rate of real gross domestic products) including the lag 1 was found negative and significant at all levels. The results

confirm that when GDP grows the level of non-performing loans decreases considerably[17]. Likewise, we have the expected outcome when we use the growth rate of unemployment rate (denominated by ΔUNEMPLOYMENT) as an alternative macroeconomic indicator. As seen from Table 23 the coefficient of the unemployment rate is found positive and statistically significant at 99% and 99.9% confidence level for all estimators including pooled-OLS, fixed and random effects respectively[18]. The level of non-performing loans increases as unemployment rate increases and conclude that the credit risk moves in line with the unemployment rate. The results for GDP and Unemployment in our study are consistent with the majority of the literature such as Nkusu (2011), Louzis, Vouldis, & Metaxas (2012) and Castro (2013).

We used percentage change of bank's nominal interest rates for commercial and consumer loans separately as a proxy for interest rates. As presented in Table 22 and Table 23 the coefficient estimates of both commercial (ΔIRC) and consumer (ΔIRI) interest rates are found positive and significant ranging between 5% and 0.1 % significance level. Based on the result for all methods (pooled OLS, random and fixed effects), the consumer loan interest rates (mortgage, car, credit cards etc.) are found to have more impact on the non-performing loans compared to commercial loan rates. For example, 1 % increase in commercial loan rates increase the ratio of non-performing loan by 0.00163 % whereas the consumer (individual) loan rates increase the level of non-perming loans by 0.002264 % or *vice versa.*

The coefficient estimates of foreign currency rates (exchange rates) is found positive both for USD and EURO rates. The exchange rate for USD is found statistically significant at 95 % confidence level (it is is also found positive and significant including lag 1). The EURO rate however, is not found significant at all levels including all models[19]. The potential reason for the positive relationship between USD rates and non-performing loans is that because, approximately 65 % of the foreign currency dominated loans in Turkish commercial banking sector are granted by US dollars. Thus, any increase in USD rates will have negative impact on the capability of the debt servicing of the borrowers and will rise the default rates of USD loans.

[17] The coefficients of GDP is also found negative and significant (at 99% confidence level) when we take two lags.
[18] We took the two lags of unemployment rate and interest rates, since any shock from unemployment and interest rates might have impact on the level of non-performing loans after certain time period.
[19] We obtained the same results when we take the lag 1, lag 2 and lag 3 for Euro rate.

No significant link is found between consumer price index (CPI) and non-performing loans. Although the coefficient of CPI is positive the significance level does support the related hypothesis indicated in the previous section. The coefficient of BIST 100 index is found positive and insignificant for the pooled-OLS and random effects but significant for fixed models. If we use the 2nd and 3rd lag, the coefficient of BIST 100 index is found negative, as expected, and statistically significant at 99 % and 99.9% confidence level in pooled-OLS model. Increase in the stock price index is a sign of improvement in the financial conditions of the major firms in Turkey and we can conclude that such increase reduce the level of non-performing loans in Turkish commercial banking sector. Our empirical findings for stock market index is in line with Castro (2013) and Jakubik & Reininger (2013).

5 CONCLUSION

The objective of this thesis is to analyze the bank-specific and macroeconomic determinants of the credit risk (i.e., non-performing loans) of the commercial banks operate in Turkey over the period 2002 and 2015. For this purpose, we selected 26 commercial banks from Turkish commercial banking sector. In order to have more consistent data we eliminated 3 banks from the sample. The final data sample consists of 23 commercial banks and roughly represents the 90 percent of the total banking sector in Turkey.

After reviewing the theoretical and empirical literature in the second chapter, we measured the technical efficiency scores of the commercial banks by employing data envelopment analysis (DEA) in chapter 3. We used the intermediation approach to select the input and output items. To obtain consistent and robust results, we measured the technical efficiency scores with two different panels. The input variables for both group (panels) is interest and non-interest expenses. The output variables for the first panel consist of non-interest income and interest income. We selected balance sheet items, total loans deposits and securities, as output variables in the second group. The measured technical efficiency groups are used as independent variables that are expected to influence the level of credit risk, in the next chapter.

Chapter 4 constitutes the focal point of this study. In this chapter we examined the bank-specific (internal) and macroeconomic (external) determinants of credit risk in commercial banks operate in Turkey. We found great deal of evidence that both internal and external factors can have significant impact on the credit risk in commercial banks. The empirical findings of this study is important particularly for the policy makers within financial institutions, bank regulators and managers.

The strong evidence on bad management hypothesis, along with rejecting skimping hypothesis, for Turkish commercial banking sector proves that credit risk can also originate from the internal (bank-specific) sources. In other words inefficient (poorly managed) banks tent to make poor quality loans (Williams, 2004). Our findings point out the overall efficiency improvements (successful managerial practices) are very important to reduce the credit risk in the banking sector. For this purpose, the policy makers, especially the bank managers should promote acts that to supervise the loan granting, monitoring and collateral appraisal procedures in commercial banks.

Another striking result in this thesis is found between the higher growth rate of loans and credit risk. This finding is particularly very important for Banking Regulation Supervision Agency (BRSA) and Central Bank of Turkey. As mentioned before, early 2000's the deposit banks in Turkey predominately investing in government securities (T-bill and Notes) to fund the government budget deficits. Later 2000's the commercial banks in Turkey returned to their primary function (as a result of political stability, tight budget policy and structural reforms in the financial sector) and channeled their funds to real sector's spending thus, the consumer and commercial credit markets has increased rapidly. The findings of this study indicate that the rapid growth of loans in Turkey over the last decade did not cause to the same level of increase in non-performing loans. The possible reason for that is because the higher number of loans have created more information (debt servicing capacity, amount of loans outstanding, number of defaults on loans or credit cards etc.) about the quality of both corporate and individual borrowers. The information about the financial conditions of the borrowers are used by commercials bank in future loans approval process. Consequently, the shift from security oriented baking system to loan based system in early 2000s did not adversely effected the level of credit risk (i.e., non-perming loans) as well as overall financial stability in Turkish banking sector.

We could not find any supporting evidence about diversification opportunities and credit risk in Turkish commercial banking sector. The subject could be investigated separately with alternative variables by using different approaches.

The findings of state bank and crisis period is important factor that determine the credit risk. As indicated in section 4 state banks are found more prone to have higher degree of credit risk compared to domestic and foreign private banks. The most important reason for that is because the top managers in different unit in these banks are appointed by the administrative officials. The political connection between bank managers and state-officials may lead to adverse selection problem especially due to political intervention in loan approval process.

Besides the bank specific factors, we found strong evidence that external factors especially, the macroeconomic environment, may also influence the credit risk in commercial banking sector. The overall deteriorations in the macroeconomic indicators trigger the level of non-performing loans. For example, as the growth rate of GDP increase and unemployment rate decrease the level of non-performing loans reduce considerably. In terms of policy implications, the regulatory authorities and policy-makers should adopt policies and

regulations to promote sustainable economic growth rate that create also employment for sound and stable banking system.

The lending rates is also another macroeconomic factor that affect the credit risk in banks. We found positive link between loan interest rate (both for commercial and consumer loans) and non-performing loans. The increasing level of interest rates usually reduce the debt servicing capability of the borrowers particularly for those who have outstanding loans on floating rate. The result is very important for the monetary policy makers, especially Central Bank of Turkey, since they can directly and directly intervene to the interest rates.

We found strong positive link between exchange rates (specifically USD) and non-performing loans. As indicated above the overall growth rate of loans did not increased the level of non-performing loans in Turkish banking system at same pace. However, the possible increasing in the amount of USD denominated loans, which constitutes 65 % of total foreign currency loans (USD loans roughly make up 20 % of total loans), along with appreciating USD rates against Turkish Lira (TL) can increase loan defaults and level of non-performing loans considerably. Thus, adopting the low volatile exchange rate regime (specifically for US dollar) is very important to reduce the level of non-performing loans in Turkish banking sector.

The subject of this thesis could be extended by several ways. First we examined the determinants of credit risk with macroeconomic and bank-specific variables, but the credit risk, especially the ex-post credit risk, might also originate from different sources such as from borrowers and natural factors. The subject cold be investigated from borrower-specific perspective. Second, we used aggregate level of non-perming loans as a proxy for credit risk. The future studies can improve this topic by examining the determinants of non-performing loans for different types of loans such as commercial or consumer (mortgage, car etc.) loans. Finally, the study can also be improved by employing different econometric approaches. Although we used traditional panel data methods (fixed and random effects) the dynamic panel data (Arellano-Bond or Arellano-Bover / Blundell-Bond) methods can be used as an alternative methodology to eliminate some drawbacks associated with traditional OLS approaches.

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APENDICES

APPENDIX A – TECHNICAL EFFICIENCY SCORES (DEA RESULTS)

Term	Banks	Panel A	Panel B
2002/12	Anadolubank	0.87590354	1.00000000
2002/12	Arap Türk Bankası	1.00000000	1.00000000
2002/12	Burgan Bank	0.86727484	0.58205538
2002/12	Citibank	1.00000000	0.67332822
2002/12	HSBC Bank	1.00000000	1.00000000
2002/12	ING Bank	0.82288966	0.74897542
2002/12	Turkish Bank	1.00000000	1.00000000
2002/12	Turkland Bank	0.96732874	0.79216956
2002/12	Türk Ekonomi Bankası	0.80205102	1.00000000
2002/12	Ziraat Bankası	0.94128202	0.92321678
2002/12	Alternatifbank	0.67364279	0.50645785
2003/03	Akbank	1.00000000	1.00000000
2003/03	Denizbank	0.65674824	0.69780684
2003/03	Finansbank	0.75713316	1.00000000
2003/03	Garanti	0.64040929	0.88625755
2003/03	İsbank	0.63550462	0.85191836
2003/03	Sekerbank	0.60146620	0.68402718
2003/03	Tekstilbank	0.57787795	0.82658411
2003/03	Vakıfbank	0.55394845	0.67658234
2003/03	Yapı Kredi	0.67936143	0.95053877
2003/03	Anadolubank	0.74242478	1.00000000
2003/03	Arap Türk Bankası	1.00000000	1.00000000
2003/03	Burgan Bank	0.64316652	0.44920031
2003/03	Citibank	1.00000000	0.69179243
2003/03	HSBC Bank	1.00000000	1.00000000
2003/03	ING Bank	0.59425384	0.54370491
2003/03	Turkish Bank	0.86786872	0.63185844
2003/03	Turkland Bank	0.80976374	0.85665225
2003/03	Türk Ekonomi Bankası	0.82883167	1.00000000
2003/03	Ziraat Bankası	1.00000000	1.00000000
2003/03	Alternatifbank	0.70709769	0.62030530
2003/06	Akbank	1.00000000	0.97953422
2003/06	Denizbank	0.83747810	0.83235712
2003/06	Finansbank	0.77020469	0.82342719
2003/06	Garanti	0.76435655	0.87733827
2003/06	İsbank	0.69778543	0.85059047
2003/06	Sekerbank	0.71800319	0.76808173

2003/06	Tekstilbank	0.91810518	1.00000000
2003/06	Vakıfbank	0.70121451	0.76217632
2003/06	Yapı Kredi	0.72208616	0.91602597
2003/06	Anadolubank	0.82715657	1.00000000
2003/06	Arap Türk Bankası	1.00000000	1.00000000
2003/06	Burgan Bank	0.75474889	0.54733359
2003/06	Citibank	0.95647215	0.66517118
2003/06	HSBC Bank	1.00000000	1.00000000
2003/06	ING Bank	0.70924429	0.64756804
2003/06	Turkish Bank	1.00000000	0.76804110
2003/06	Turkland Bank	0.85222376	0.95724230
2003/06	Türk Ekonomi Bankası	0.85942348	1.00000000
2003/06	Ziraat Bankası	1.00000000	1.00000000
2003/06	Alternatifbank	1.00000000	0.46275244
2003/09	Akbank	1.00000000	1.00000000
2003/09	Denizbank	0.72390408	0.84231817
2003/09	Finansbank	0.76543076	0.84589493
2003/09	Garanti	0.87504578	1.00000000
2003/09	İsbank	0.62777133	0.72853073
2003/09	Sekerbank	0.74743515	0.69453895
2003/09	Tekstilbank	0.85327220	0.93286536
2003/09	Vakıfbank	0.78714349	0.88649589
2003/09	Yapı Kredi	0.74384198	0.91814443
2003/09	Anadolubank	0.76792801	1.00000000
2003/09	Arap Türk Bankası	1.00000000	1.00000000
2003/09	Burgan Bank	0.75519934	0.53941235
2003/09	Citibank	0.99580763	0.69953654
2003/09	HSBC Bank	1.00000000	1.00000000
2003/09	ING Bank	0.74263069	0.74759750
2003/09	Turkish Bank	1.00000000	1.00000000
2003/09	Turkland Bank	0.86847274	1.00000000
2003/09	Türk Ekonomi Bankası	0.84176051	1.00000000
2003/09	Ziraat Bankası	1.00000000	1.00000000
2003/09	Alternatifbank	1.00000000	0.42179884
2003/12	Akbank	1.00000000	1.00000000
2003/12	Denizbank	0.74754639	0.81482151
2003/12	Finansbank	0.75878470	0.83139107
2003/12	Garanti	0.77427290	1.00000000
2003/12	Halkbank	1.00000000	0.97500805
2003/12	İsbank	0.66091663	0.77191852
2003/12	Sekerbank	0.65794795	0.63765240
2003/12	Tekstilbank	0.68426252	0.77053990

