Competition, Efficiency, and the Impact of Monetary Policy Changes in the Turkish Banking Sector

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When you earn knowledge in good deeds.
That knowledge without action is a useless thing.
(Mawlana Jami)

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Extensive summary

Since its founding era (1923-1945), Turkish banking sector has undergone several developmental stages during which the Turkish economy and its banking sector have experienced high inflation, financial instability, and inefficiency. After the political and currency crises of 2000-2001, the Turkish government and Central Bank of Turkey (CBT) with the help of the International Monetary Fund (IMF) imposed several restructuring programmes to strengthen the private banks, progress with privatisations and establish supervisory entities. Consequently, Turkey's banking sector began to recover during the period 2002 until 2008. However, after 2008, financial imbalances were beginning to be reflected again in the Turkish banking sector and its economy. A review of the Turkish banking literature clearly demonstrates which essential finance and banking areas have been under-evaluated. For instance, the links among risk-taking activities, the transmission of monetary policy through different channels, and competition are all significantly unexplored. Hence, this thesis assesses the three main areas in the Turkish banking sector by studying the impact of Non-Performing Loans (NPLs) on Turkish bank efficiency, examining the transmission of monetary policy through Bank Lending Channel (BLC) in Turkish banks whilst considering the impact of bank characteristics, and investigating the relationship between competition, stability, and efficiency in Turkish banks.

Initially, this thesis investigates bank efficiency whilst considering the impact of NPLs. To compute technical, allocative, and cost efficiency, the current thesis uses a modified Data Envelopment Analysis (DEA) approach with NPLs identified as an undesirable output. The obtained results suggest that there is a negative relationship between NPLs and all three kinds of efficiency. To consider more closely what balance sheet items and employee characteristics tell us about efficiency, this thesis investigates efficiency determinants by applying a quantile regression technique. In addition to investigating the balance sheet items, this thesis considers

two unique efficiency determinants, namely employees' gender and education. The results reflect the positive impact of capitalisation and Net Interest Margin (NIM) on all kinds of efficiency. In contrast, the relationship between Net Non-Interest Margin (NNIM) and efficiency in Turkish banks has been found to be negative. This negative sign emphasises the fact that Turkish banks do not reflect an efficient approach in managing their non-interest sources of income. Furthermore, the findings show that a higher percentage of female employees can have a positive impact on the efficiency, innovation, flexibility, and management culture of the banks. Moreover, the results gained from evaluating education, confirm the positive impact of having more educated employees.

This thesis further examines the monetary transmission mechanism through BLC with consideration of NPLs by applying the Bayesian estimation. In addition to capitalisation, liquidity, and size, this thesis introduces technical and allocative efficiency as an additional characteristic. The results show the existence of BLC in Turkish banks from 2002 until 2017. The results also highlight that the efficiency scores in the Turkish banks can determine the bank's sensitivity to any monetary policy shock. The results also confirm the impact of other characteristics (size, liquidity, and capitalisation) on a bank's approach toward interest rate changes. Larger and more liquid banks with higher capitalisation are more stable.

Finally, this thesis evaluates the impact of competition on financial stability and efficiency by deploying the Boone indicator to measure bank competition, the *Z*-score to measure for financial stability, and a DEA approach to compute technical efficiency. Three main hypotheses are tested: 'bad management'[1], 'bad luck[2]', and 'moral hazard'[3]. This thesis tests

[1] This hypotheis is discussed by Berger and De Young (1997). It explains that higher costs will be incurred by banks with lower levels of efficiency due to the fact that in these banks credit is inadequately monitored, and operating expenses are not managed efficiently.

[2] Berger and De Young (1997) discuss more on exogenous events rather than managers' skills or their risk-taking appetite to explain NPLs ratio in a bank.

[3] Moral hazard hypothesis explains that weaker banks are more vulnerable to risk-taking attitude and danger than stronger banks.

the relationship between the ‘bad management’ hypothesis and efficiency in Turkish banks. The Boone indicator for forty-two Turkish banks was found to be negative. Only two banks represent a positive Boone indicator, Diler Yatirim Bankasi A.S and Istanbul Takas ve Saklama Bankasi A.S. The positive Boone score for these two banks shows that they are competing for the amount of equity. The results support a positive relationship between competition and stability, which supports the competition-stability theory. The results also reflect the similar relationship between competition and efficiency. Hence, enhancing competition reduces NPLs and has a positive effect on financial stability.

In conclusion, the findings of this thesis and its evaluations emphasise the importance of bank efficiency and managing the NPLs ratio. Strengthening and improving a bank’s balance sheet quality and controlling the NPLs ratio should be one of the CBT’s main actions. This thesis not only confirms the importance of bank efficiency in the process of money generation, profit making, and capitalisation but also in the fields of competition and stability. Hence, boosting efficiency scores should be one of the main missions for Turkish regulators and policy makers. In addition, optimising interest and non-interest income sources also would improve the possibility for banks to utilise their financial and non-financial sources. Moreover, having gender diversity in the workplace and hiring more educated people would improve the management culture of Turkish banks as it would usher in novel ideas and different perspectives. It would also increase flexibility and create more innovations. Experiencing volatile economic indicators like inflation rate fluctuation and unstable economic conditions should be enough to bring the sense of necessity needed to impose an efficient reform plan to address these fundamental issues.

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List of abbreviations

BAT: Bank Association of Turkey

BLC: Bank Lending Channel

BRSA: Banking Regulation and Supervision Agency

BSRP: Bank Sector Restructuring Program

CAR: Capital Adequency Ratio

CBT: Central Bank of Turkey

CDs: Certificate of Deposits

CMB: Capital Market Board

CPF: Country Partnership Framework

CR: Concentrated Ratio

DEA: Data Envelopment Analysis

DMUs: Decision-Making Units

EU: European Union

ECB: European Central Bank

GMM: Generalised Method of Moment

HHI: Herfindahl-Hirschman Index

HTI: Hall-Tideman Index

IMF: International Monetary Fund

MCMC: Monte Carlo Markov Chain

NEIO: New Empirical Industrial Organisation

NIM: Net Interest Margin

NNIM: Net Non-Interest Margin

NPLs: Non-Performing Loans

OECD: Organisation for Economic Co-operation and Development

OLS: Ordinary Least Square

ROA: Return On Asset

SCP: Structure-Conduct-Performance Paradigm

SDIF: Saving Depository Insurance Fund

SFA: Stochastic frontier approach

TL: Turkish Lira

WBG: World Bank Group

WTO: World Trade Organisation

List of Publications

1. “Bank Efficiency and non-performing loans: Evidence from Turkey” is published in Journal of Research in International Business and Finance in 2018. Professor Roman Matousek is a co-author of this paper. Chapter three of this thesis is mapped on this paper.

2. “How Monetary Policy affect the Lending Channel in Turkey: Bayesian Estimation” is a conference paper (European Academic Research Conference on Global Business, Economics, Finance and Banking [EAR18Swiss Conference]) in 2018. Chapter four of this thesis is mapped on this paper

Chapter 1

Introduction

The banking systems of major emerging economies have experienced significant reforms which have aimed to develop competitive and efficient financial systems in order to stimulate economic growth, financial mobility and stability. In banking studies, banking efficiency (which includes, but is not limited to, the impact of deregulation, more concentrated banking systems, and the introduction of more technology) in pursuit of financial stability is a continuous topic. Although the focus of the research changes depending on the requirements of the financial market, considering developments in technology, human achievements, and the way banking has been done across different eras, the role of banks stays the same. Despite a rich seam of banking literature, the 2008 financial crisis indicates there is still much to be investigated across the financial market and specifically in the banking sector. The aftermath of the 2008 financial crisis saw a changing of regulatory frameworks, and banks were forced to adjust to the new operation platforms and re-evaluate their strategies and models. Hence, following the 2008 crisis, one area receiving significant attention from scholars and researchers after the financial crisis in 2008 in banking sector relates to banks' efficiency, their profitability, and their performance.