2003/12	Vakıfbank	0.66744750	0.67285117
2003/12	Yapı Kredi	0.72037701	0.85328440
2003/12	Anadolubank	0.81311928	1.00000000
2003/12	Arap Türk Bankası	1.00000000	1.00000000
2003/12	Burgan Bank	0.81156341	0.59635440
2003/12	Citibank	0.93148124	0.61668573
2003/12	HSBC Bank	1.00000000	1.00000000
2003/12	ING Bank	0.78365272	0.84223837
2003/12	Turkish Bank	1.00000000	1.00000000
2003/12	Turkland Bank	0.85979187	1.00000000
2003/12	Türk Ekonomi Bankası	0.87441249	1.00000000
2003/12	Ziraat Bankası	1.00000000	1.00000000
2003/12	Alternatifbank	1.00000000	0.47577623
2004/03	Akbank	1.00000000	1.00000000
2004/03	Denizbank	0.76450037	0.69506226
2004/03	Finansbank	0.82419522	0.88156628
2004/03	Garanti	0.73644628	0.95539390
2004/03	Halkbank	1.00000000	0.92072752
2004/03	İsbank	0.76990768	0.81116956
2004/03	Sekerbank	0.71208602	0.55659123
2004/03	Tekstilbank	0.80919036	0.77677882
2004/03	Vakıfbank	0.68565212	0.70039658
2004/03	Yapı Kredi	0.69192611	0.86130114
2004/03	Anadolubank	0.76633559	0.95851561
2004/03	Arap Türk Bankası	1.00000000	1.00000000
2004/03	Burgan Bank	0.67833390	0.61984568
2004/03	Citibank	0.92241990	0.65944756
2004/03	HSBC Bank	1.00000000	1.00000000
2004/03	ING Bank	0.74995628	0.87253213
2004/03	Turkish Bank	0.93008599	0.67058142
2004/03	Turkland Bank	0.86083944	0.83786380
2004/03	Türk Ekonomi Bankası	0.77526778	1.00000000
2004/03	Ziraat Bankası	1.00000000	1.00000000
2004/03	Alternatifbank	1.00000000	0.47703843
2004/06	Akbank	1.00000000	1.00000000
2004/06	Denizbank	0.69165510	0.74472880
2004/06	Finansbank	0.78716803	1.00000000
2004/06	Garanti	0.71892390	0.87012607
2004/06	Halkbank	1.00000000	0.99782508
2004/06	İsbank	0.83496158	0.77069677
2004/06	Sekerbank	0.71693485	0.58615751
2004/06	Tekstilbank	0.60108320	0.92723686

2004/06	Vakıfbank	0.65088866	0.67595580
2004/06	Yapı Kredi	0.61218756	0.77486543
2004/06	Anadolubank	0.71750424	0.89187460
2004/06	Arap Türk Bankası	1.00000000	1.00000000
2004/06	Burgan Bank	0.62889975	0.53964566
2004/06	Citibank	1.00000000	0.69176748
2004/06	HSBC Bank	1.00000000	1.00000000
2004/06	ING Bank	0.66256853	0.89334765
2004/06	Turkish Bank	0.81898054	0.58552832
2004/06	Turkland Bank	0.91901483	0.71012555
2004/06	Türk Ekonomi Bankası	0.73601881	1.00000000
2004/06	Ziraat Bankası	1.00000000	1.00000000
2004/06	Alternatifbank	0.65539902	0.72073115
2004/09	Akbank	1.00000000	1.00000000
2004/09	Denizbank	0.72352745	0.78702654
2004/09	Finansbank	0.76786697	1.00000000
2004/09	Garanti	0.71178343	0.84458429
2004/09	Halkbank	1.00000000	0.98592926
2004/09	İsbank	0.77769045	0.80540348
2004/09	Sekerbank	0.69006757	0.55462189
2004/09	Tekstilbank	0.62291615	1.00000000
2004/09	Vakıfbank	0.67118331	0.71739865
2004/09	Yapı Kredi	0.68826618	0.70591816
2004/09	Anadolubank	0.72310254	1.00000000
2004/09	Arap Türk Bankası	1.00000000	1.00000000
2004/09	Burgan Bank	0.62562041	0.57459717
2004/09	Citibank	1.00000000	0.68486730
2004/09	HSBC Bank	1.00000000	1.00000000
2004/09	ING Bank	0.69882373	0.95141996
2004/09	Turkish Bank	0.76792514	0.71492774
2004/09	Turkland Bank	1.00000000	0.90840659
2004/09	Türk Ekonomi Bankası	0.70847105	0.92479165
2004/09	Ziraat Bankası	1.00000000	1.00000000
2004/09	Alternatifbank	0.68161389	0.77175701
2004/12	Akbank	1.00000000	1.00000000
2004/12	Denizbank	0.72453287	0.88688477
2004/12	Finansbank	0.82272119	1.00000000
2004/12	Garanti	0.77401336	0.89811486
2004/12	Halkbank	1.00000000	1.00000000
2004/12	İsbank	0.83968224	0.88973169
2004/12	Sekerbank	0.74900425	0.62359911
2004/12	Tekstilbank	0.68349212	0.83535128

2004/12	Vakıfbank	0.81080514	0.94544623
2004/12	Yapı Kredi	0.59737830	0.63920334
2004/12	Anadolubank	0.79963845	0.91942822
2004/12	Arap Türk Bankası	1.00000000	1.00000000
2004/12	Burgan Bank	0.70013956	0.76192760
2004/12	Citibank	0.92136749	0.77556489
2004/12	Fibabanka	0.59789784	0.87650164
2004/12	HSBC Bank	1.00000000	1.00000000
2004/12	ING Bank	0.78470212	0.98745343
2004/12	Turkish Bank	0.80073829	0.79616336
2004/12	Turkland Bank	1.00000000	0.84654348
2004/12	Türk Ekonomi Bankası	0.73992243	0.91652227
2004/12	Ziraat Bankası	1.00000000	1.00000000
2004/12	Alternatifbank	0.79313909	0.64087644
2005/03	Akbank	1.00000000	1.00000000
2005/03	Denizbank	0.87070965	0.82519818
2005/03	Finansbank	0.90918339	0.97374071
2005/03	Garanti	0.79538247	0.93026699
2005/03	Halkbank	1.00000000	0.90048973
2005/03	İsbank	0.82179072	0.92829428
2005/03	Sekerbank	0.93695609	0.76631249
2005/03	Tekstilbank	0.70071782	0.78254294
2005/03	Vakıfbank	0.95718894	0.88881561
2005/03	Yapı Kredi	0.70681041	0.69557486
2005/03	Anadolubank	0.93671619	0.96052883
2005/03	Arap Türk Bankası	1.00000000	1.00000000
2005/03	Burgan Bank	0.65723192	0.71515873
2005/03	Citibank	1.00000000	0.86444839
2005/03	Fibabanka	0.55692194	0.94523394
2005/03	HSBC Bank	1.00000000	1.00000000
2005/03	ING Bank	0.86550026	0.96430230
2005/03	Turkish Bank	0.84607995	0.80721889
2005/03	Turkland Bank	0.82365824	0.79447529
2005/03	Türk Ekonomi Bankası	0.86932141	1.00000000
2005/03	Ziraat Bankası	1.00000000	1.00000000
2005/03	Alternatifbank	0.84975657	1.00000000
2005/06	Akbank	1.00000000	1.00000000
2005/06	Denizbank	0.90357700	0.95715309
2005/06	Finansbank	0.95337720	0.96357937
2005/06	Garanti	0.85255442	0.90755407
2005/06	Halkbank	1.00000000	0.89605903
2005/06	İsbank	0.84620723	0.88970527

2005/06	Sekerbank	0.85126598	0.69906487
2005/06	Tekstilbank	0.70635996	0.93282612
2005/06	Vakıfbank	0.74869906	0.74938018
2005/06	Yapı Kredi	0.68101533	0.69584429
2005/06	Anadolubank	0.82209262	0.86584115
2005/06	Arap Türk Bankası	1.00000000	1.00000000
2005/06	Burgan Bank	0.66227105	0.71262831
2005/06	Citibank	1.00000000	0.91100648
2005/06	Fibabanka	0.54343209	1.00000000
2005/06	HSBC Bank	0.98194576	1.00000000
2005/06	ING Bank	0.84359061	0.99471540
2005/06	Turkish Bank	0.79768843	0.72992137
2005/06	Turkland Bank	0.79506566	0.85004860
2005/06	Türk Ekonomi Bankası	0.86991859	1.00000000
2005/06	Ziraat Bankası	1.00000000	1.00000000
2005/06	Alternatifbank	0.74738904	0.98450932
2005/09	Akbank	1.00000000	1.00000000
2005/09	Denizbank	0.92618902	0.94714485
2005/09	Finansbank	1.00000000	0.92621417
2005/09	Garanti	0.87847972	0.97096029
2005/09	Halkbank	1.00000000	0.87242279
2005/09	İsbank	0.85756381	1.00000000
2005/09	Sekerbank	0.86604883	0.72086237
2005/09	Tekstilbank	0.71955489	1.00000000
2005/09	Vakıfbank	0.82376728	0.79186480
2005/09	Anadolubank	0.85165646	0.87158880
2005/09	Arap Türk Bankası	1.00000000	1.00000000
2005/09	Burgan Bank	0.68454352	0.71441456
2005/09	Citibank	1.00000000	1.00000000
2005/09	Fibabanka	0.57639657	0.91220202
2005/09	HSBC Bank	0.97338089	1.00000000
2005/09	ING Bank	0.86510394	0.95484237
2005/09	Turkish Bank	0.80971875	0.86090772
2005/09	Turkland Bank	0.82762165	0.84437282
2005/09	Türk Ekonomi Bankası	0.90203110	1.00000000
2005/09	Ziraat Bankası	1.00000000	1.00000000
2005/09	Alternatifbank	0.82379002	0.96943394
2005/12	Akbank	1.00000000	1.00000000
2005/12	Denizbank	0.91563104	0.92706832
2005/12	Finansbank	1.00000000	0.93465849
2005/12	Garanti	0.88427444	1.00000000
2005/12	Halkbank	0.93224362	0.81031652

2005/12	İsbank	0.88670054	1.00000000
2005/12	Sekerbank	0.86805827	0.72563781
2005/12	Tekstilbank	0.79219740	1.00000000
2005/12	Vakıfbank	0.86404959	0.90054553
2005/12	Anadolubank	0.83933478	0.78639733
2005/12	Arap Türk Bankası	1.00000000	1.00000000
2005/12	Burgan Bank	0.70438071	0.88260282
2005/12	Citibank	1.00000000	1.00000000
2005/12	Fibabanka	0.61243991	0.98482837
2005/12	HSBC Bank	0.96292875	0.96472922
2005/12	ING Bank	0.88679899	0.86177783
2005/12	Turkish Bank	0.82456782	0.74168354
2005/12	Turkland Bank	0.80847976	0.78756796
2005/12	Türk Ekonomi Bankası	0.87763496	1.00000000
2005/12	Ziraat Bankası	1.00000000	1.00000000
2005/12	Alternatifbank	0.84584887	0.92632539
2006/03	Akbank	1.00000000	1.00000000
2006/03	Denizbank	0.82073881	0.97991810
2006/03	Finansbank	1.00000000	0.97464475
2006/03	Garanti	0.98531951	1.00000000
2006/03	Halkbank	1.00000000	1.00000000
2006/03	İsbank	0.94579493	0.85291517
2006/03	Sekerbank	1.00000000	0.72360055
2006/03	Tekstilbank	0.77676329	1.00000000
2006/03	Vakıfbank	1.00000000	1.00000000
2006/03	Yapı Kredi	0.79150816	0.81530513
2006/03	Anadolubank	0.81137055	0.99237884
2006/03	Arap Türk Bankası	0.79547912	1.00000000
2006/03	Burgan Bank	0.69409508	0.74509102
2006/03	Citibank	1.00000000	1.00000000
2006/03	Fibabanka	0.55908794	1.00000000
2006/03	HSBC Bank	0.89996073	0.97869428
2006/03	ING Bank	0.87984324	1.00000000
2006/03	Turkish Bank	0.83462223	0.68968122
2006/03	Turkland Bank	0.75537249	0.77249742
2006/03	Türk Ekonomi Bankası	0.89960768	1.00000000
2006/03	Ziraat Bankası	1.00000000	1.00000000
2006/03	Alternatifbank	0.98318139	1.00000000
2006/06	Akbank	1.00000000	1.00000000
2006/06	Denizbank	0.87909405	0.86631822
2006/06	Finansbank	1.00000000	0.89617709
2006/06	Garanti	0.97215098	1.00000000