Although the efficiency and profitability of the banking sector is a crucial way to ensure and evaluate the performance of banks in developed countries, these elements are more important for less developed countries due to the economic conditions of these countries. Accordingly, many studies have assessed different aspects of the banking sector across different countries. For example, Degl'Innocenti *et al.* (2017) evaluate if the geographic location of a bank can influence the bank's technical efficiency. They collected data from the top 1000 banks, globally from 2004-2010. Additionally, because Islamic banking and the positive impact of using Islamic Bonds (Sukuk) was both a novel concept and an attractive topic both during and after

financial crisis, Alqahtani *et al.* (2017) compared the efficiency of Islamic and Conventional banks in the GCC region using DEA and SFA approaches before, during and after the 2008 financial crisis. Their results confirm that Islamic banks in the GCC region during the crisis were more cost efficient. However, as profit is the main foundation of the Islamic commercial banks, during the crisis the profit efficiency in these banks decreased more compared to Conventional banks. Luo *et al.* (2016) discuss the relationship between openness, a bank's risk, and bank profit efficiency using a multinational sample from 140 countries from 1999 to 2011. They argued that financial openness can encourage banks to take more risks and decrease the profit efficiency in the banking sector.

In addition to these studies, the financial crisis prompted researchers to consider other relevant aspects that could prevent future financial disasters or could help economies recover from the crisis. For instance, Alexakis *et al.* (2020) study the impact of foreign ownership and competition across 26 European countries over the last sixteen years. This research shows that despite numerous studies on market structure and its relationship with the bank's performance, well capitalised banks still are benefiting from a monopoly on rents via cost-cutting strategies. The study's conclusion illustrates that the policies and regulations around the banking sector require thorough evaluation. This topic shows potential for critical investigation under different conditions. Similar to the aforementioned study, there are many more researches (for example, Xu *et a*l., 2020; Cabrera *et al*., 2018; and Bitar *et al.*, 2018) that investigate the impact of risk, ownership, regulation and efficiency on the banks' performance.

The role and importance of Turkey and its financial market during the last two decades has attracted interest from the WBG and has led to a strong partnership between the two. This is underscored by the recent announcement from WBG of the CPF[4]. According to the 2018 IMF

[4] The Country Partnership Framework (CPF) for Turkey aims to help Tukey to obtain its 10th Development plan. According to the 10th Development plan, Turkey is going to improve the macroeconomics factors like inflation, GDP, unemployment rate. In addition, Turkey aims to achieve stability, sustainability, and growth in its social and economic aspects.

report, CPF is in line with the Turkey's 10th National Development Plan[5]. Taking into account that, according to the key economic indicators like GDP, Turkey is the world's nineteenth largest economy and one of the most important in Asia this, coupled with its unique geographic and financial characteristics, makes Turkey a unique case to study. According to the 2018 IMF report, Turkey is among the countries most affected by the November 2016 emerging market asset selloff. Turkey was also influenced by a large exchange rate shock in late 2018 which was resulted in financial imbalances. According to the aforementioned IMF report Turkey's economic performance (especially, following the 2000-2001 financial crisis) was incredible. Taken together these past events prove that the Turkish financial markets are sensitive to both changes in the international and local markets. Considering all the features outlined above and the strong relationship between Turkey's financial markets and the WBG's plans, makes an investigation into the Turkish banking sector, crucial.

Turkey with a nominal GDP of $761.43 billion and GDP growth of 0.9% in 2019 is ranked as the nineteenth largest economy in the world and the eighth biggest in the Middle East. Thus, it is one of the world's most important economies. It provides a different banking and financial structure due to its regional importance, the economic challenges it has experienced (for example, a high inflation ratio of 15.17% in 2019) and the monetary policies and regulations its banking sector has required in order to address these challenges. Turkey has made important steps in achieving macroeconomic stability by successfully passing important structural reforms following several financial crises (2001, 2008, and 2016) but the provision of sustainable and high economic growth remains one of the country's most important problems. With the help of resuscitative policies for internal demand, Turkey recovered from the adverse effects of the financial crises, seeing high growth in 2010 and 2011. Now the Turkish economy

[5] The 10th national Development Plan aims to improve and prepare for the 2023 targets which includes both economic and social development processes by considering multi-dimensional perspectives through several approaches.

is about to enter a low growth period once again. It is important that we do not neglect the impact of unfavourable global economic conditions regarding this. However, the existence of the problems that Turkey needs to solve in order to deliver high and sustainable growth must also not be ignored. The Turkish banking sector dominates the country's financial sector: 88.2% of total financial assets belong to its banks. According to the BRSA, there are 44 banks operating in Turkey of which nine of them are private banks, three of them are state-owned, thirteen of them are development and investment banks[6]. The rest are foreign banks. One of the most interesting economic features of Turkey is its banking sector, which has experienced financial crises, especially following the financial liberalisation implemented during the 1980s. Turkey's economy and consequently its banking sector experienced further crises in 1994, 1998-1999, 2000-2001, 2008-2009, and 2016. In spite of this, Turkey has shown impressive economic improvement since 2000. In September 2018, according to the European Banking Federation, despite an increase in external shocks, Turkey had achieved a rapid growth in economic and banking profitability.

In addition to this, there are several other reasons why the Turkish banking sector is an interesting area for research for both academics and policymakers. The Turkish banking sector shows considerable fluctuation in the trend of its NPLs. This makes it more difficult for the country to join the European Union; the percentage of NPLs is a concern for the Union. Moreover, the performance of the government and the CBT in resolving its economic challenges and addressing the issues in the banking sector is controversial. Through the imposition of many aggressive, yet effective, restructuring and reform programmes, Turkish banks have reported an increase in their risky loans and bad loans, which in turn directly and indirectly influence Turkish banking efficiency and productivity.

[6] In Turkey, the category of 'development banks' was originally named 'development and investment banks. Investment banks are those institutions which provide long–term project financing.

All of the above points encourage the current thesis to investigate more about Turkish banks from 2002 through to 2017. Due to the importance of the role of the main indicators (efficiency, stability and competition) on the Turkish banking sector, this thesis studies the efficiency scores of Turkish banks. We do this through three different types of efficiency: technical, allocative, and cost efficiency. In order to define efficiency, this thesis uses the Lovell (1993) description which defines efficiency as a valuation that is based on the experiential and optimum level of outputs. Later in this research we will consider the role of BLC in Turkish banks, considering a bank's characteristics namely size, liquidity and capitalisation. This thesis considers efficiency as an additional characteristic in examining the monetary transmission mechniasm through BLC. Finally, this thesis investigates the relationship between competition, stability, and efficiency in Turkish banks.

1.1. Research background

1.1.1. A Turkish economy and its banking sector

The crucial role of banks all over the world has always been interesting for researchers and regulators because they play an important role in every economy. The bank's function has changed continuously throughout history adjusting to new requirements and new financial environments. These changes can be seen the transformation in the function of this intermediate organisation, whether in merger and acquisition policies, offering several financial and off-balance sheet services to the customers, or offering in person and online services. Banking performance pre- and post-globalisation, the introduction of technological innovation and the 2008 financial crisis are some of the subjects of the core international studies. Although all of these revolutionary phenomena have had their influence on the structure and performance of the banks all over the world, the 2008 financial crisis can be discussed as one of the main milestones for all financial markets. Therefore, although evaluating all significant changes in the banking sector is crucial, banking literature before and after the financial crisis will be

particularly discussed. Before the 2008 financial crisis, different aspects of the banking sector across different countries have been investigated. Researchers studied the three main banking theories: the prevalent financial intermediation theory[7], the older fractional reserve theory[8], and the credit creation theory[9]. In addition to these theories, scholars applied different methods to evaluate the efficiency, competition, profitability, and the impact of globalisation in the banking industry. The 2008 financial crisis was a massive shock to the financial market and it was left to regulators and researchers to illustrate the importance of banks, their functions, their level of their efficiency, the complexity of their structure, and their competition strategies. Therefore, investigating banks' efficiency, their stability, their financial channels, the impact of ownership, and reviewing the theories and functions around the banking sector have all become attractive for regulators and researchers alike, particularly after the most recent financial crisis.