2006/06	Halkbank	1.00000000	1.00000000
2006/06	İsbank	1.00000000	0.86786561
2006/06	Sekerbank	1.00000000	0.67882007
2006/06	Tekstilbank	0.73357398	0.89972750
2006/06	Vakıfbank	1.00000000	0.98873368
2006/06	Yapı Kredi	0.78729662	0.83875380
2006/06	Anadolubank	0.88731396	0.97208655
2006/06	Arap Türk Bankası	0.69763467	1.00000000
2006/06	Burgan Bank	0.69781400	0.67487738
2006/06	Citibank	1.00000000	1.00000000
2006/06	Fibabanka	0.67698881	1.00000000
2006/06	HSBC Bank	1.00000000	0.95670698
2006/06	ING Bank	0.88811597	1.00000000
2006/06	Turkish Bank	0.84939199	0.71307681
2006/06	Turkland Bank	0.59863128	0.77219325
2006/06	Türk Ekonomi Bankası	0.87971778	1.00000000
2006/06	Ziraat Bankası	1.00000000	1.00000000
2006/06	Alternatifbank	0.94808205	1.00000000
2006/09	Akbank	0.99781908	0.95302971
2006/09	Denizbank	0.93625762	0.87875433
2006/09	Finansbank	1.00000000	0.83694129
2006/09	Garanti	0.92657682	1.00000000
2006/09	Halkbank	1.00000000	1.00000000
2006/09	İsbank	0.87601091	0.87148124
2006/09	Sekerbank	0.86496603	0.65025143
2006/09	Tekstilbank	0.80035582	0.89535984
2006/09	Vakıfbank	0.97844691	0.98890771
2006/09	Yapı Kredi	0.82571658	0.78699558
2006/09	Anadolubank	0.91444555	0.89823256
2006/09	Arap Türk Bankası	0.75444075	1.00000000
2006/09	Burgan Bank	0.74606125	0.69181659
2006/09	Citibank	1.00000000	1.00000000
2006/09	Fibabanka	0.57060877	1.00000000
2006/09	HSBC Bank	0.96374251	0.89356890
2006/09	ING Bank	0.87957968	0.97954902
2006/09	Turkish Bank	0.82409793	0.62580849
2006/09	Turkland Bank	0.67594638	0.79125689
2006/09	Türk Ekonomi Bankası	0.88122571	0.94462483
2006/09	Ziraat Bankası	1.00000000	1.00000000
2006/09	Alternatifbank	1.00000000	1.00000000
2006/12	Akbank	0.97452074	0.96540092
2006/12	Denizbank	0.99043566	1.00000000

2006/12	Finansbank	1.00000000	0.98366623
2006/12	Garanti	0.93902139	1.00000000
2006/12	Halkbank	1.00000000	1.00000000
2006/12	İsbank	0.88602063	0.90073350
2006/12	Sekerbank	1.00000000	0.82175820
2006/12	Tekstilbank	0.88249661	1.00000000
2006/12	Vakıfbank	0.94308725	0.94605568
2006/12	Yapı Kredi	0.85911888	0.90733587
2006/12	Anadolubank	0.90221927	0.85010366
2006/12	Arap Türk Bankası	0.95291476	1.00000000
2006/12	Burgan Bank	0.82274701	0.85226957
2006/12	Citibank	1.00000000	1.00000000
2006/12	Fibabanka	0.68203618	0.98942482
2006/12	HSBC Bank	1.00000000	1.00000000
2006/12	ING Bank	0.88156820	1.00000000
2006/12	Turkish Bank	0.85268997	0.65750004
2006/12	Turkland Bank	0.69673332	0.68524610
2006/12	Türk Ekonomi Bankası	0.90316508	1.00000000
2006/12	Ziraat Bankası	1.00000000	1.00000000
2006/12	Alternatifbank	1.00000000	0.96555165
2007/03	Akbank	0.96664189	1.00000000
2007/03	Denizbank	0.89858118	1.00000000
2007/03	Finansbank	1.00000000	1.00000000
2007/03	Garanti	0.96497201	1.00000000
2007/03	Halkbank	0.99322484	1.00000000
2007/03	İsbank	0.89547077	0.90191414
2007/03	Sekerbank	0.97181639	0.87102672
2007/03	Tekstilbank	0.92607284	1.00000000
2007/03	Vakıfbank	0.88864565	0.86088479
2007/03	Yapı Kredi	0.83476918	0.85157190
2007/03	Anadolubank	0.93482942	0.85370416
2007/03	Arap Türk Bankası	0.92449895	1.00000000
2007/03	Burgan Bank	0.74186111	0.75658653
2007/03	Citibank	1.00000000	1.00000000
2007/03	HSBC Bank	0.95726127	1.00000000
2007/03	ING Bank	0.82162989	0.87801668
2007/03	Turkish Bank	0.83275738	0.84278901
2007/03	Turkland Bank	0.83366545	0.72656782
2007/03	Türk Ekonomi Bankası	0.87475183	0.91028911
2007/03	Ziraat Bankası	1.00000000	1.00000000
2007/03	Alternatifbank	1.00000000	1.00000000
2007/06	Akbank	0.95986273	1.00000000

2007/06	Denizbank	0.87949374	0.99761282
2007/06	Finansbank	1.00000000	1.00000000
2007/06	Garanti	1.00000000	1.00000000
2007/06	Halkbank	0.90607017	0.91287668
2007/06	İsbank	0.82050959	0.83705984
2007/06	Sekerbank	0.89659523	0.88935553
2007/06	Tekstilbank	0.91816359	1.00000000
2007/06	Vakıfbank	0.87708183	0.88353992
2007/06	Yapı Kredi	0.81516937	0.87512773
2007/06	Anadolubank	0.91265998	0.90874789
2007/06	Arap Türk Bankası	1.00000000	1.00000000
2007/06	Burgan Bank	0.73700018	0.83907218
2007/06	Citibank	1.00000000	1.00000000
2007/06	HSBC Bank	0.96654434	1.00000000
2007/06	ING Bank	0.83245459	0.86814583
2007/06	Turkish Bank	0.80635326	0.91715462
2007/06	Turkland Bank	0.82365612	0.74564591
2007/06	Türk Ekonomi Bankası	0.84309859	0.88177329
2007/06	Ziraat Bankası	1.00000000	1.00000000
2007/06	Alternatifbank	1.00000000	1.00000000
2007/09	Akbank	0.95001204	0.99567000
2007/09	Denizbank	0.88267467	0.97753757
2007/09	Finansbank	1.00000000	0.98654116
2007/09	Garanti	1.00000000	1.00000000
2007/09	Halkbank	0.92932122	0.99482529
2007/09	İsbank	0.86257791	0.82951473
2007/09	Sekerbank	0.92729485	0.87723709
2007/09	Tekstilbank	0.91049408	0.88477136
2007/09	Vakıfbank	0.90289375	0.91858686
2007/09	Yapı Kredi	0.83392193	0.88931437
2007/09	Anadolubank	0.93400533	0.83720967
2007/09	Arap Türk Bankası	1.00000000	1.00000000
2007/09	Burgan Bank	0.80064565	1.00000000
2007/09	Citibank	1.00000000	1.00000000
2007/09	HSBC Bank	0.99540690	1.00000000
2007/09	ING Bank	0.85083776	0.88351539
2007/09	Turkish Bank	0.83203535	0.87672591
2007/09	Turkland Bank	0.80073382	0.72347752
2007/09	Türk Ekonomi Bankası	0.84589283	0.94167674
2007/09	Ziraat Bankası	1.00000000	1.00000000
2007/09	Alternatifbank	1.00000000	1.00000000
2007/12	Akbank	0.97713790	0.97809142

2007/12	Denizbank	0.92271968	0.99288630
2007/12	Finansbank	1.00000000	0.95313798
2007/12	Garanti	1.00000000	1.00000000
2007/12	Halkbank	0.95772642	1.00000000
2007/12	İsbank	0.90476561	0.84869795
2007/12	Sekerbank	0.94609798	0.89879623
2007/12	Tekstilbank	0.92999026	1.00000000
2007/12	Vakıfbank	0.92181894	1.00000000
2007/12	Yapı Kredi	0.83606465	0.86209016
2007/12	Anadolubank	0.99608284	0.82432553
2007/12	Arap Türk Bankası	1.00000000	1.00000000
2007/12	Burgan Bank	0.83519511	1.00000000
2007/12	Citibank	1.00000000	0.96690335
2007/12	HSBC Bank	0.97880251	1.00000000
2007/12	ING Bank	0.89466993	0.91509180
2007/12	Turkish Bank	0.84634940	0.89455116
2007/12	Turkland Bank	0.79157601	0.79172859
2007/12	Türk Ekonomi Bankası	0.88772986	0.80610758
2007/12	Ziraat Bankası	1.00000000	1.00000000
2007/12	Alternatifbank	1.00000000	1.00000000
2008/03	Akbank	0.97192876	1.00000000
2008/03	Denizbank	0.91239634	0.81639821
2008/03	Finansbank	1.00000000	0.78732941
2008/03	Garanti	0.90265370	0.86911048
2008/03	Halkbank	1.00000000	1.00000000
2008/03	İsbank	0.91908436	0.86219676
2008/03	Sekerbank	1.00000000	0.75338852
2008/03	Tekstilbank	0.92446393	0.87185216
2008/03	Vakıfbank	0.90746130	0.95769748
2008/03	Yapı Kredi	0.91544061	0.82139119
2008/03	Anadolubank	0.95443704	0.75537945
2008/03	Burgan Bank	0.91585339	0.90032665
2008/03	Citibank	1.00000000	0.77752291
2008/03	Fibabanka	0.89407657	1.00000000
2008/03	HSBC Bank	0.95096873	0.65196173
2008/03	ING Bank	0.94150149	0.87508350
2008/03	Turkish Bank	1.00000000	0.75384582
2008/03	Turkland Bank	0.81933431	0.78192155
2008/03	Türk Ekonomi Bankası	0.88347133	0.61492440
2008/03	Ziraat Bankası	1.00000000	1.00000000
2008/03	Alternatifbank	1.00000000	0.91709137
2008/06	Akbank	0.99379846	0.90297130

2008/06	Denizbank	0.90530116	0.83831898
2008/06	Finansbank	0.96713108	0.75802321
2008/06	Garanti	0.97309918	0.90380084
2008/06	Halkbank	1.00000000	1.00000000
2008/06	İsbank	0.97759068	0.79556411
2008/06	Sekerbank	0.94167665	0.71709406
2008/06	Tekstilbank	0.86580649	0.82696895
2008/06	Vakıfbank	0.92624177	1.00000000
2008/06	Yapı Kredi	0.94648415	0.78376270
2008/06	Anadolubank	0.95466287	0.84490022
2008/06	Burgan Bank	0.93794715	0.91147100
2008/06	Citibank	1.00000000	0.66172639
2008/06	Fibabanka	0.91365982	1.00000000
2008/06	HSBC Bank	0.96258983	0.68861492
2008/06	ING Bank	0.93673397	0.87475856
2008/06	Turkish Bank	1.00000000	0.76183157
2008/06	Turkland Bank	0.80404047	0.79648534
2008/06	Türk Ekonomi Bankası	0.88520794	0.67284112
2008/06	Ziraat Bankası	1.00000000	1.00000000
2008/06	Alternatifbank	1.00000000	1.00000000
2008/09	Akbank	0.90278238	0.89980172
2008/09	Denizbank	0.90849654	0.82561676
2008/09	Finansbank	0.94022676	0.78411640
2008/09	Garanti	0.89594345	0.94720545
2008/09	Halkbank	1.00000000	1.00000000
2008/09	İsbank	0.83254808	0.79889788
2008/09	Sekerbank	0.88766285	0.70119485
2008/09	Tekstilbank	0.85518922	0.76102115
2008/09	Vakıfbank	0.88009072	0.92254691
2008/09	Yapı Kredi	0.84699810	0.84784947
2008/09	Anadolubank	0.99951771	0.83088300
2008/09	Arap Türk Bankası	1.00000000	1.00000000
2008/09	Burgan Bank	0.90421414	0.88012462
2008/09	Citibank	0.82157467	0.79373667
2008/09	Fibabanka	0.87603447	1.00000000
2008/09	HSBC Bank	0.85016955	0.68446559
2008/09	ING Bank	0.88434028	0.89046737
2008/09	Turkish Bank	0.89620757	0.76600182
2008/09	Turkland Bank	0.76110098	0.82331459
2008/09	Türk Ekonomi Bankası	0.83073259	0.71371495
2008/09	Ziraat Bankası	1.00000000	1.00000000
2008/09	Alternatifbank	1.00000000	1.00000000

2008/12	Akbank	0.98392851	0.97559567
2008/12	Denizbank	0.97756713	0.94226776
2008/12	Finansbank	0.95598247	0.90975079
2008/12	Garanti	1.00000000	1.00000000
2008/12	Halkbank	0.97468480	1.00000000
2008/12	İsbank	0.97410278	0.89458857
2008/12	Sekerbank	0.96837437	0.85891713
2008/12	Tekstilbank	0.86961354	0.59323914
2008/12	Vakıfbank	0.92247934	0.90955895
2008/12	Yapı Kredi	1.00000000	0.89482991
2008/12	Anadolubank	1.00000000	0.83367019
2008/12	Burgan Bank	0.84237740	0.77280174
2008/12	Citibank	1.00000000	1.00000000
2008/12	Fibabanka	0.89346763	1.00000000
2008/12	HSBC Bank	1.00000000	0.76733469
2008/12	ING Bank	0.90871652	0.89113942
2008/12	Turkish Bank	0.96280009	0.80915935
2008/12	Turkland Bank	0.86001361	0.74241106
2008/12	Türk Ekonomi Bankası	0.89119708	0.65291212
2008/12	Ziraat Bankası	1.00000000	1.00000000
2008/12	Alternatifbank	0.94094885	0.86177257
2009/03	Akbank	0.96024912	1.00000000
2009/03	Denizbank	1.00000000	1.00000000
2009/03	Finansbank	0.92550622	0.82308974
2009/03	Garanti	1.00000000	0.90778247
2009/03	Halkbank	0.96986905	1.00000000
2009/03	İsbank	0.95875499	0.94048428
2009/03	Sekerbank	0.98997072	0.84819357
2009/03	Tekstilbank	0.87021088	0.69373113
2009/03	Vakıfbank	0.92698016	0.99692998
2009/03	Yapı Kredi	1.00000000	0.94711779
2009/03	Anadolubank	1.00000000	0.90743246
2009/03	Burgan Bank	0.92857514	0.69873413
2009/03	Citibank	1.00000000	1.00000000
2009/03	Fibabanka	0.64917086	1.00000000
2009/03	HSBC Bank	1.00000000	0.85232403
2009/03	ING Bank	0.95470095	0.87825903
2009/03	Turkish Bank	0.85369838	0.93609434
2009/03	Turkland Bank	0.90509209	0.79195846
2009/03	Türk Ekonomi Bankası	0.88687662	0.67843875
2009/03	Ziraat Bankası	1.00000000	1.00000000
2009/03	Alternatifbank	0.90958212	0.69567505

2009/06	Akbank	0.99351333	1.00000000
2009/06	Denizbank	1.00000000	1.00000000
2009/06	Finansbank	0.92036838	0.77741262
2009/06	Garanti	1.00000000	0.90128025
2009/06	Halkbank	0.94575214	1.00000000
2009/06	İsbank	0.97400866	1.00000000
2009/06	Sekerbank	0.95690912	0.86803347
2009/06	Tekstilbank	0.80652432	0.70795483
2009/06	Vakıfbank	0.90117176	1.00000000
2009/06	Yapı Kredi	1.00000000	0.90648359
2009/06	Anadolubank	1.00000000	0.98662962
2009/06	Burgan Bank	0.97157975	0.58795986
2009/06	Citibank	1.00000000	1.00000000
2009/06	Fibabanka	0.64114133	1.00000000
2009/06	HSBC Bank	1.00000000	0.91621316
2009/06	ING Bank	0.97060232	0.98544745
2009/06	Turkish Bank	0.76849783	0.98009016
2009/06	Turkland Bank	0.89416954	0.82049079
2009/06	Türk Ekonomi Bankası	0.82969801	0.66766460
2009/06	Ziraat Bankası	1.00000000	1.00000000
2009/06	Alternatifbank	0.87619920	0.86999553
2009/09	Akbank	1.00000000	0.96145086
2009/09	Denizbank	0.81558746	0.92013756
2009/09	Finansbank	0.75814909	0.71077471
2009/09	Garanti	1.00000000	0.87643698
2009/09	Halkbank	0.94627153	1.00000000
2009/09	İsbank	0.96010326	0.97473275
2009/09	Sekerbank	0.77786385	0.80897751
2009/09	Tekstilbank	0.69562032	0.71450942
2009/09	Vakıfbank	0.84742058	1.00000000
2009/09	Yapı Kredi	1.00000000	0.86490058
2009/09	Anadolubank	0.97495991	1.00000000
2009/09	Arap Türk Bankası	1.00000000	1.00000000
2009/09	Burgan Bank	0.90859382	0.56987454
2009/09	Citibank	1.00000000	1.00000000
2009/09	Fibabanka	0.54550619	1.00000000
2009/09	HSBC Bank	0.88530096	0.87198311
2009/09	ING Bank	0.85674962	0.89769724
2009/09	Turkish Bank	0.70683339	1.00000000
2009/09	Turkland Bank	0.80631823	0.75377226
2009/09	Türk Ekonomi Bankası	0.79421331	0.74585083
2009/09	Ziraat Bankası	1.00000000	1.00000000

2009/09	Alternatifbank	0.80644715	0.86872556
2009/12	Akbank	0.99549576	0.93186226
2009/12	Denizbank	0.80877839	0.86282869
2009/12	Finansbank	0.77732529	0.75942156
2009/12	Garanti	1.00000000	0.86375835
2009/12	Halkbank	0.93975775	1.00000000
2009/12	İsbank	0.97670653	0.90393649
2009/12	Sekerbank	0.75520899	0.74519239
2009/12	Tekstilbank	0.66297963	0.80167683
2009/12	Vakıfbank	0.84320287	0.96822776
2009/12	Yapı Kredi	0.97180829	0.77467973
2009/12	Anadolubank	0.89885015	0.94625923
2009/12	Arap Türk Bankası	1.00000000	1.00000000
2009/12	Burgan Bank	0.83906779	0.55810516
2009/12	Citibank	1.00000000	0.76149257
2009/12	Fibabanka	0.58839067	1.00000000
2009/12	HSBC Bank	0.75458406	0.77473767
2009/12	ING Bank	0.87084726	0.93739661
2009/12	Turkish Bank	0.65519803	1.00000000
2009/12	Turkland Bank	0.63942363	0.83611589
2009/12	Türk Ekonomi Bankası	0.75439530	0.77213514
2009/12	Ziraat Bankası	1.00000000	1.00000000
2009/12	Alternatifbank	0.76057230	0.90648320
2010/03	Akbank	1.00000000	0.97089487
2010/03	Denizbank	0.96161150	0.81140941
2010/03	Finansbank	0.95881206	0.81567487
2010/03	Garanti	1.00000000	0.91746170
2010/03	Halkbank	0.98845807	1.00000000
2010/03	İsbank	0.99501534	0.90983932
2010/03	Sekerbank	0.73249950	0.67684042
2010/03	Tekstilbank	0.80546394	0.85912622
2010/03	Vakıfbank	0.82913886	0.91225795
2010/03	Yapı Kredi	1.00000000	0.99742369
2010/03	Anadolubank	0.95848083	0.95695712
2010/03	Arap Türk Bankası	1.00000000	1.00000000
2010/03	Burgan Bank	0.76621882	0.60615951
2010/03	Citibank	0.76486629	0.87071182
2010/03	Fibabanka	0.68871068	1.00000000
2010/03	HSBC Bank	0.91857673	0.77192469
2010/03	ING Bank	0.97294095	0.87836440
2010/03	Turkish Bank	0.74902620	0.88776588
2010/03	Turkland Bank	0.84797635	0.82739758

2010/03	Türk Ekonomi Bankası	0.76463939	0.78708495
2010/03	Ziraat Bankası	1.00000000	1.00000000
2010/03	Alternatifbank	0.81926446	1.00000000
2010/06	Akbank	1.00000000	0.97295035
2010/06	Denizbank	0.97123209	0.82243670
2010/06	Finansbank	0.97748986	0.79620524
2010/06	Garanti	1.00000000	0.90423617
2010/06	Halkbank	1.00000000	1.00000000
2010/06	İsbank	1.00000000	0.88275165
2010/06	Sekerbank	0.78252745	0.69948515
2010/06	Tekstilbank	0.80189082	0.83835930
2010/06	Vakıfbank	0.80991611	0.85048794
2010/06	Yapı Kredi	1.00000000	1.00000000
2010/06	Anadolubank	0.99008046	0.88339873
2010/06	Arap Türk Bankası	1.00000000	1.00000000
2010/06	Burgan Bank	0.68921662	0.56836227
2010/06	Citibank	0.79918837	0.89583367
2010/06	Fibabanka	0.72248562	1.00000000
2010/06	HSBC Bank	0.86189056	0.70267381
2010/06	ING Bank	0.96947699	0.84940504
2010/06	Turkish Bank	0.78760045	1.00000000
2010/06	Turkland Bank	0.71128353	0.83293841
2010/06	Türk Ekonomi Bankası	0.78750905	0.78122900
2010/06	Ziraat Bankası	1.00000000	1.00000000
2010/06	Alternatifbank	0.82900533	1.00000000
2010/09	Akbank	1.00000000	0.97143180
2010/09	Denizbank	0.92977469	0.81977619
2010/09	Finansbank	0.97092379	0.78521324
2010/09	Garanti	1.00000000	0.92769241
2010/09	Halkbank	1.00000000	1.00000000
2010/09	İsbank	0.94488156	0.83945014
2010/09	Sekerbank	0.78887542	0.68214571
2010/09	Tekstilbank	0.78114669	0.83665241
2010/09	Vakıfbank	0.82664553	0.84721215
2010/09	Yapı Kredi	1.00000000	0.93993762
2010/09	Anadolubank	1.00000000	0.89438478
2010/09	Arap Türk Bankası	1.00000000	1.00000000
2010/09	Burgan Bank	0.70887404	0.54172436
2010/09	Citibank	0.83567587	0.89650812
2010/09	Fibabanka	0.71363188	0.91111352
2010/09	HSBC Bank	0.85964779	0.65327320
2010/09	ING Bank	0.97245123	0.83802088

2010/09	Turkish Bank	0.80551664	1.00000000
2010/09	Turkland Bank	0.71349968	0.73948982
2010/09	Türk Ekonomi Bankası	0.77448689	0.73694345
2010/09	Ziraat Bankası	1.00000000	1.00000000
2010/09	Alternatifbank	0.84209779	1.00000000
2010/12	Akbank	1.00000000	0.96686805
2010/12	Denizbank	0.93116529	0.84923242
2010/12	Finansbank	0.98921971	0.86184812
2010/12	Garanti	1.00000000	0.91068185
2010/12	Halkbank	0.99483209	1.00000000
2010/12	İsbank	0.96842662	0.83653457
2010/12	Sekerbank	0.79694935	0.67531050
2010/12	Tekstilbank	0.76695139	0.98254445
2010/12	Vakıfbank	0.83392719	0.86634544
2010/12	Yapı Kredi	1.00000000	0.91996280
2010/12	Anadolubank	1.00000000	0.93814604
2010/12	Arap Türk Bankası	1.00000000	1.00000000
2010/12	Burgan Bank	0.70414012	0.50457341
2010/12	Citibank	0.83702121	0.76487119
2010/12	Fibabanka	0.69609979	0.83717738
2010/12	HSBC Bank	0.86489605	0.63413309
2010/12	ING Bank	0.96204897	0.88376133
2010/12	Turkish Bank	0.79738205	1.00000000
2010/12	Turkland Bank	0.69514320	0.68498048
2010/12	Türk Ekonomi Bankası	0.76911709	0.76056260
2010/12	Ziraat Bankası	1.00000000	1.00000000
2010/12	Alternatifbank	0.69939897	0.81217459
2011/03	Akbank	0.98702530	0.98427137
2011/03	Denizbank	0.91038238	0.80092421
2011/03	Finansbank	0.98168006	0.79467514
2011/03	Garanti	1.00000000	0.88430681
2011/03	Halkbank	1.00000000	1.00000000
2011/03	İsbank	0.88690664	0.84011166
2011/03	Sekerbank	0.77881225	0.70929420
2011/03	Tekstilbank	0.76633787	0.86395499
2011/03	Vakıfbank	0.91044099	0.93830393
2011/03	Yapı Kredi	0.93971385	0.84738809
2011/03	Anadolubank	0.94083702	0.85677791
2011/03	Arap Türk Bankası	1.00000000	1.00000000
2011/03	Burgan Bank	1.00000000	0.56439110
2011/03	Citibank	0.76754977	0.43753664
2011/03	Fibabanka	0.72070982	1.00000000

2011/03	HSBC Bank	0.80309348	0.60884860
2011/03	ING Bank	0.86215632	0.84106872
2011/03	Turkish Bank	0.75029897	0.47685616
2011/03	Turkland Bank	0.72521447	0.73997589
2011/03	Türk Ekonomi Bankası	0.80708397	0.92745209
2011/03	Ziraat Bankası	1.00000000	1.00000000
2011/03	Alternatifbank	0.80141224	0.92485058
2011/06	Akbank	0.97283730	1.00000000
2011/06	Denizbank	0.92604286	0.75626465
2011/06	Finansbank	0.97449585	0.76500752
2011/06	Garanti	1.00000000	0.90667348
2011/06	Halkbank	1.00000000	1.00000000
2011/06	İsbank	0.87502836	0.82196572
2011/06	Sekerbank	0.74174587	0.61492485
2011/06	Tekstilbank	0.79969480	0.87864278
2011/06	Vakıfbank	0.87762469	0.91908746
2011/06	Yapı Kredi	0.86261697	0.90778420
2011/06	Anadolubank	0.94975009	0.78148999
2011/06	Arap Türk Bankası	1.00000000	1.00000000
2011/06	Burgan Bank	0.81802924	0.57160166
2011/06	Citibank	0.80510025	0.45103661
2011/06	Fibabanka	0.79155493	1.00000000
2011/06	HSBC Bank	0.85062682	0.62190572
2011/06	ING Bank	0.83432029	0.74708127
2011/06	Turkish Bank	0.74286259	0.51252697
2011/06	Turkland Bank	0.73714048	0.69816975
2011/06	Türk Ekonomi Bankası	0.81668691	0.90529153
2011/06	Ziraat Bankası	1.00000000	1.00000000
2011/06	Alternatifbank	0.80537370	0.85860822
2011/09	Akbank	0.96036386	1.00000000
2011/09	Denizbank	0.87396479	0.69765254
2011/09	Finansbank	0.94112263	0.72634107
2011/09	Garanti	1.00000000	0.93427440
2011/09	Halkbank	1.00000000	1.00000000
2011/09	İsbank	0.84142910	0.83007366
2011/09	Sekerbank	0.75394051	0.60720784
2011/09	Tekstilbank	0.79463998	0.80439534
2011/09	Vakıfbank	0.87450169	0.87646588
2011/09	Yapı Kredi	0.85368300	0.87592131
2011/09	Anadolubank	0.95181954	0.76337536
2011/09	Arap Türk Bankası	1.00000000	1.00000000
2011/09	Burgan Bank	0.80070318	0.61691978