Key studies have investigated aspects such as technological changes, deregulation and supervisory polices, mergers and acquisitions, bank ownership and efficiency, bank concentration and competition, and the impact of efficiency for different sectors in banking (e.g. Leroy and Lucotte, 2017; Chronopoulos *et al.*, 2015; Barth *et al.*, 2013; Chortareas *et al.*, 2012; DeYoung *et al*., 2009; Iannotta *et al*., 2007; Berger *et al.*, 2004; Berger and Mester, 2003; Berger, 2003; Bikker and Haaf, 2002; Altunbas *et al*., 2001; Berger and DeYoung, 2001; Dell'Ariccia, 2001; Strahan and Weston, 1998; Shaffer, 1989).

Some of the most recent studies have been considering competition and concentration. For instance, Leroy and Lucotte (2017) have investigated the relationship between competition and bank risk considering *Z*-score and distance-to-default measures. They focus on the European

[7] This theory explains how intermediaries serve to reduce transaction costs and informational asymmetries.
[8] According to this theory, each individual bank is a financial intermediary without the power to create money, but the banking sector collectively is able to create money through the process of 'multiple deposit expansion.
[9] According to the Credit Creation theory, any individual banks can generate money by not only lending the deposit but also by creating bank deposits which is a result of bank lending.

banks between 2004 and 2013. In addition, Berger (2003) and Berger and Mester (2003) have researched the impact of technological progress and development on the banking sector. Both studies relate to the US market. And both studies have reported that technological development, despite being beneficial for a bank's performance and effective for competition, are not the only reason for improved performance of banks. Berger (2003) stated that the way in which technology is implemented is also very important. Other studies like Chronopoulos *et al*. (2015), Barth *et al*. (2013), and Chortareas *et al*. (2012) investigated bank supervision, efficiency and profitability. The findings from these studies about the supervisory and regulation differs: Barth *et al.* (2013) reported that tighter restrictions and policies negatively influence a bank's efficiency while Chortareas *et al*. (2012) stated that official supervisory powers can enhance a bank's efficient operation.

Similar to more developed countries, studies on different aspects of banking and performance have been improving and receiving attention from developing countries as well. For instance, Wang and Sun (2019) examined the impact bank owners have on risk taking behaviour in the banks of developing countries. They studied over 43 developing countries between 2004 and 2012. Their results suggest that banks with larger owners (like a government) take fewer risks than other banks. Pelletier's 2018 study is another recent piece of research on bank ownership and impact it has on the bank's performance. He studied 47 sub-Saharan countries' banks from 2003 to 2012. His results show that it is important to consider the heterogeneity of foreign banks in African countries while evaluating the impact of foreign ownership. Leon (2015) investigated how a bank's competition can help better financing and functioning in a market. He considered 69 developing and emerging countries using three non-structural measures including the Boone indicator, the Lerner Index, and H-statistic. The results demonstrate that bank competition reduces credit constraints and also reduces borrower concerns. Cubillas and Gonzalez (2014) studied the channels through which liberalisation has

influenced banks' risk-taking behaviour. They examined 83 developed and developing countries from 1991 until 2007. Their findings suggest that financial liberalisation boosted the risk-taking behaviour of banks in both developed and developing countries through different channels. Their research indicates that in developing countries more risky decisions are the result of increasing competition, whilst in developing countries taking more risky decisions is due to being faced with new opportunities. Barth *et al*. (2013) assessed the impact of the global financial crisis in 2008 on the banking sector and the importance of renewing bank regulations in order to obtain stability and improve performance. They analysed 72 countries from 1999 to 2007 using un-balanced panel analysis. They stated that the more restrictions there are on a bank's activities, the greater the degree of negative influence on the bank's efficiency, whilst capital regulations can improve the efficiency scores of banks. Bonin *et al*. (2005b) investigated the impact of bank privatisation on efficiency in 6 transition countries including Bulgaria, the Czech Republic, Croatia, Hungary, Poland, and Romania from 1994 until 2002. They state that foreign banks are more efficient compared with state-owned banks. They also emphasise the importance of a foreign investors in the success of the privatisation process. Another piece of research that investigated bank efficiency in developing countries is Sathye's 2003 study. His study analyses productive efficiency in India during 1997-1998 using DEA approach to compute efficiency. This study concluded that Indian banks are doing well compared to banks globally and that the only aspect needing to be addressed is the amount of NPLs.

It is also worth providing an overview of Turkish macroeconomic circumstances and Turkey's performance before and after the financial crises in 2000-2001 and 2008 so that the overall economic growth and development of the country can be linked with the issues in the following discussion. The most significant problems for Turkey since 2001 have been the high savings deficit due to the drop-in savings rates, and the current account balance deficit. Since 2001 low rates of saving have led the economy to become increasingly dependent on external

savings in order to reach the desired investment levels. This makes the economy more sensitive and vulnerable to the movement of foreign capital, especially in times of global economic uncertainty. Although the Turkish economy has attracted considerable foreign capital due to its successful stabilisation policies and opportunities and attractive returns in the post-2001 period, it is clear that this growth strategy is not sustainable. The Turkish economy has experienced significant levels of inflation almost continuously. During the last thirty years, the majority of programmes aimed at imposing disinflation have failed. Although Turkey experienced inflation of over 10% during some years, since 2002 it has not reached hyperinflation levels. The average yearly inflation rate during the 1970s was approximately 20%. Despite considerable fluctuation, this rate reached 105.21% in 1995. Hence, in 1998 the Turkish government started a new disinflation programme under the guidance of an IMF Staff Monitored Programme. As mentioned above, in December 2000, after meetings of the Turkish authorities and the main foreign banks, foreign commercial banks committed to keep their inter-bank and trade-related activities with Turkish banks and other financial institutions (Barkbu, 2011). The agreement was to maintain external funding in order for Turkish banks to remain stable. However, in February 2001 when the currency crisis happened in Turkey, this agreement came to an end.

Soon after the crisis, extensive reforms and policy initiatives were imposed. In May 2003, the BRSA established a comprehensive restructuring programme for the Turkish banking sector (BRSA, 2010). The programme had four main goals: (1) a restructuring of state-owned banks, (2) the swift establishment of the SDIF banks, (3) the strengthening of private banks, and (4) a strengthening of the regulatory and supervisory framework.

To reinforce the capital structures of the state-owned banks, at the end of 2003 a total of 22 billion dollars was provided by the SDIF. Furthermore, weaker state-owned banks were protected via mergers and acquisitions through the privatisation system. More liquidity was

provided for the banks under SDIF control. Moreover, weaker banks merged with or transferred to other stronger banks. In addition, to strengthen the capital structure in banks under SDIF control, a total of 28 billion dollars was transferred to them. The SDIF was financed by the Turkish government through the issuing of special bonds.

The regulatory and supervisory framework was improved by numerous amendments to the banking laws bringing them in line with international best practice and with EU directives (Turkey is willing to be a member of the EU). To minimise financial risks, capital adequacy ratios for Turkish banks were increased to 12%, while international regulations required only 8% for the European banks (BAT report, 2009). The Turkish government and the CBT restricted the lending of foreign currencies. Only banks and other financial institution with foreign revenue were eligible to lend foreign currencies. The target was to minimise the foreign exchange disparity on bank balance sheets. Futures and options contracts with other derivative products also were considered under the definition of credit.