2011/09	Citibank	0.76618068	0.59209208
2011/09	Fibabanka	0.78093001	1.00000000
2011/09	HSBC Bank	0.81881418	0.59132861
2011/09	ING Bank	0.86309512	0.67715048
2011/09	Turkish Bank	0.73083052	0.55687610
2011/09	Turkland Bank	0.74135616	0.68091736
2011/09	Türk Ekonomi Bankası	0.81802842	0.80744271
2011/09	Ziraat Bankası	1.00000000	1.00000000
2011/09	Alternatifbank	0.81350886	0.78220631
2011/12	Akbank	1.00000000	1.00000000
2011/12	Denizbank	0.87182386	0.65245533
2011/12	Finansbank	0.92907003	0.69641547
2011/12	Garanti	1.00000000	0.89675677
2011/12	Halkbank	1.00000000	1.00000000
2011/12	İsbank	0.90112084	0.86098513
2011/12	Sekerbank	0.77297597	0.56428539
2011/12	Tekstilbank	0.81070424	0.84649163
2011/12	Vakıfbank	0.86412846	0.88031731
2011/12	Yapı Kredi	0.87616446	0.88046276
2011/12	Anadolubank	0.96977558	0.72964324
2011/12	Arap Türk Bankası	1.00000000	1.00000000
2011/12	Burgan Bank	0.86898243	0.61142451
2011/12	Citibank	0.78325632	0.38110038
2011/12	Fibabanka	0.79915772	1.00000000
2011/12	HSBC Bank	0.80952741	0.56291351
2011/12	ING Bank	0.86343465	0.70598413
2011/12	Turkish Bank	0.73315861	0.45829894
2011/12	Turkland Bank	0.73277066	0.66326037
2011/12	Türk Ekonomi Bankası	0.82316129	0.76536148
2011/12	Ziraat Bankası	1.00000000	1.00000000
2011/12	Alternatifbank	0.83723163	0.72795444
2012/03	Akbank	0.84794912	1.00000000
2012/03	Denizbank	0.81256801	0.74834322
2012/03	Finansbank	0.80687227	0.73412576
2012/03	Garanti	1.00000000	0.96835853
2012/03	Halkbank	1.00000000	1.00000000
2012/03	İsbank	0.81542840	0.89445527
2012/03	Sekerbank	0.72290298	0.57766951
2012/03	Tekstilbank	0.79331554	0.83282213
2012/03	Vakıfbank	0.81444733	0.90403754
2012/03	Yapı Kredi	0.76326808	0.94240070
2012/03	Anadolubank	0.97522270	0.79293980

2012/03	Arap Türk Bankası	1.00000000	1.00000000
2012/03	Burgan Bank	0.89932516	0.62764203
2012/03	Citibank	0.72754447	0.67385863
2012/03	Fibabanka	0.77641925	0.96298923
2012/03	HSBC Bank	0.72740811	0.70081246
2012/03	ING Bank	0.82098440	0.95857028
2012/03	Turkish Bank	0.58261526	0.92904721
2012/03	Turkland Bank	0.79718324	0.80436884
2012/03	Türk Ekonomi Bankası	0.78897905	0.88529273
2012/03	Ziraat Bankası	1.00000000	1.00000000
2012/03	Alternatifbank	0.77443800	0.64874629
2012/06	Akbank	0.89638643	1.00000000
2012/06	Denizbank	0.77949051	0.75289091
2012/06	Finansbank	0.78342100	0.74629537
2012/06	Garanti	0.98734486	0.95881765
2012/06	Halkbank	1.00000000	1.00000000
2012/06	İsbank	0.85300696	0.87461036
2012/06	Sekerbank	0.73792571	0.60938548
2012/06	Tekstilbank	0.78549146	0.87442447
2012/06	Vakıfbank	0.82562932	0.90652260
2012/06	Yapı Kredi	0.76842162	0.94944909
2012/06	Anadolubank	0.98897527	0.78446230
2012/06	Arap Türk Bankası	1.00000000	1.00000000
2012/06	Burgan Bank	0.93179531	0.66272059
2012/06	Citibank	0.67096740	0.63551161
2012/06	Fibabanka	0.87293538	1.00000000
2012/06	HSBC Bank	0.67969240	0.69582929
2012/06	ING Bank	0.64717085	0.83769335
2012/06	Turkish Bank	0.57993562	0.70033901
2012/06	Turkland Bank	0.80495492	0.85508466
2012/06	Türk Ekonomi Bankası	0.77235503	0.88993661
2012/06	Ziraat Bankası	1.00000000	1.00000000
2012/06	Alternatifbank	0.76116847	0.70779070
2012/09	Akbank	0.91623580	1.00000000
2012/09	Denizbank	0.77758163	0.84959496
2012/09	Finansbank	0.80391295	0.83374186
2012/09	Garanti	1.00000000	0.90142401
2012/09	Halkbank	1.00000000	1.00000000
2012/09	İsbank	0.89024467	0.88827350
2012/09	Sekerbank	0.72384033	0.64870412
2012/09	Tekstilbank	0.77465740	0.91063934
2012/09	Vakıfbank	0.84358274	0.93342090

2012/09	Yapı Kredi	0.81506458	0.99224029
2012/09	Anadolubank	0.99407685	0.80046598
2012/09	Arap Türk Bankası	1.00000000	1.00000000
2012/09	Burgan Bank	0.84212195	0.65281303
2012/09	Citibank	0.64232209	0.88485058
2012/09	Fibabanka	0.92230468	1.00000000
2012/09	HSBC Bank	0.70654579	0.79451480
2012/09	ING Bank	0.72737804	0.99096376
2012/09	Turkish Bank	0.60963970	0.81597811
2012/09	Turkland Bank	0.81037646	0.86088369
2012/09	Türk Ekonomi Bankası	0.80271047	0.91432286
2012/09	Ziraat Bankası	1.00000000	1.00000000
2012/09	Alternatifbank	0.77450716	0.72477523
2012/12	Akbank	1.00000000	1.00000000
2012/12	Denizbank	0.80549114	0.62256804
2012/12	Finansbank	0.80483443	0.58353633
2012/12	Garanti	0.95460631	0.86159218
2012/12	Halkbank	1.00000000	1.00000000
2012/12	İsbank	0.98976999	0.83499384
2012/12	Sekerbank	0.73927211	0.46825746
2012/12	Tekstilbank	0.82343825	0.73773151
2012/12	Vakıfbank	0.85650287	0.80163333
2012/12	Yapı Kredi	0.82232042	0.78092045
2012/12	Odeabank	1.00000000	1.00000000
2012/12	Anadolubank	0.95684665	0.60859337
2012/12	Arap Türk Bankası	1.00000000	1.00000000
2012/12	Burgan Bank	0.71959692	0.50583699
2012/12	Citibank	0.65603855	0.36740279
2012/12	Fibabanka	0.90492296	1.00000000
2012/12	HSBC Bank	0.74446330	0.49509134
2012/12	ING Bank	0.77855558	0.62611751
2012/12	Turkish Bank	0.65595727	0.53830889
2012/12	Turkland Bank	0.75992292	0.66888398
2012/12	Türk Ekonomi Bankası	0.82344311	0.70326054
2012/12	Ziraat Bankası	1.00000000	1.00000000
2012/12	Alternatifbank	0.79021045	0.52712457
2013/03	Akbank	0.95052825	0.96382433
2013/03	Denizbank	0.76680232	0.66331092
2013/03	Finansbank	0.82371393	0.73501437
2013/03	Garanti	0.96792585	0.93166537
2013/03	Halkbank	1.00000000	1.00000000
2013/03	İsbank	0.94102902	0.91659470

2013/03	Sekerbank	0.76509578	0.65553974
2013/03	Tekstilbank	0.75468014	0.86530318
2013/03	Vakıfbank	0.83513644	0.83378741
2013/03	Yapı Kredi	0.83836111	0.89760250
2013/03	Odeabank	0.45388510	0.99493088
2013/03	Anadolubank	0.92152189	0.80779531
2013/03	Arap Türk Bankası	1.00000000	1.00000000
2013/03	Burgan Bank	0.62739084	0.67123068
2013/03	Citibank	1.00000000	1.00000000
2013/03	Fibabanka	0.84916982	1.00000000
2013/03	HSBC Bank	0.66295202	0.62013143
2013/03	ING Bank	0.74097799	0.81993772
2013/03	Turkish Bank	0.60384834	0.54699856
2013/03	Turkland Bank	0.82787455	0.91284389
2013/03	Türk Ekonomi Bankası	0.80059048	0.85208433
2013/03	Ziraat Bankası	1.00000000	1.00000000
2013/03	Alternatifbank	0.75305471	0.65203276
2013/06	Akbank	1.00000000	1.00000000
2013/06	Denizbank	0.82792387	0.65276258
2013/06	Finansbank	0.83855821	0.64048657
2013/06	Garanti	0.96933631	0.94743756
2013/06	Halkbank	1.00000000	1.00000000
2013/06	İsbank	0.92477705	0.92894418
2013/06	Sekerbank	0.81727464	0.66203236
2013/06	Tekstilbank	0.76165052	0.77980864
2013/06	Vakıfbank	0.86903683	0.83470665
2013/06	Yapı Kredi	0.88336886	0.91878376
2013/06	Odeabank	0.57182101	1.00000000
2013/06	Anadolubank	0.96957144	0.74491987
2013/06	Arap Türk Bankası	1.00000000	1.00000000
2013/06	Burgan Bank	0.65925662	0.68590870
2013/06	Citibank	1.00000000	0.88862556
2013/06	Fibabanka	0.88652801	1.00000000
2013/06	HSBC Bank	0.73291621	0.56973216
2013/06	ING Bank	0.82062346	0.81339485
2013/06	Turkish Bank	0.64078057	0.67640862
2013/06	Turkland Bank	0.79434600	0.81937276
2013/06	Türk Ekonomi Bankası	0.83133266	0.81642463
2013/06	Ziraat Bankası	1.00000000	1.00000000
2013/06	Alternatifbank	0.81439996	0.65020751
2013/09	Akbank	0.98844373	0.99974690
2013/09	Denizbank	0.82900104	0.63235321

2013/09	Finansbank	0.85378428	0.59654539
2013/09	Garanti	1.00000000	0.91400011
2013/09	Halkbank	1.00000000	1.00000000
2013/09	İsbank	0.93826941	0.90431710
2013/09	Sekerbank	0.80751091	0.62036012
2013/09	Tekstilbank	0.89830730	0.71383113
2013/09	Vakıfbank	0.88145997	0.81967738
2013/09	Yapı Kredi	0.90322487	0.87787984
2013/09	Odeabank	0.66925658	1.00000000
2013/09	Anadolubank	0.94985118	0.68099924
2013/09	Arap Türk Bankası	1.00000000	1.00000000
2013/09	Burgan Bank	0.69465080	0.70706101
2013/09	Citibank	1.00000000	1.00000000
2013/09	Fibabanka	0.86925092	0.96750542
2013/09	HSBC Bank	0.74544291	0.55538117
2013/09	ING Bank	0.85988324	0.75723107
2013/09	Turkish Bank	0.69808543	0.63839009
2013/09	Turkland Bank	0.78752393	0.75960452
2013/09	Türk Ekonomi Bankası	0.83564448	0.75654170
2013/09	Ziraat Bankası	1.00000000	1.00000000
2013/09	Alternatifbank	0.84957105	0.63647017
2013/12	Akbank	0.91814031	0.95888950
2013/12	Denizbank	0.79246935	0.55251900
2013/12	Finansbank	0.81205002	0.52851670
2013/12	Garanti	0.93941331	0.84327425
2013/12	Halkbank	1.00000000	0.98982543
2013/12	İsbank	0.90183596	0.85279473
2013/12	Sekerbank	0.77866865	0.53646627
2013/12	Tekstilbank	0.77157004	0.61045394
2013/12	Vakıfbank	0.87162330	0.77598249
2013/12	Yapı Kredi	0.87290836	0.78161689
2013/12	Odeabank	0.74710546	1.00000000
2013/12	Anadolubank	0.86307856	0.58239292
2013/12	Arap Türk Bankası	1.00000000	1.00000000
2013/12	Burgan Bank	0.65720274	0.65731941
2013/12	Citibank	0.99515121	0.94013556
2013/12	Fibabanka	0.89935691	0.84549825
2013/12	HSBC Bank	0.69127545	0.45832614
2013/12	ING Bank	0.84493769	0.68116525
2013/12	Turkish Bank	0.74110267	0.58930853
2013/12	Turkland Bank	0.75461217	0.67108357
2013/12	Türk Ekonomi Bankası	0.81764105	0.66312892

2013/12	Ziraat Bankası	1.00000000	1.00000000
2013/12	Alternatifbank	0.84083013	0.56450590
2014/03	Akbank	0.90117753	0.96838543
2014/03	Denizbank	0.74313459	0.59637033
2014/03	Finansbank	0.69292541	0.58632137
2014/03	Garanti	0.94162241	0.85915905
2014/03	Halkbank	0.95680159	1.00000000
2014/03	İsbank	0.84556232	0.81878349
2014/03	Sekerbank	0.71149183	0.55960463
2014/03	Tekstilbank	0.85379148	0.72384209
2014/03	Vakıfbank	0.83548342	0.83578175
2014/03	Yapı Kredi	0.78421884	0.84005249
2014/03	Odeabank	0.77112891	0.99457211
2014/03	Anadolubank	0.80869902	0.68444309
2014/03	Arap Türk Bankası	1.00000000	1.00000000
2014/03	Burgan Bank	0.71090103	0.72979762
2014/03	Citibank	1.00000000	0.88826351
2014/03	Fibabanka	0.88822061	0.94699191
2014/03	HSBC Bank	0.56119178	0.43358996
2014/03	ING Bank	0.75076486	0.73279707
2014/03	Turkish Bank	0.75404978	0.72580310
2014/03	Turkland Bank	0.89167253	0.72351200
2014/03	Türk Ekonomi Bankası	0.79565922	0.77392597
2014/03	Ziraat Bankası	1.00000000	1.00000000
2014/03	Alternatifbank	0.77013904	0.63029826
2014/06	Akbank	0.85661642	0.95654047
2014/06	Denizbank	0.71095945	0.62064282
2014/06	Finansbank	0.67199381	0.57152039
2014/06	Garanti	0.84970326	0.87409728
2014/06	Halkbank	0.95636625	0.99897417
2014/06	İsbank	0.81281435	0.83310951
2014/06	Sekerbank	0.67407877	0.51961901
2014/06	Tekstilbank	0.75209306	0.66432759
2014/06	Vakıfbank	0.80164065	0.79599722
2014/06	Yapı Kredi	0.74951234	0.82355637
2014/06	Odeabank	0.87295048	1.00000000
2014/06	Anadolubank	0.82389877	0.58644840
2014/06	Arap Türk Bankası	1.00000000	1.00000000
2014/06	Burgan Bank	0.71807314	0.75458254
2014/06	Citibank	1.00000000	0.48779121
2014/06	Fibabanka	0.83667082	0.85875657
2014/06	HSBC Bank	0.54291953	0.44185826

2014/06	ING Bank	0.65812069	0.66360497
2014/06	Turkish Bank	0.69854696	0.75745975
2014/06	Turkland Bank	0.76019677	0.67216257
2014/06	Türk Ekonomi Bankası	0.74296116	0.71021133
2014/06	Ziraat Bankası	1.00000000	1.00000000
2014/06	Alternatifbank	0.80555312	0.66652170
2014/09	Akbank	0.85476559	0.96583167
2014/09	Denizbank	0.71211268	0.65433122
2014/09	Finansbank	0.71094167	0.63958263
2014/09	Garanti	0.87148928	0.89995844
2014/09	Halkbank	0.94909334	0.98427062
2014/09	İsbank	0.86939823	0.92690769
2014/09	Sekerbank	0.68394930	0.55894712
2014/09	Tekstilbank	0.73316053	0.77470981
2014/09	Vakıfbank	0.81422598	0.84752494
2014/09	Yapı Kredi	0.75776542	0.88319650
2014/09	Odeabank	0.85239218	1.00000000
2014/09	Anadolubank	0.81950872	0.68046716
2014/09	Arap Türk Bankası	1.00000000	1.00000000
2014/09	Burgan Bank	0.70919738	0.85786917
2014/09	Citibank	1.00000000	0.48178045
2014/09	Fibabanka	0.84287359	0.92769849
2014/09	HSBC Bank	0.56228631	0.45527692
2014/09	ING Bank	0.68580367	0.75291865
2014/09	Turkish Bank	0.71333196	0.87344625
2014/09	Turkland Bank	0.80282936	0.79780435
2014/09	Türk Ekonomi Bankası	0.76337248	0.77985206
2014/09	Ziraat Bankası	1.00000000	1.00000000
2014/09	Alternatifbank	0.82681477	0.72156805
2014/12	Akbank	0.93056746	0.97814599
2014/12	Denizbank	0.73165383	0.64537969
2014/12	Finansbank	0.76704505	0.65010878
2014/12	Garanti	0.90115765	0.89789796
2014/12	Halkbank	0.93134132	0.93476549
2014/12	İsbank	0.93431839	0.93033504
2014/12	Sekerbank	0.74950162	0.57559193
2014/12	Tekstilbank	0.72549994	0.72618350
2014/12	Vakıfbank	0.90869317	0.85007938
2014/12	Yapı Kredi	0.79739941	0.90592001
2014/12	Odeabank	0.87225174	1.00000000
2014/12	Anadolubank	0.85598923	0.64640336
2014/12	Arap Türk Bankası	1.00000000	1.00000000

2014/12	Burgan Bank	0.73960786	0.86468732
2014/12	Citibank	1.00000000	0.47232529
2014/12	Fibabanka	0.84878917	0.83343306
2014/12	HSBC Bank	0.60845599	0.48777140
2014/12	ING Bank	0.71506046	0.74060192
2014/12	Turkish Bank	0.74464544	0.81979846
2014/12	Turkland Bank	0.75566003	0.67077032
2014/12	Türk Ekonomi Bankası	0.77955398	0.75274921
2014/12	Ziraat Bankası	1.00000000	1.00000000
2014/12	Alternatifbank	0.84761142	0.72400033
2015/03	Akbank	0.92197799	0.96163443
2015/03	Denizbank	0.85395769	0.61052720
2015/03	Finansbank	0.81094999	0.68931078
2015/03	Garanti	0.93784214	0.87330292
2015/03	Halkbank	1.00000000	1.00000000
2015/03	İsbank	1.00000000	0.91569934
2015/03	Sekerbank	0.68009803	0.62401317
2015/03	Tekstilbank	0.58498715	0.72838830
2015/03	Vakıfbank	0.91051494	0.90599981
2015/03	Yapı Kredi	0.92718866	0.88394083
2015/03	Odeabank	0.85593717	1.00000000
2015/03	Anadolubank	0.82275879	0.77861998
2015/03	Arap Türk Bankası	1.00000000	1.00000000
2015/03	Burgan Bank	0.79801599	0.95341484
2015/03	Citibank	1.00000000	0.64561710
2015/03	Fibabanka	0.76707464	0.90535531
2015/03	HSBC Bank	0.56896242	0.51559745
2015/03	ING Bank	0.66112487	0.77720077
2015/03	Turkish Bank	0.68034475	1.00000000
2015/03	Turkland Bank	0.83306209	0.75510588
2015/03	Türk Ekonomi Bankası	0.82399519	0.81857170
2015/03	Ziraat Bankası	1.00000000	1.00000000
2015/03	Alternatifbank	0.68032911	0.72331571
2015/06	Akbank	0.86270186	0.94075843
2015/06	Denizbank	0.68531022	0.67170822
2015/06	Finansbank	0.77269433	0.72189948
2015/06	Garanti	0.88406581	0.94505243
2015/06	Halkbank	0.94102295	0.91075490
2015/06	İsbank	0.92573339	0.96029487
2015/06	Sekerbank	0.68615589	0.62919654
2015/06	Tekstilbank	0.57603665	0.83953118
2015/06	Vakıfbank	0.83621284	0.90146832

2015/06	Yapı Kredi	0.77627107	0.90482134
2015/06	Odeabank	0.87625266	1.00000000
2015/06	Anadolubank	0.82244561	0.79591665
2015/06	Arap Türk Bankası	1.00000000	1.00000000
2015/06	Burgan Bank	0.82031672	1.00000000
2015/06	Citibank	1.00000000	0.74184054
2015/06	Fibabanka	0.79746377	0.91529257
2015/06	HSBC Bank	0.60140152	0.56847496
2015/06	ING Bank	0.70216612	0.88089297
2015/06	Turkish Bank	0.69367614	0.93078511
2015/06	Turkland Bank	0.79830544	0.69577474
2015/06	Türk Ekonomi Bankası	0.79049258	0.86856669
2015/06	Ziraat Bankası	1.00000000	1.00000000
2015/06	Alternatifbank	0.72711584	0.65789116
2015/09	Akbank	0.92738974	1.00000000
2015/09	Denizbank	0.72775587	0.65204537
2015/09	Finansbank	0.79161518	0.70051312
2015/09	Garanti	0.86875971	0.91768088
2015/09	Halkbank	0.96033201	0.95205167
2015/09	İsbank	0.85867442	0.92235330
2015/09	Sekerbank	0.71169535	0.60865312
2015/09	Tekstilbank	0.64741698	0.91711111
2015/09	Vakıfbank	0.91399052	0.91156600
2015/09	Yapı Kredi	0.79096070	0.89754186
2015/09	Odeabank	0.90098833	1.00000000
2015/09	Anadolubank	0.83290967	0.78268996
2015/09	Arap Türk Bankası	1.00000000	1.00000000
2015/09	Burgan Bank	0.81351279	0.97867522
2015/09	Citibank	1.00000000	0.64281015
2015/09	Fibabanka	0.84372266	0.84811856
2015/09	HSBC Bank	0.62125877	0.54455253
2015/09	ING Bank	0.74940237	0.87947929
2015/09	Turkish Bank	0.69765124	0.84936775
2015/09	Turkland Bank	0.76361521	0.71252965
2015/09	Türk Ekonomi Bankası	0.81790949	0.84189954
2015/09	Ziraat Bankası	1.00000000	1.00000000
2015/09	Alternatifbank	0.76161307	0.72897921

APPENDIX B - CURRICULUM VITAE

Surname, Name: ŞAHİN Fethullah
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Place of Birth: Erzincan
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EDUCATION

Yıldırım Beyazıt University, Banking and Finance, Ph.D., 2016
Texas A&M – Commerce University, MBA Finance, M.S., 2010
University of Gaziantep, Business Administration, B.A., 2005

PROFESSIONONAL EXPERIENCE

Melikşah University-Department of Business Administration, Research Assistant, 2011-2016.

FOREING LANGUAGE

English (Fluent)
Russian (Intermediate)

PUBLICATIONS

Publications (SSCI)

Celik, Tuncay; Kaplan, Muhittin; Sahin, Fethullah;. (2015). Efficiency, Concentration and Competition in Turkish Banking Sector. *İktisat İsletme ve Finans* , 55-72.

Other Publications (Non-SSCI)

H. Ali Ata, Mehmet Körpi, Mustafa Uğurlu, Fethullah Şahin;, (2015) Factors Influencing the Credit Rationing on the Commercial Lending Process. *Journal of Business, Economics and Finance,* 250-267.

Paper Presentations and Conference

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APPENDIX C - TURKISH SUMMARY

TÜRK BANKACILIK SEKTÖRÜNDE KREDİ RİSKİNİ BELİRLEYEN FAKTÖRLER

ETKİNLİK ÖNEMLİ BİR FAKTÖR MÜDÜR?

Bu tezin amacı; Türk Ticaret (mevduat) Bankacılığında 2002 ve 2015 yılları arasında kredi riskini (takipteki krediler veya sorunlu alacaklar) belirleyen faktörleri incelemektir. Bu amaçla ilk bölümde tezin amaç ve önemi ortaya konulmuştur. Tezin 2. bölümü iki kısımdan oluşup birinci kısımda kredi riski ile ilgili yapılan teorik çalışmalar yazılmıştır. Bir sonraki kısımda ise kredi riskini belirleyen faktörlerle alakalı ampirik çalışmalar gruplandırılıp özetlenmiştir. Tezin 3. bölümü ise birinci ampirik kısım olup bu bölümde Türk mevduat bankalarının teknik etkinlik skorları ölçülmüştür. Etkinlik skorları bir sonraki bölümde diğer bağımsız değişkenlerle birlikte kredi riskini belirleyen faktörler olarak kullanılmıştır. 4. bölümde Türk mevduat bankacılığında kredi riskini belirleyen hem içsel (banka kaynaklı) hem de dışsal (makroekonomik) faktörler incelenmiştir. Son bölüm olan 5. bölümde ise elde edilen bulgular (sonuçlar) tartışılmıştır.

Kredi riski, iki taraf arasında yapılan herhangi bir sözleşmede taraflardan birinin yükümlülüğünü yerine getirip getirememesi olasılığı olarak tanımlanmaktadır. Bankacılık literatüründe ise kredi riski borç alan ile borç veren (banka) arasında gerçekleşmektedir ve borç (kredi) alan birey ya da firmaların borçlarını ödeyememe ihtimali olarak karşımıza çıkmaktadır. Bankacılık sektöründe kredi riskini belirleyen faktörlere baktığımızda; söz konusu faktörlerin içsel ve dışsal faktörler olmak üzere iki ana gruptan oluştuğu görülmektedir. Bankalar açısından içsel faktörler; genel olarak bankanın kredilendirme işlemini etkin yapması, etkin kredi izleme, teminatların doğru değerlenmesi ve banka yönetici veya sahiplerinin risk algıları gibi sıralanabilir. Dışsal faktörler ise borç alanın (firma ya da birey) kendisinden kaynaklanan ödeme gücü, mevcut borç durumu, nakit akımlarındaki volatilite, sermaye yapısı, likidite gibi temel unsurlardan oluşmaktadır. Bunların dışında Gayrı safi yurtiçi hâsıla, işsizlik, faiz oranları, döviz kurları gibi makroekonomik faktörler de dışsal faktörlerden sayılmaktır ve firma ya da bireylerin yükümlüklerini yerine getirebilme olasılığını doğrudan etkilemektedir.