Although there was a massive level of public debt, Turkey could manage its sovereign debt. In June 2001, the Turkish government, faced again with the same problems as before, accordingly organised a voluntary debt-swap operation (Özatay and Sak, 2002). The TL, which were held by private Turkish banks in the form of government securities, were exchanged for US denominated bonds, in order to extend the government debt maturities and support banks in addressing their negative foreign exchange positions. In doing so, the TL bonds with an average of five months maturity were exchanged with the US denominated bonds with an average debt maturity of 36 months.

In addition to public debt, corporate debt was also restructured. The main target was to assist companies in recovering from the financial crisis and to eliminate their NPLs ratios. Due to the devaluation of TL in February 2001, several entities failed to adapt to the new environment in Turkey. Hence, to survive in the market, the ‘Istanbul Approach’, was announced in June 2002

(Özatay and Sak, 2002). According to this approach, 6 billion dollars of corporate loans were restructured, mainly through lengthening maturities.

The programme delivered some significant improvements after which the inflation rate in Turkey started to decline continuously. Eventually, Turkey was successful in meeting its mission of achieving a single-digit inflation rate from 2004 onwards, when its inflation rate was reported as 8.5%, to 2016, when inflation dropped to 7.7%. However, due once again to Turkey's political issues, the inflation rate increased to approximately 12% in 2017. This trend continued in 2018.

Moreover, Turkey enjoyed five years of rapid growth in its economy and its financial system after the currency and financial crisis in 2001 with GDP per capita increasing by almost 6% per year. During this period Turkey implemented many structural changes and increased its productivity and economic activity. However, after 2007, Turkish economic growth slowed down significantly. An aggressive privatisation programme reduced the participation of state-owned financial institutions in the Turkish financial system. Global economic conditions and tighter fiscal policy resulting from Turkey's disinflation programme caused GDP growth – to fall to around 4.7%. However, Turkey's well-regulated financial system and its banking sector (more tightly regulated and improved after the 2001 crisis) helped the country to rebound and in 2011 GDP growth reached around 10%. From 2017 GDP started to grow again and in 2018 it reached approximately 7.7%.

Since 2014, productivity and growth rates have slowed down indicating a persistent underlying imbalance in the Turkish economy. In particular, Turkey's huge current account deficit shows it must rely on external investment inflows which have damaged investor confidence regarding Turkey's financial market. Another challenging point relates to increasing unemployment and the inflation rate, which from 2017 started to increase again. Hence, the Turkish currency is depreciating against the US dollar. Even though the government

was successful in keeping debt low (around 30% of GDP), the amount of borrowing by banks and corporate institutions has almost tripled as a percentage of GDP during the past decade resulting in local and international concerns regarding Turkey's long-term sustainability. One of the main reasons for this slow-down trend in Turkish productivity and economy during the last five years is shocks to the exchange rate system.

Since the era of deregulation and liberalisation, Turkey has experienced two main changes in its foreign exchange system. As a result of the 2001 crisis the exchange rate system altered from a fixed to a free-floating system. During this period, a new economic stabilisation programme was initiated which limited CBT intervention in the foreign exchange market. Between 2001 and 2017, these reforms led to a considerable improvement in Turkey's banking sector and in its financial market conditions. After experiencing several years of strong growth and significant external borrowing, the value of TL has depreciated continuously since the middle of 2017. Due to an increase in market pressure and in response to growing imbalances, the CBT tightened monetary conditions enormously.

1.1.2. A summary of non-performing loans in the Turkish banking sector

Since the crisis in 2001, another key issue that has concerned the Turkish government and the CBT is the high ratio of NPLs. The NPLs were a core issue that shattered financial stability after the Turkish financial and currency crisis. The extraordinary amount of NPLs undermined the banking sector, forcing banks and financial institutions to declare bankruptcy. In the recessions in 1999 and in November 2000 banks started to close their interbank credit lines in Turkey due to their concern about the health of the banking sector. This concern prompted foreign investors to withdraw their funds by selling off treasury bills and equities. This currency crisis, ended by IMF assistance and prescriptions, was followed by a political crisis in early 2001. The ratio of NPLs in the banking sector started to increase rapidly and reached 17.6% in 2002 as a result of the combination of these crises. However, after implementing reforms the

rate of NPLs dropped to 2.84% in 2017. In Turkey, NPLs have become a major source of concern experiencing the two recent financial crises. By the end of 2000 the total amount of bad loans was reported to stand at 5.8 billion dollars. This figure represents 12.5% of total loans and 3.9% of total assets. During the same year, private banks were in a better position having 1.7 billion dollars of NPLs: 6.1% of their total loans and 2.3% of their total assets. This however, does not alter the sensitivity of the Turkish banking sector to NPLs, nor their magnitude. At the end of June 2001, based on the published reports of the CBT, the total amount of bad loans in the Turkish banking sector was 4.8 billion dollars. Although TL devaluated and weakened considerably in foreign currency terms, the ratio of NPLs to total loans increased to 17%. The entire banking sector's losses because of the deterioration of loan quality, coupled with the losses from the devaluation and changes in the interest rate have caused a significant damage to banks' equity. Despite the fact that historically, Turkish banks had significant proportion of NPLs, a collaborative attempt has been needed to protect the Turkish banking sector from the expected impact of the unexpected decline in asset quality. For instance, as NPLs are a proxy for measuring credit risk, these loans before specific provisions increased by 22% in 2016. Hence, specific provisions are required to be set aside for these loans.

Several investigations indicate that the impact of NPLs on almost all Turkish commercial banks was the same. However, the impact of these bad loans on state-owned banks performance was the most significant. The reason lies in the ownership and size of these banks. The state-owned banks are the largest in Turkey, sharing 66% of total assets and 65% of total deposits in the Turkish banking sector. These banks are also the oldest ones in Turkey. Since these banks have strong support from the Turkish government, they take more risks in their activities. The highest NPLs ratio belongs to state-owned banks, followed by private banks, who share the second-highest NPLs ratio. Because these Turkish banks are commercial banks and they

generate income through the lending process, a high ratio of NPLs illustrates the fact that they are suffering from bad management. They are not able to generate anticipated income from their available liquidity sources. Since the required income could not be generated, the profitability of Turkish banks dropped. Consequently, the total number of branches started to decrease. Moreover, weaker banks merged with stronger ones to optimise resources. Hence, there was a reduction in the overall number of banks. The number of private banks decreased by 167 and the number of foreign banks by 265[10]. There was no change in the number of investment and development banks. Surprisingly, despite the weak performance of state-owned banks, the number of their branches increased by 21. One explanation for this is a central government practice wherein commercial lending by state-owned banks is permitted in order to support government targets and the financial sector.

1.2. Research motivation

Having been involved in many restructuring programmes and having a unique political and geographical location in emerging markets, Turkey provides an interesting case by which to investigate the impact of NPLs and monetary policy changes on the banking sector. Turkey experienced many 'boom and bust' periods particularly in the last thirty years due to financial crises and the implementation of restrictive programmes. Although there are several challenges within Turkey's economy and its banking sector, there is some evidence to support the positive impact of imposing restructuring and reform programmes. These helped Turkey to address significant financial drawbacks. Policy and regulations are frequently revised in Turkey; the last occasion was in September 2018 when the BRSA announced a broad restructuring programme in relation to the debts of companies owed to Turkish financial creditors. The BRSA's recent 'Regulation on the Restructuring of Debts Owed' policy aims to pave the way for companies to initiate a general restructuring of their financial debts and ensure coordination

[10] Another reason for this reduction is the political situation in Turkey, particularly during the recent years.

amongst Turkish financial institutions in the restructuring of these debts. After implementing all these restructuring programmes Turkey has remained unable to overcome its economic and banking challenges, which is concerning. Hence, the motivation of this thesis is to investigate Turkish banks' performance based on information released by the CBT regarding the performance of Turkish banks. In this thesis there will be a special emphasis on the impact of NPLs while studying the efficiency of Turkish banks. This thesis will examine the monetary transmission mechanism through BLC and evaluate the relationships between competition, stability, and efficiency.