Kredi riski ile yapılan teorik çalışmaların en önemlisi Nobel ekonomi ödüllü Robert Merton'un 1974 yılında yazmış olduğu "On the pricing of Corporate Debt: The Risk Structure of Interest Rates" isimli makaledir. Merton (1974) bu makalesinde temerrüt olasılığı olan bir şirket tahvilinin aynı riski içermeyen başka bir devlet tahviline göre ne kadar daha fazla getirisinin olması gerektiğini ortaya koymuştur. Diğer bir ifade ile temerrüt risk priminin nasıl hesaplanacağını formülize etmiştir. Merton (1974) bu çalışmasında aynı zaman temerrüt (yükümlüklerin yerine getirilememe riski) riskinin nasıl hesaplanacağını da göstermiştir. Buna göre temerrüdü; firmanın toplam varlıklarının piyasa değerinin borçlarının toplam piyasa değerinin altına düşmesi olarak tanımlamıştır. Bu tanımlamaya göre temerrüt riskini belirleyen faktörler; firmanın toplam aktiflerinin piyasa değeri, aktiflerin volatilitesi (oynaklık), borçlarının ödeme tarihindeki piyasa değeri olarak sınıflandırılmıştır. Merton'un (1974) çalışması ilerleyen dönemlerde özelikle makaledeki bazı varsayımlar değiştirilerek geliştirilmiştir.

Allen Berger ve Robert De-Young (1997) ise çalışmalarında mevduat bankalarında etkinliğin (verimliliğin) kredi riskini belirleyen önemli faktör olduğunu ortaya koymuşlardır. Buna göre, etkin (maliyet etkinliği) olan bankaların etkin olmayanlara göre kredi tahsis ve izleme, teminatların değerlenmesi gibi kredilendirme süreçlerinde daha başarılı olduklarını ve bunun da bankanın takipteki krediler miktarını (diğer bir ifadeyle kredi riskinin gerçekleşen kısmı) azalttığını ileri sürmüşlerdir. ABD'deki mevduat bankaları üzerine yaptıkları ampirik çalışmalarında da yukarıda bahsedilen hipoteze uygun sonuçlara ulaşmışlardır.

Kredi riskiyle alakalı yapılan teorik çalışmalar tezin ikinci bölümünün ilk kısmında bu şekilde açıklandıktan sonra ikinci kısımda konuyla alakalı yapılan ampirik (deneye dayalı) çalışmalar özetlenmiştir. Bu kısımdaki çalışmalar genel olarak banka, makroekonomik ve borç alan kaynaklı faktörler olmak üzere 3 farklı grupta özetlenmiştir.

Çalışmanın 3. bölümü tezin ilk ampirik kısmı olup bu bölümde 2002-2015 yılları arası çeyrek dönemli veriler kullanılarak Türk mevduat bankalarının teknik etniklik skorları hesaplanmıştır. Veri Zarflama Yöntemi kullanarak yaptığımız ölçümlerde veriler Türkiye Banklar Birliği'nin (TBB) web sayfasından alınmıştır. Türk bankacılık siteminde, dönem dönem değişmekle birlikte, 2015 itibariyle toplam 54 adet banka bulunmaktadır ve bunların 26 tanesini mevduat bankaları oluşturmaktadır. Bu çalışmaya tüm mevduat bankaları (katılım bankaları hariç) dâhil edilmiş fakat 3 tane banka veri eksikliği ve tutarsızlığından

dolayı örneklem dışında bırakılmıştır. Son haliyle 23 banka ile çalışmaya devam edilmiştir. Mevcut haliyle de bu 23 mevduat bankası Türk bankacılık sektörünün toplam aktiflerinin yaklaşık % 90'ını oluşturmaktadır.

Bu bölümün literatür kısmında Türk bankacılık sektöründe etkinlikle alakalı yapılan çalışmalar özetlendikten sonra bir sonraki bölümde bağımsız değişken olarak kullanılacak olan teknik etkinlik skorlarının hesaplanmasına geçilmiştir. Teknik etkinlik skorlarının kullanılmasındaki temel amaç bu etkinlik türü bankaların yöneticilerinin başarısını ölçmeye olanak sağlamasıdır. Etkinlik skorları girdi ve çıktıların çeşitliliğine bağlı olarak 2 farklı grup olarak hesaplanmıştır. Birinci grupta bankaların girdileri faiz giderleri ve faiz dışı giderler; çıktılarını ise faiz gelirleri ve faiz dışı gelirle oluşturmaktadır. İkinci grupta ise bankaların girdilerini yine faiz giderleri ve faiz dışı giderler oluştururken bankaların çıktılarını bilanço kalemleri olan toplam krediler, toplam mevduat ve toplam menkul kıymetler oluşturmaktadır.

Efficiency Measurement System (EMS) 1.3.0 yazılımı yardımıyla ve girdi odaklı (input oriented) yöntemle etkinlik skorları hesaplanmıştır. Etkinlik skorları 0-1 arasında değer almaktadır. Skoru 1 olan bankalar tam etkin olarak kabul edilirken bu oranın 0'a yaklaşması teknik etkinliğin azaldığını göstermektedir. Hesaplanan etkinlik skorlarına baktığımızda Türk bankacılık sektöründe etkinlik skorlarının 2004 ve 2007 yılları arasında genel olarak arttığı görülmektedir. Söz konusu yıllardaki artışın temel nedenin 2000'lerin başında hayata geçirilen Türk bankacılık sektörünü yeniden yapılandırma programı olduğu düşünülmektedir. 2008 ve 2009 yıllarından sonra ise Türk mevduat bankacılık sektörünün ortalama etkinlik skorlarının düşme eğiliminde olduğu gözlenmiştir. Çalışmamızda; devlet bankalarının ortalama etkinlik skorlarının, diğer yerli ve yabancı bankalara göre daha yüksek olduğu sonucuna ulaşılmıştır.

Tezin 4. bölümünde ise Türk ticaret (mevduat) bankacılığı sektöründe 2002 -2015 arası kredi riskini belirleyen içsel (banka-kaynaklı) ve dışsal (makroekonomik) faktörler incelenmiştir. Yaptığımız kapsamlı literatür taramasında Türk bankacılık sektörüyle alakalı yapılan çalışmalarda, içsel faktörle özellikle etkinlikle kredi riski arasında boşluğun olduğu gözlemlenmiştir. Konuyla alakalı Setiwan ve diğ. (2013) Türkiye'nin de dahil olduğu İslam İşbirliği Teşkilatının üye ülkelerinin bankacılık sektörüne yönelik çalışmaları mevcut olsa da Türkiye'nin tekil olarak ele alındığı bir çalışmaya rastlanılmamıştır. Bu tezde kredi riski ile içsel faktörler (etkinlik, çeşitlendirme ve kredi hacmindeki büyüme) kapsamlı olarak ele

alınmıştır. Aynı şekilde dışsal faktörlerle (makroekonomik) kredi riskini inceleyen çalışmalara baktığımızda çalışmaların çoğunun bankaları tek tek değil de kümülatif olarak ele alıp zaman serileri yöntemleriyle analiz ettiği görülmüştür. Bu çalışmada ise mevduat bankalarının tamamı kullanılmış olup makroekonomik faktörlerle olan ilişki panel regresyon yöntemiyle analiz edilmiştir.

Veri setini oluşturmak için Türkiye'de faaliyet gösteren tüm mevduat bankaları kullanılmış fakat 3 tanesi çıkarılmış ve son haliyle 23 banka ile çalışma devam edilmiştir. Söz konusu 23 bankanın 3 tanesi devlet, 10 tanesi yerli, kalan 10 tanesi de yabancı sermayeli bankalardan oluşmaktadır. Banka verileri Türkiye Bankalar Birliği'nin (TBB) web sayfasından, makroekonomik veriler ise Türkiye Cumhuriyet Merkez Bankası (TCMB), OECD ve Türkiye İstatistik Kurumunun web sayfalarından alınmıştır. Veri seti son haliyle 2002 son çeyrek ile 2015 yılı 3. çeyrek dönemlerinden oluşmaktadır.

Çalışmada bağımlı değişken olarak, kredi riskinin gerçekleşen hali olarak da kabul edilen, toplam takipteki kredilerin (alacaklar) toplam kredilere oranı alınmıştır. Literatürde kredi riskini temsilen toplam karşılıkların toplam kredilere oranı veya Moodys-KMV tarafından hesaplanan firmaların (banka) temerrüde düşme olasılığı da değişken olarak kullanılabilmektedir. Bağımsız değişkenler makroekonomik ve mikroekonomik (banka kaynaklı) olarak ikiye ayrılmıştır. Banka kaynaklı veriler ile yaptığımız analizde değişkenler ve hipotezler şu şekilde özetlenebilir;

Berger ve De Young'un (1997) çalışmalarındaki "Bad Management" hipotezine göre etkin bankaların daha düşük kredi riskine sahip oldukları görülmektedir. Buna göre;

H_1: Etkin olan bankalar daha düşük kredi riskine (takipteki krediler oranına) sahiptir.

Bu hipotezi test etmek amacıyla 3. Bölümde iki farklı grupta hesaplanan teknik etkinlik skorları kullanılmıştır. Bu değişkenlere ilaveten literatürde sıkça kullanılan bankaların öz sermaye karlılık (ROE) oranları da etkinlik göstergesi olarak çalışmaya dâhil edilmiştir.

Aynı çalışmada "Skimping" hipotezinin test edilmesi amacıyla kurulan hipotez:

H_2: Geçmiş dönemde etkin olan bankalar, cari dönemde daha yüksek takipteki krediler (kredi riski) oranına sahip olabilirler.

Bu hipotezi test etmek amacıyla 3. bölümde kullanılan etkinlik skorları ve etkinlik göstergesi olan öz sermaye karlık oranlarının 4 çeyrek döneme kadarki gecikmeli değerleri kullanılmıştır.

"Moral Hazard" Ahlaki Tehlike hipotezinin test edilmesi amacıyla kurulan hipotez:

H_3: Sermayesi düşük olan bankaların takipteki krediler oranı daha yüksektir.

Bu hipotez için ise bankaların öz sermayelerinin toplam aktiflere bölünmesiyle elde edilen öz sermaye oranı kullanılmıştır.

Test edilen diğer hipotezler ise "diversification" çeşitlendirme hipotezidir. Buna göre;

H_4: Çeşitlendirme artıkça takipteki kredilerin oranı (kredi riski) azalmaktadır.

Buradaki hipotez 2 farklı değişken ile test edilmiştir. Birincisi bankanın toplam mevduat bankacılığı içerisindeki payını gösteren banka büyüklüğü diğeri ise bankanın faiz dışı gelirlerinin toplam gelirlere bölünmesiyle elde edilen ve faiz dışı gelir oranıdır. Her iki değişkenin katsayısının da negatif olması beklenmektedir.

Yukarıda kullanılan değişkenlerin dışında bu tezde araştırdığımız konulardan bir tanesi de kredi hacminde büyümenin kredi riskini artırıp artırmayacağıdır. Bilindiği üzere 2000'lerin başında Türk bankacılık sektöründe art arda iki kriz yaşanmış ve bu krizlerin neticesinde ciddi yapısal reformlar yapılmıştır. Bu reformlardan ve yaşanan olumlu politik gelişmelerden sonra Türkiye'de bankalar topladıkları fonları kamu harcamalarından ziyade özel sektörün (bireysel ve kurumsal) yatırım ve tüketim finansmanına yöneltmişlerdir. Bunun neticesinde özellikle 2002'den günümüze kadar bankaların bilançolarındaki "krediler" kaleminde ciddi bir artış yaşanmıştır. Öyle ki kredilerdeki artış hızı toplam aktiflerin hızından fazla olmuştur. Söz konusu artışın kredi riskini (takipteki krediler oranını) artırıp artırmadığını ölçmek amacıyla toplam kredilerin toplam aktiflere olan oranı değişken olarak alınmıştır.

H_5: Kredi portföyünde artış takipteki kredilerin oranı (kredi riski) değiştirmektedir.

Bu değişkenlerin dışında çalışmamıza iki tane de kontrol değişken ilave edilmiştir. Bunlardan birincisi; devlet bankalarının diğer yabancı ve yerli özel bankalara göre, daha fazla takipteki krediler oranına sahip olduğu varsayımıdır. Bu amaçla devlet bankalarına kukla değişken verilmiştir. İkinci kontrol değişken ise kriz dönemlerinin bankaların

alacakları üzerinde olumsuz etkisini (diğer bir değişle takipteki krediler oranını artırması) incelemektedir. Bu amaçla, 2008 yılının sonunda başlayan, Türkiye'de etkileri daha ziyade 2009'da görülen küresel finansal krizin etkilerini görmek için 2009 yılına kukla değişken atanmıştır. Hipotezler aşağıdaki gibi belirtilmiştir.

H_6: Devlet bankaları daha fazla takipteki krediler oranına sahiptir.

H_7: 2009 yılı takipteki krediler oranı üzerinde pozitif bir etkiye sahiptir.

Buraya kadar kredi riskini etkileyen banka kaynaklı değişkenler ve hipotezler tanımlanmıştır. Makroekonomik değişkenler ve takipteki krediler üzerindeki etkileri ise aşağıdaki gibi özetlenmiştir.

Genel ekonomik konjonktürün de bankaların üslendiği kredi riski üzerinde ciddi etkisinin olduğu düşünülmektedir. Bu amaçla değişken olarak Gayri Safi Yurtiçi Hasıla'daki (GSYH) çeyrek dönemli büyüme ve çeyrek dönemli işsizlik oranları kullanılmış ve hipotezler aşağıdaki gibi belirtilmiştir.

H_8: Gayri Safi Yurtiçi Hasıla'daki artış, bankaların takipteki alacaklar oranında azalmaya neden olmaktadır.

H_9: İşsizlik oranındaki artış, bankaların takipteki alacaklar oranını düşürmektedir.

Bunun dışında faiz oranlarındaki değişiklikler de bankaların kredi risklerini etkilemektedir. Bunun için bankaların bireysel ve kurumsal kredilere uygulamış oldukları faiz oranlarının haftalık ağırlıklı ortalamalarının çeyrek dönemlere göre ortalamaları alınmıştır.