Bank performance is a well-established research field both worldwide and in Turkey. An important factor in evaluating bank performance is through the computing of efficiency scores and productivity growth. Efficiency in particular has received considerable attention after the 2008 crisis because it could have been used as a metric to reassure the government and the CBT about the soundness of the banking and the financial sector. Studying efficiency also clarifies the main efficiency determinants and their impact. This is important because information on efficiency scores and productivity growth could have been used for comparison purposes, for example on the efficiency differences between banks, or between different performance measures (return on assets, return on equity) or more advanced measures through regressions with numerous independent effective variables. Furthermore, performance rankings could have been revealed, thus allowing bank managers and policymakers to pinpoint the best and worst performers. Productivity growth is also of interest to managers in determining the driving forces behind growth.

There are several studies around the impact of banks' efficiency which evaluate the global impact of different economic factors and various determinants. These studies measure various kinds of efficiency by applying several econometrics methods. For instance, Fujii *et al*. (2018) studied bank efficiency and productivity changes amongst the EU28 imposing a new approach

of weighted Russell directional distance model. Using a disaggregated approach, they separately evaluated the impact of bank inputs on bank efficiency and productivity. Fiordelisi and Mare (2014) studied the relationship between competition and bank soundness for European cooperative banks between 1998 and 2009. Their results support a positive relationship between competition, stability and bank soundness. Similarly, Fu *et al*. (2014) used data from 14 Asian Pacific countries during 2003 to 2009 to study the impact of competition, concentration and regulation on banks' performance. In evaluating bank performance, they particularly focused on the banks' efficiency. Their results show that strict regulations and having more market concentrated decline the bank' efficiency and have negatively influenced banks' performance. However, greater regulatory freedom allows banks to improve their efficiency by providing various types of services and imposing different ways to diversify their risks.

Homma *et al*. (2014) proposed a novel test of the efficiency structure hypothesis by assessing the relationship between bank efficiency and bank growth on Japanese banks from 1974 to 2005. Their results are in line with the efficient structure hypothesis and quiete life hypothesis as they show that a greater degree of market concentration reduces a bank's cost efficiency. Kao and Liu (2016) suggested applying a relational network model to study the operations of individual periods to measure efficiency. They calculated total efficiency and efficiency per period for decision making units for Taiwanese commercial banks from 2009 to 2011. Their results show a constant increase in total efficiency over the three years of their study. Furthermore, Glass *et al*. (2014) also studied the efficiency of Japanese cooperative banks from 1998 to 2009. They focussed on the impact of NPLs as an undesirable output. By applying a translog enhanced hyperbolic distance function model, their results suggest a decrease in technical inefficiency in Japanese banks.

Casu *et al.* (2013) investigated the impact of a regulatory system on Indian banks' productivity and efficiency. They used non-parametric techniques to measure the efficiency frontier which is followed by a Divisia Index and a Malmquist Index of Total Factor Productivity (TFP). Their results support a sustainable growth for Indian banks' productivity. They also considered different ownerships and reported that different ownerships perform differently in the variable operation environment.

Fiordelisi *et al*. (2011) analysed the relationship between efficiency and bank risk. They designed inter-temporal relationships among efficiency, capital and risk for large European commercial banks. Their results suggest that cutting costs and revenue efficiency lead to an increase in banks' future risk, which is in line with bad management and moral hazard hypotheses.

Koutsomanoli-Filippaki and Mamatzakis (2009) provided a new evidence on interactions between risk and efficiency using a directional distance function framework which used cost and profit frontiers. To measure for bank default risk, they then used VAR analysis to examine the relationship between efficiency and risk. Lensink *et al.* (2012), Berger *et al.* (2009), Bonin *et al.* (2005a), and Sturm and Williams (2004) studied the impact of ownership and bank efficiencies in different countries, including China and Australia. Some of them like Bonin *et al.* (2005a) focused on transition countries. There are various models in these studies: the SFA, traslog function, and mixed approaches. The reported results are not consistent in these studies; some of them confirm that foreign banks are performing better (Berger *et al*., 2009) and some of them argue that foreign ownership has a negative influence on bank efficiency (Lensink *et al*., 2008). Fries and Taci (2005) also examined the cost efficiency of 289 banks across 15 Eastern European countries to evaluate the process of transforming the banking system following the fall of Communism. They explain that the earlier stages of reform are associated

with a reduction in cost while the cost increases eventually as time passes. They also stated that private banks are more efficient than state-owned banks.

In addition to these studies, some other scholars in early 2000 and during the 1990s also investigated bank efficiency. For instance, Berger and Mester (2003) studied the technological changes and impact of deregulation on the performance of US banks from 1991 until 1997. Drake and Hall (2003) also using the DEA approach study technical and scale efficiency in Japanese banks. They took the impact of NPLs into consideration, but as a controlled variable. Reviewing more literature, the study of Tortosa *et al.* (2008), Cuesta and Orea (2002), Alam (2001), Kumbhakar *et al.* (2001), Berger and Humphrey (1998), Berger and Mester (1997), Berger and DeYoung (1997), Miller and Noulas (1996), Molyneux *et al*. (1994), Berg *et al.* (1993) also focus on bank performance and efficiency studies.

Considering all of the international studies on efficiency, it is worth emphasising that efficiency studies regarding the Turkish banks' performance are rather limited compared to other countries (for example, Glass *et al.*, 2014; Assaf *et al.*, 2013; Barros *et al.*, 2012; Altunbas *et al.*, 2001; Fukuyama *et al.*, 1999). Based on efficiency studies, areas of input overuse or output underproduction can be detected so that managers can adjust banking operations accordingly (Berger and Humphrey, 1997). Considering the current literature in Turkey, we can see there are some gaps and questions that have not been given enough attention and consideration. For instance, some questions regarding the source of the inefficiencies in the Turkish banking system have yet to be satisfactorily explored. Hence, in the next section, the main questions and contributions of this thesis are going to be discussed.

1.3. Research questions and contributions

To address all of the research questions of this thesis the data for 44 Turkish banks are collected. The details for all of these banks are presented in Table1.1. Each sub-section in this thesis discusses the relevant questions and attendant contributions.

1.3.1. How do non-performing loans influence technical and allocative efficiency scores in the Turkish banking sector?

Accordingly, the first part of this dissertation deals with the impact of NPLs on bank efficiency in Turkey. The results are in line with the working hypothesis that NPLs have a detrimental effect on bank efficiency. To expand the investigation on efficiency, this study also endeavours to explore other determinants that affect bank efficiency by introducing some qualitative factors, including employees' gender and education.