H_{10}: Faiz oranları artıkça bankalardaki kredi riskleri (takipteki krediler) artmaktadır.

Kredi riskini etkileyen diğer bir makroekonomik faktör ise döviz kurlarıdır. Türk mevduat bankacılık sektörü tarafından tahsis edilen kredilerin yaklaşık yüzde 30'u döviz cinsinden verilmiştir. Dolayısıyla, döviz kurlarında özellikle Dolar ve Euro' da oluşacak herhangi bir dalgalanma döviz cinsinden verilen kredilerin geri ödenmesini olumlu veya olumsuz etkileyecektir.

H_{11}: Döviz kurlarındaki artış bankaların takipteki alacaklarını pozitif etkilemektedir.

Sermaye piyasalarındaki gelişmelerin de bankaların takipteki kredileri üzerinde etkileri olduğu düşünülmektedir. Özellikle borsadaki firmalara ilişkin geleceğe ait beklentilerin

göstergesi olan BIST 100 endeksinin de kredi riskini etkilediği düşünülmektedir. BIST 100 endeksindeki artışın firmalar ve ekonominin geneliyle alakalı olumlu bir gösterge olduğu ve bankaların takipteki alacaklarını azaltacağı varsayılmaktadır.

H_{12}: BIST 100 endeksindeki artış bankaların takipteki krediler oranını düşürmektedir.

Çalışmamızdaki son makroekonomik bağımsız değişken ise enflasyondur. Fiyatlar genel düzeyindeki sürekli artış olarak da tanımlanan enflasyon ile bankaların kredi riskleri (takipteki alacakları) arasında hem negatif hem de positif ilişki olduğu düşünülmüştür. Enflasyon değişkeni için TÜFE endeksi kullanılmıştır

H_{13}: TÜFE'deki değişim bankaların kredi riskini (takipteki kredileri) değiştirmektedir.

Bu çalışmadaki veri seti; panel veri formatına uygun olduğu için, yöntem olarak geleneksel panel regresyon yaklaşımları kullanılmıştır. Bu amaçla Stata 13.1 kullanılarak öncelikle tüm değişkenlere ilişkin tanımlayıcı istatistikler daha sonra değişkenler arasındaki korelasyon katsayıları hesaplanmıştır. Bir sonraki aşamada ise Fisher-type ADF testi kullanılarak değişkenlerin durağanlıkları ölçülmüştür. Makroekonomik değişkenlerin tamamı (yüzdelik değişimler olduğu için) durağan çıkmıştır. İçsel (banka-kaynaklı) değişkenlerin ise 3 tanesi durağan çıkmamış ve bu değişkenlerin birinci derece farkları alınarak değişkenler durağan hale getirilmiş ve analize devam edilmiştir.

Tezin analiz kısmına öncelikle banka kaynaklı (içsel) değişkenlerle başlanmıştır. Bu amaçla ilk aşamada havuzlanmış EKK (Pooled-OLS) yöntemiyle tahmin yapılmış sonra da panel regresyon yaklaşımlarından Sabit Etkiler (Fixed Effects) yöntemiyle katsayılar tahmin edilmiştir. Bu iki yöntemin hangisinin daha uygun olduğunu test etmek amacıyla Breusch & Pagan LM testi yapılmış ve Sabit Etkiler (Fixed Effects) yönteminin daha uygun bir yöntem olduğu görülmüştür. Bir sonraki aşamada ise katsayılar Rassal Etkiler (Random Effects) yöntemi ile tahmin edilmiş ve sonrasında Sabit ve Rassal etkiler yöntemlerinden hangisinin daha etkin tahmin edici olduğunu belirlemek amacıyla Hausman testi uygulanıştır. Hausman testi de bize Sabit Etkiler yönteminin daha etkin yöntem olduğu sonucunu vermiştir. Bu testlerden sonra otokorelasyon problemi için Durbin-Watson ve Baltagi-Wu eşvaryans problemi için ise Modified Wald testleri yapılmıştır. Her iki test sonucu da bize veri setimizde otokorelasyon ve eşvaryans problemlerinin olduğunu göstermektedir. Söz konusu

problemleri kontrol etmek amacıyla analizdeki katsayıların hepsi dirençli tahmin yöntemlerinden olan *vce cluster* opsiyonu ile yeniden tahmin edilip sonuçlar bu katsayılara göre değerlendirilmiştir. Her ne kadar yapılan testler bize Sabit Etkiler (Fixed Effects) yönteminin daha uygun tahmin edici olduğunu gösterse de çalışmada tüm tahmin edicilere ilişkin katsayılar kullanılmıştır.

Yukarıdaki analiz sonucunda elde edilen bulgulara göre, Türk bankacılık sektöründe takipteki krediler ile teknik etkinlik skorları (her iki panelde) arasında negatif ve istatiksel olarak %95, %99 ve %99,9 düzeylerinde anlamlı ilişki bulunmuştur. Diğer bir ifadeyle, etkin bankaların daha düşük kredi riski taşıdıkları görülmüştür. Bu bulgular hem Veri Zarflama Analiziyle ölçülen etkinlik skorlarıyla hem de teknik etkinlik göstergesi olan öz-kaynak karlılığı değişkeni ile desteklenmiştir. Kredi riski ile etkinlik skorlarının gecikmiş değerleri arasında (skimping hypothesis) beklenen ilişkiye rastlanmıştır. İkinci hipotezde belirtildiği üzere t_0 döneminde etkin olan bankaların ilerleyen dönemlerde yüksek kredi riski (takipteki krediler oranı) taşımaları muhtemel görünüyordu. Elde edilen bulgularda, gerek katsayıların anlamlılıklarına göre gerekse de işaretlerine göre, Türk ticaret bankacılığında etkinlik ile kredi riski arasında farklı bir durumun ortaya çıkmadığı görülmüştür.

Takipteki kredilerle bankaların sermaye yapısı arasında beklenildiği üzere negatif ilişki bulunamamıştır. Sermaye yapısı katsayıları tüm modellerde pozitif ve çoğunlukla da istatiksel olarak anlamsız çıkmıştır. Bu sonuçlar da "moral hazard" (ahlaki tehlike) hipotezinin Türk mevduat bankacılık sektöründe geçerli olmadığını göstermektedir.

Diğer önemli bir sonuç ise kredi hacmindeki büyüme ile takipteki krediler arasında bulunmuştur. Gerek normal haliyle gerekse de birinci derece farkı alınmış haliyle olsun toplam kredilerin toplam aktiflere oranı değişkeni ile kredi riski arasında negatif ve istatiksel olarak (%95, %99 ve %99,9 güven düzeylerinde) anlamlı ilişki bulunmuştur. Buna göre Türk Mevduat Bankacılık Sektöründe özellikle son 10 yılda hızla artan kurumsal ve bireysel kredilerin takipteki kredilere oranını aynı düzeyde artırmadığı sonucuna varılmıştır.

Çeşitlendirmenin (diversification hypothesis) bankaların kredi riski üzerinde etkisinin olup olmadığını incelemek amacıyla iki farklı değişken kullanılmıştır. Bu değişkenler sırasıyla banka büyüklüğü ve faiz dışı gelirlerin toplam faiz gelirleri içerisindeki payıdır. Kullanılan değişkenlerin katsayılarına ve anlamlılıklarına baktığımızda çeşitlendirme ile kredi riski arasında tutarlı bir ilişki bulunamamıştır. Banka büyüklüğü (mevduat bankacılık

sektöründeki payı olarak düşünülmüştür) ile kredi riski arasında pozitif ve istatistiksel olarak anlamsız bir ilişki bulunmuştur. Aynı şekilde faiz dışı gelirlerin toplam gelirler içerisindeki payını dikkate alarak yaptığımız analizde kredi riski ile söz konusu değişken arasında pozitif ve istatistiksel olarak anlamsız bir ilişki bulunmuştur.

Küresel finansal krizin ve devlet bankalarının takipteki krediler oranına olan etkilerine baktığımızda devlet bankalarının (toplam mevduat bankacılık sektörünün yaklaşık % 30 unu oluşturmaktadır) yerli ve yabancı özel mevduat bankalarına göre daha fazla kredi riskine sahip oldukları görülmüştür. Aynı şekilde 2008'in sonlarında yaşanan ve Türkiye ekonomisinde etkilerinin daha ziyade 2009'da görüldüğü Küresel Finansal Krizinin de bankaların takipteki alacaklar kalemini artırdığı sonucuna varılmıştır.

İçsel (banka-kaynaklı) değişkenlerle elde edilen bulgulardan sonra analize makroekonomik değişkenlerle devam edilmiştir. Makroekonomik değişkenlerle yapılan analizin banka kaynaklı verilerle yapılan analizden farkı bu analiz panel veri seti şartlarını sağlamamaktadır. Diğer bir ifadeyle, banka kaynaklı değişkenlerle yaptığımız tahminde her bir değişkenin zaman ve birey (banka) boyutu varken bu kısımda sadece zaman serisi boyutu olup birey (banka) boyutu bulunmamaktadır. Yukarıda takip edilen adımlar bu kısımda da aynen uygulanmış ve yapılan testler neticesinde Havuzlamış EKK (Pooled-OLS) tahmincisinin en uygun yöntem olduğu görülmüştür. Daha sonraki aşamada otokorelasyon ve eşvaryans testleri yapılmış ve makroekonomik verilerde eşvaryans problemine rastlanırken otokorelasyon probleminin olduğu görülmemiştir. Eşvaryans problemini kontrol etmek amacıyla katsayılar, dirençli tahmin yöntemlerinden "robust" opsiyonu eklenerek tekrardan tahmin edilmiş ve tüm sonuçlar bu katsayılara göre yorumlanmıştır. Yine benzer şekilde yapılan testler bize Havuzlamış EKK (Pooled-OLS) yönteminin daha uygun tahmin edici olduğunu gösterse de çalışmada tüm tahmin edicilere (Sabit ve Rassal Etkiler) ilişkin katsayılar kullanılmıştır.

Makroekonomik faktörlerin bankaların kredi riski üzerinde farklı etkilerinin olduğu görülmüştür. Gayri safi yurtiçi hasıladaki (GSYİH) değişimin mevduat bankalarının takipteki alacaklarındaki değişim üzerinde negatif etkisinin olduğu sonucuna varılmıştır. Söz konusu değişkenin bir dönemlik gecikmesi de alındığında aynı bulgulara ulaşılmıştır.

İşsizlik oranındaki değişim ile bankaların kredi riski arasında beklenildiği gibi pozitif ve istatiksel olarak anlamlı (%99,9 güven düzeyinde) bir ilişki bulunmuştur. Bu ilişki bize

işsizliğin artmasının belli bir zaman sonra bankaların takipteki kredilerinin de arttığını göstermektedir.

Faiz oranları ile kredi riski arasındaki ilişki iki farklı faiz oranı ile incelenmiştir. Bunlardan birincisi kurumsal kredi faiz oranları diğeri ise bireysel kredi faiz oranlarıdır. Söz konusu faiz oranlarının çeyrek dönemlik yüzdelik değişimlerinin iki dönemli gecikmeli değerleri kullanılmıştır. Elde ettiğimiz bulgularda; her iki faiz oranı türüyle takipteki alacaklar oranı arasında %95 ve %99 güven düzeyinde pozitif ilişkiye rastlanmıştır. Diğer bir ifadeyle bankaların uygulamış olduğu faiz oranlarındaki artış bankaların takipteki alacaklarını da artırmaktadır.

Döviz kurları ile kredi riski arasındaki ilişkiye baktığımızda ise faiz oranlarındaki sonuca yakın bir bulguya rastlanmıştır. Döviz kurları iki farklı para biriminin (UDS ve EURO) Türk Lirası (TL) karşısındaki yüzdelik değişimi olarak alınmıştır. Analiz sonucunda takipteki krediler oranındaki değişim ile dolar (USD) kuru arasında istatiksel olarak %95 düzeyinde anlamlı ve pozitif ilişkiye rastlanmıştır. Euro kuru ile takipteki alacaklar oranı arasında ise pozitif fakat; istatistiksel olarak anlamlı bir ilişki bulunamamıştır. Türk bankacılık sektörünün yabancı para cinsinden vermiş olduğu kredilerin yaklaşık % 65' i dolar (USD) cinsindendir dolayısıyla dolar kurundaki artışın bankaların maruz kaldığı kredi risklerini (takipteki krediler tutarını) artıracağı görülmektedir.

Sermaye piyasası varlık fiyatlarındaki (BIST 100 endeksi) değişimin de kredi riskini etkileyen faktörlerden birisi olduğu sonucuna ulaşılmıştır. Finansal varlık fiyatlarındaki - balon durumu hariç- artış; genel olarak özelde firmalarla genelde ise ekonominin gidişatıyla alakalı ileriye yönelik olumlu bir havanın göstergesidir. Elde ettiğimiz bulgularda BIST-100 endeksindeki değişim ile takipteki krediler oranı değişimi arasında negatif ve istatistiksel çok anlamlı (% 99 ve % 99,9 düzeylerinde) ilişki bulunmuştur. Enflasyon oranındaki değişme ile takipteki krediler arasında anlamlı herhangi bir ilişkiye rastlanılmamıştır.

Ek M: Örnek Tez Fotokopisi İzin Formu (Dönem Projesi Hariç)

TEZ FOTOKOPİSİ İZİN FORMU

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Adı : Fethullah
Bölümü : Bankacılık ve Finans

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