To answer the first research questions, this thesis (Chapter Three in particular) contributes to the current Turkish literature by measuring technical, allocative, and cost efficiency by modifying a DEA, which is introduced by Aparicio *et al*. (2015). Applying this method enables this study to define a separate vector to define the undesirable variable. In this study, NPLs are taken as a bad output. Unlike most studies on Turkish banking which consider problem loans as a control variable, or a proxy for risk (Liu and Tone, 2008; Drake and Hall, 2003; Altunbas *et al*., 2001), we follow a new strand of literature by treating problem loans as an undesirable output in bank efficiency measurement (Glass *et al*., 2014; Barros *et al*., 2012; Fukuyama and Weber, 2008). This methodology allows for a simultaneous expansion of desirable outputs and a contraction of inputs and undesirable outputs. The model is adjusted for a vector of one undesirable output, namely problem loans. We use the term 'problem loans' on occasion in this study rather than NPLs in order to be consistent with the classification of problem assets under "Financial Reconstruction Law". In addition to conventional activities, Turkish commercial banks also invest in government bonds, corporate bonds and securities, as well as offering non-traditional banking services such as guarantees and acceptances. They are an output component of banking operations. Thus, evaluating them helps to capture the wider picture of a bank's performance to detect both positive and negative activities in Turkish banks. To measure all three types of efficiency, we took capital and deposit as our main inputs. Accordingly, the

desirable outputs are total loan and receivables, total securities, total off-balance sheet activities, and non-interest income of Turkish banks. One undesirable output is NPLs. Having quarterly data on NLPs in the Turkish banking sector enables us to detect and monitor the credit risk in Turkish banks thoroughly. This is because these loans measure the level of risk held within Turkish banks. The variation of these loans can be due to management issues and exogenous shocks. In turn, these overdue loans can raise bank operating costs in the short-term. Hence, one would expect these loans to decrease bank productivity (Ray and Das, 2010; and DeYoung, 1997).

Given the extensive volume of bad loans in Turkey, it is expected that we will find that these loans have a negative impact on bank productivity. Hence, in this study, we evaluate the efficiency determinants as well. The main determinants we take into consideration are NIM and NNIM with the aim of evaluating the management system in Turkish banks. Moreover, we consider ROA, which reflects the profitability of the banks. We consider the bank' age to see if there is any meaningful relationship between the efficiency score and the age of the Turkish banks. Unequivocally we see that equity plays a significant role in banking production as a buffer against risks (Boucinha *et al.*, 2013). Equity is the shock absorber for unexpected operating losses, preventing banks from temporary illiquidity and insolvency risks (Diamond and Rajan, 2005). Besides embracing incurred risks, the level of equity should also facilitate future growth of the bank's assets (Boucinha *et al.*, 2013). In the short-term, altering a significant level of equity would be impossible (Lozano- Vivas and Pasiouras, 2014). In other words, banks benefit from equity but do not need to pay for it in the short-term. Equity can also serve as a cost-reducing factor because less interest is paid for debt financing (Hughes and Mester, 2013). In addition to these benefits of equity, neglecting their impact in the Turkish banking system would result in biased estimations. Due to database limitations, we could not collect relevant data for Turkish banks' equity.However, we considered the capital ratio in our

investigations. This paper considers two novel efficiency determinants: employee's gender and their education. Moreover, the issue of different ownerships as a means to evaluate performance is considered separately. The results obtained from these banks' technical, allocative, and cost efficiency indicate the main source of the inefficiency both in these banks, and in the entire Turkish banking sector. This is particularly important for regulators when they are implementing new restructuring Acts and plans for Turkish banks. This research finds that NPLs have a negative effect on all three types of efficiency. Moreover, similarly to Fukuyama and Matousek (2011) and Athanasoglou *et al*. (2008), this study finds that an extensive restructuring program implemented in Turkey not only led to a greater degree of efficiency but also to better managerial decisions while assessing the efficiency determinants. In addition, the results obtained regarding employees' education and gender have led us to find that education has a positive impact on all three types of efficiency scores. These findings may be used to encourage the whole banking sector and regulators to invest more in human capital in Turkish banks. This study could have been improved by having more details and categories around bank loans and different earnings.

1.3.2. Question two: Considering the efficiency level of a bank, how do monetary policy changes influence banks' loan portfolios through bank lending channels?

The second part of the dissertation deals with the role of Turkish banks in the monetary transmission mechanism through BLC. The standard analysis is extended to include bank performance in terms of efficiency and its impact on the monetary policy stance of the CBT.

To answer this second research question, this thesis (Chapter Four specifically) focuses on the impact of monetary policy shocks directly and indirectly through the BLC on the volume of NPLs. This dissertation contributes to the current literature in Turkey by deploying a unique methodology by which to examine the monetary transmission mechanism through BLC. Applying a Bayesian estimation approach provides us with the opportunity to deal with more

accurate information in defining the prior and posterior probabilities. Since data in this thesis is not normally distributed, a Bayesian approach declines the error. This research is different from all other available studies on the monetary transmission mechanism in Turkey not only because it applies different methods but also because it expands the characteristics under consideration. The literature around developing countries is not particularly developed and does not consider the most recent improvements. Hence, there is not enough evidence exploring the impact of the banks' other characteristics. For instance, there is only one study on Turkish banks which investigates the impact of cost and profit efficiency (Akinci *et al*., 2013). Knowing that the ratio for NPLs is growing provides motivation for this thesis to investigate more thoroughly and concentrate on this characteristic (efficiency). This study helps in identifying the main source of NPLs in Turkish banks. Moreover, the challenging economic situation in Turkey has provided the motivation for this chapter to investigate the accuracy of the sudden monetary policy changes in this country. The political and financial crises in 2015 and 2017 could be used as evidence to highlight the importance of this matter. It is expected that evidence will be found to support the existence of lending channels in Turkey. Moreover, it is expected that a meaningful and significant relationship between technical and allocative efficiency with monetary policy changes will be found. Since allocative efficiency includes cost and profit efficiency, this study uses allocative efficiency, since it provides a wider picture. Following the study of Akinci *et al*. (2013), this study considers two- and three-way interactions of a bank's characteristics with fluctuations of the interest rate. This study finds that there are significant and negative relationships between changes in the interest rate and inflation in the short term. However, in the longer term, the results of a bank's loan growth should support a stronger impact of interest rate changes through money lending channels.

1.3.3. Question three: How do banks with higher efficiency scores perform more profitably in a competitive market?

The final part of the thesis thoroughly investigates the existence of efficiency and higher profitability under competitive circumstances.

Finally, to answer the third research question, this thesis (Chapter Five to be specific) investigates the quantitative relationship between competition, stability, and efficiency. As discussed, the main aim of this part of the thesis is to analyse the relationship between competition, stability, and efficiency. To achieve this target, this dissertation contributes to the available Turkish literature by employing the Boone indicator (2008) for the first time in Turkish literature to measure bank competition and to examine these underlying linkages among competition, stability, and efficiency. This competition proxy is valid under different situations that could lead to more intense competition in the market. For instance, an increase in the number of market participants, a lift in entry barriers, a decrease in costs for other incumbents, or more aggressive interactions between firms can result in heightened competition. This research further adds to the Turkish literature by providing bank-level Boone indicators, as existing studies usually compute either industry/country-level scores or time-varying ones at most. In addition, applying a unique measure enriches the study because the impact of NPLs is indirectly considered in measuring banks' efficiency. The results in this paper suggest a positive relationship will be found between competition and efficiency in line with the competition-stability hypothesis (Schaeck and Cihak, 2008; Stiroh and Strahan, 2003), which not only indicates the positive impact of competition on bank performance but also illustrates the motivation for banks to be more efficient by having lower NPLs ratios and better non-interest income management strategies. Moreover, this study focuses only on Turkey, which leads to more reliable results in assessing the relationships between competition, stability, and efficiency without dealing with the impact of any other external factors.

Considering ongoing debates on the relationship between competition, stability and efficiency, this study delivers new insights to support a clear relationship between competition, financial stability, and efficiency further than what can be actually seen in the market.

1.4. Research outline

This thesis is structured as follows:

Chapter Two provides a literature review on the global banking sectors and then it narrows the discussion down to the Turkish banking sector. The main economy and banking revolutions are discussed in this chapter.

Chapter Three investigates the impact of NPLs on Turkish banks' technical, allocative, and cost efficiency using modified DEA measure. This chapter also consideres the gender and education of employees as two unique efficiency determinants. All the efficiency determinants are evaluated through quantile regression, which, to the best of our knowledge, has never been applied before to study the efficiency determinants in Turkish studies. Quantile regression has been applied in some other studies in the area of banking and finance, for example the determinants of Islamic bank performance was considered by Chowdhury *et al*. (2017); banking risk regulation by Klomp and De Haan (2012); diversification and risk-adjusted performance by Lee and Li (2012); the relationship between stock price index and exchange rates by Tsai (2012); Chiang *et al*. (2010) evaluated stock market behaviour; bankruptcy prediction by Li and Miu (2010); ownership and profitability is addressed by Li *et al*. (2009); and capital structure was researched by Fattouh *et al*. (2005). The negative impact NPLs have on the efficiency of Turkish banks is confirmed.

Chapter Four analyses the monetary transmission mechanism through BLC in Turkish banks after the crisis in 2001. A unique Bayesian approach is applied to assess the existence of bank lending in Turkey. Moreover, while evaluating the existence of bank lending using a bank's characteristics, technical and allocative efficiency as an additional characteristic have been

taken into consideration. The impact of these characteristics alone, and in terms of two- and three- way interactions along with changes in the interest rate are evaluated. This chapter confirms the existence of a BLC in Turkey. More importantly, this chapter confirms there is a significant impact on the efficiency of Turkish banks' loan supply in in the instance of any sudden monetary policy shocks.

Chapter Five investigates the relationship stability and efficiency have with competition in Turkey from 2002 to 2017. This chapter uses the Boone indicator to measure the competition with regards to efficiency and profitability in Turkish banks. This chapter also applies competition scores to analyse the relationship between competition and stability, which is indicated in the form of *Z*-score, and efficiency, which is measured using a modified DEA method.

Finally, Chapter Six provides a summary of all the three main studies in this thesis along with the main contributions, ways of addressing these contributions, and their findings. Moreover, more research directions and some recommendations for policymakers are provided.

Chapter 2

The Turkish Economy and Its Banking System

This chapter provides a review on the international banking sector studies and reviews the fondumental theories about the maket structure. Then, it evaluates the Turkish economy and it banking sector in section 2.2.

2.1. Review of international banking sector studies

Banks and the banking industry have long been attractive for both regulators and researchers. Due to the importance of the banking industry and the crucial role it plays in every economy, the majority of significant financial decisions and policies are implemented through banks all over the world. The crucial role of this financial entity has not only caused banks to continuously make changes and upgrades based on market requirements, it has also made them significantly sensitive to financial disaster and sudden shocks. The importance of banks has therefore led researchers to study different aspects and theories emerging in this sector. Study around the banking sector and its characteristics is quite broad; to consider every aspect of the sector is beyond the scope of this thesis. This thesis aims to measure the efficiency of Turkish banks. The efficiency scores will then be used to define Turkish banks' characteristics while evaluating the mechanisms and policies for monetary transmission in Turkey. This thesis also investigates the relationship between competition, stability and efficiency in Turkish banks. It narrows down the literature by focusing on studies around structural measurements, including SCP and the efficiency structure hypothesis. Moreover, this thesis considers the studies which evaluate the impact of banks' characteristics on their performance under different market conditions.

While evaluating the banking sector, it is important to consider that the structure, culture and banking operations in developing and developed countries are significantly different.

Considering different economies, demographics, geography, and financial characteristics is important in evaluating a market structure. The market structure in turn influences the performance of banks in that country (Gilbert, 1984). Banks are one of the main institutions in any economy that can directly or indirectly determine financial development. Financial development is the key to economic growth. Banking operation and the total amount of money and credits they can generate for economic activities are the key elements counting towards financial development (Cetorelli and Gambera, 2001). Hence, for banks to be able to contribute to the economic development process, it is crucial to provide advanced banking and financial services. There is a clear link between these aforementioned concepts. The relationship between market structure and a bank's characteristics and aspects can be defined in the form of a SCP and an efficiency structure model.

It is clear that for banks to be able to survive in the financial market, they should compete with the other banks both locally and internationally, and with other financial institutions. Financial globalisation has made this competition vital. To concentrate more on reviewing the relevant studies around competition measurements, bank performance and market structure, this thesis reviews the researches which have followed financial globalisation; we take this approach because there have been significant changes and innovations following financial globalisation. Moreover, financial globalisation has become a unique phenomenon. Governments' elimination of financial regulations and capital restrictions from the 1970s created new opportunities for all countries to expand their financial transactions and exchange their financial commodities. Financial globalisation increased trade, investment and capital flow everywhere (Moshirian, 2008). It helped countries all over the world to expand their business activities outside their own borders and to utilise resources available elsewhere. So, instead of national financial markets, there emerged the new concept of the global financial market.

It is crucial that we note that the discussion around the relationship between market concentration and bank performance started before the era of financial globalisation. However, affording special attention to the role of competition in bank performance (locally and internationally) has motivated researchers to apply the SCP and the efficiency structure hypotheses with different considerations. Before reviewing the literature around the SCP and the efficiency structure hypotheses, it is worth mentioning two main points: First, it is important to have a clear definition of SCP and efficiency structure hypothesis. When evaluating the structural measurement for competition, the focus would be on the SCP and the efficiency structure model. As Koutsomanoli and Staikouras (2006) explain, these two models examine whether a more concentrated market can make larger banks perform better or whether a higher efficiency score is the main reason for a good performance amongst larger banks. Gilbert (1984) outlines that, whilst these hypotheses do not consider the micro and macroeconomic indicators, they can nonetheless provide useful information about the market structure and bank performance and the relationship between these two.

Focusing on the SCP hypothesis, this offers a general picture of market performance. Under this hypothesis the competitive behaviour of a financial unit could be determined by the market's structural features which can influence a firm's performance (Carbo *et al*., 2009). The market structure in the SCP hypothesis is measured using different measures such as market shares, concentration ratios or HHI (Gilbert, 1984). According to Carbo *et al*. (2009) the aim of the SCP hypothesis is to examine the relationship between the features of market structure and a firm's performance. Initially researchers used the SCP hypothesis to study the manufacturing industry, which was performing in a very close market with minimal new entries and a lesser degree of competition during the 1940s and 1950s (Carbo *et al*., 2009). Later, scholars started to test this hypothesis in the area of banking in order to discover more information about the relationship between bank performance and market structure. According

to the SCP hypothesis, the more concentrated the market, the lower the degree of competition. The SCP hypothesis tests the relationship between market concentration and bank performance by considering bank profitability. So, the higher the bank's profitability, the better its performance. As stated by the SCP hypothesis there should be a positive relationship between the bank's profitability and market concentration. In such an environment, the competition score is low.

Conversely, as Gilbert (1984) discusses, interpretation of the SCP hypothesis can be challenging when one also considers the efficiency structure hypothesis. In this case, bank performance should be investigated because it could be due to market concentration, or to having a higher efficiency score. Carbo *et al.* (2009) discuss the idea that higher prices and profit can be the result of a concentrated market structure as much as it can be the result of higher efficiency scores of a financial institution and high management and production quality of a firm. The efficiency hypothesis explains that the more efficient banks can generate higher profits. Consequently, their market share increases. This may in turn lead to a higher market concentration. There are studies to support the efficiency hypothesis, for example, Evanoff and Fortier (1988) and Smirlock (1985). We see that when evaluating the relationship between market structure and market concentration, it is crucial too to consider the efficiency structure hypothesis (Evanoff and Fortier, 1988).

Moreover, while studying the structural competition measurements, following Gilbert's (1984) survey, literature can be divided into two groups: The first group evaluates the relationship between the market structure and bank performance. The second group of literature focuses on the banks' cost structure. The first group of studies emphasise the relationship between market structure and bank performance. They are mainly interested in evaluating either the SCP hypothesis or the efficiency hypothesis. The findings from these studies regarding the influence of market structure on bank performance is not consistent. Depending

on the market environment and different banks' characteristics (profitability, for example) the SCP or efficiency hypothesis can be confirmed. The second group of studies evaluates whether or not the market structure that determines price competition (in the banking sector) can also determine the efficiency of a bank's products and services. The studies also evaluate whether relaxing restrictions around bank consolidation (which leads to more market concentration) can influence on a bank's operating costs. They also use different functions for cost-output relationships. For example, these studies use the Cobb-Douglas functional form, where cost function is estimated using the translog functional form, and cost ratios as a function of total deposits. Researchers in these studies use more bank characteristics to evaluate the cost structure of the banking sector than a market structure indicator. For instance, one of the main discussions in this group of literature focuses on the efficiency scores of different banks. These studies (for example, Smirlock,1985) discuss how the efficiency score of a bank can influence the bank's market share and profitability rather than the market concentration itself.

Moreover, the studies consider different approaches by which to measure a bank's output. Colwell and Davis (1992) explain the two main approaches to measuring a bank's output. The first is the production approach wherein banks use capital and labour to make a deposit and loan accounts and generate money. This approach means the bank's output is the number of accounts and the number of transactions. The second approach is an intermediation one, wherein banks act as an intermediary or financial service. This approach means the bank's output is the value of loans and investments instead of the number of transactions and loan/deposit accounts (Colwell and Davis, 1992).

To study the relationship between the market structure and bank behaviour, Gilbert (1984) explains that the relationship between bank performance and market structure began to be evaluated around the 1960s when federal bank regulatory sections started to evaluate the impact that bank mergers had on competition. Gilbert (1984) in his survey summarised all the studies

that applied the SCP hypothesis while analysing the relationship between market structure and bank performance. According to his survey, some studies used the regression analysis to measure the bank's performance in the form of profit rates, loan interest rates and deposit interest rates as a function of local market concentration. He concludes that the results of these studies vary. His results show that studies that applied better measures of bank performance, like profitability, and used the best estimation process, (for example, applying a more appropriate model to account for market concentration), concluded that market structure can influence a bank's performance. According to Gilbert one of the main issues around the SCP hypothesis is that it neglects bank regulation because theoretical approaches do not consider the impact of bank regulations on the relationship between the market structure and bank performance.

Similarly, Smirlock (1985) states that many researchers have extensively considered the SCP hypothesis in banking after detecting the "jurisdiction of antitrust laws"[11] in the US banking sector. Smirlock argues that initially researchers failed to provide any link between market concentration and a bank's performance. In his paper, Smirlock posits that although there is no relationship between market concentration and a bank's profitability, there is a positive relationship between the bank's market share and its profitability. Smirlock asserts that market concentration is the result of high efficiency, which is a result of the more efficient banks having a large market share. To investigate the relationship between the profit, market share and market concentration, Smirlock considers more than 2700 state banks. Hannan (1991) explored the practice of antitrust in banking analysis in the US, testing whether a loan market is local to the US and evaluating the concentration of non-competitive behaviour in US banks. Hannan collected data from the Federal Reserve's Survey. He followed the Klein (1971)

[11] Prior 1960 US government failed to control the bank mergers. The bank merger mainly was due to a competitive banking behaviour. Imposing the Sherman Act to eliminate the monopolistic behaviours of the financial participants was not very successful (Carter, 1978). Hence, the Federal Reserve and the US government decided to impose antitrust Laws, which was in line with the Bank Merger Act, to be able to control the bank mergers.

neoclassical analysis model for his evaluation. His results confirm the dominance of the SCP hypothesis in the relationship between commercial loan rates and market concentration.

Berger *et al*. (2004) review the literature around market structure and banks performance. They found that the majority of studies carried out during the 1990s assess the impact of competition and bank concentration using the traditional SCP and efficiency structure hypotheses in the US banking sector. To test the SCP these1990s studies mainly apply HHI or concentration ratio. Moreover, these studies largely assume that the market shares and sizes of the different kinds of commercial banks are equal when they compute the concentration. Conversely, these studies use profitability or bank prices as key indicators to evaluate banks performance. Berger *et al*. (2004) explain that recognising the issues with HHI and concentration ratio (for example, endogeneity problems) motivated the researchers to use alternatives measures of competitiveness, like the size and type of commercial banks to consider efficiency, quality of services and risk/stability in the banking sector. According Berger, studies have begun to apply different versions of the SCP and efficiency structure hypotheses in models of banks profitability. They focused on X-efficiency and scale efficiency by considering the concentration in functioning these efficiency measures. In addition, some other studies looking at the US banking sector use different competition models (for example, the conjectural variations Cournot models) to examine banks' price-taking and price setting behaviour (Berg and Kim, 1998). Later studies started to use the non-structural models, like Panzar-Rosse (Bikker and Haff, 2002) to examine market structure and banks' performance. Berger *et al*. (2004) outline that scholars distinguish between concentration and competition measures by considering the role of regulation barriers on competition, the role of market openness and different ownerships. Berger *et al.* (2004) highlight the importance of credit availability and financial stability in all countries, and especially developing ones. This is important because banks have a different role in developing countries. Berger *et al*. (2004)

conclude their survey noting that both developing and developed countries place emphasis on different banks and on market structure and on other elements, such as a country's entry restrictions, and how the role of different ownership, (particularly foreign ownership) can change the competitive environment and a bank's performance evaluations.

Lloyd-Williams *et al*. (1994) test the two competing hypotheses (the SCP and efficiency structure hypothesis) from 1986 to 1988 in the Spanish banking sector. Their results illustrate that a greater degree of concentration in the Spanish banking sector has resulted in a lower cost of collusion among the banks and made an abnormal profit for all the participants in the market. They failed to support the efficiency hypothesis, concluding that higher market concentration in the Spanish banking sector leads to a lower level of competition. Their results are very different to the studies on the US banking sector, which strongly support the efficiency structure hypothesis. Lloyd-Williams *et al*. (1994) explain that this difference in results between the Spanish and US markets is due to the 1960 Bank Merger Act[12] which switched the power from a more regulated market to a more competition-oriented market. In addition, the US banking sector benefits from practicing interbank competition, for instance offering commercial papers to the customer.

Later, Golberg and Rai (1996) examined the relationship between market structure and bank performance by applying a Stochastic Frontier Cost (SFC). They considered eleven European countries across four years, 1988 to 1991. Their findings cannot confirm the SCP hypothesis for the eleven European banks considered. According to them the results from their evaluation of the SCP hypothesis highly depend on the performance measure. Their results can only support the X-efficiency version of the efficiency structure hypothesis the countries that have a less concentrated financial markets. Heggestad (1997) studies the relationship between market structure, risk and profitability. The study explains that according to price theory,

[12] Bank Merger Act prohibits any approval and/or merger that would result in monopoly in the market.

market structure can impact the price and profit of all firms that are operating in a market. The basic belief is all the financial institutions (including banks) in a market are willing to maximise profits. Hence, according to Heggestad (1997) price and profit should increase if the degree of market concentration increases.

Studies around the relationship between market concentration and bank performance is not limited to those which evaluated the competition, market concentration and bank performance. Researchers have also paid close attention to bank characteristics (ownership, efficiency, and size) and market conditions while evaluating the SCP and efficiency hypotheses. For example, while evaluating the SCP and efficiency structure hypotheses, the researcher may focus on a financial crisis, a feature unique to a bank and novel financial innovations. For instance, De Bandt and Davis (2000) found that having a single currency can influence the degree of competition in the banking sectors. They focus on Europe and the US from 1992 until 1996. They apply a Panzar-Rosse model and to do this they used a balance sample provided by the Bank Scope-IBCA data base, which offers yearly data that can be compared across all countries in the sample. Their findings suggest that banks in the US reflect a higher competition level compared to the banks in the EU. In Europe, Germany and France have a higher monopolistic competition for larger banks and a monopoly market for smaller ones. Italy reflects a monopolistic competition for all sizes of bank. According to their findings there is room for European banks to increase competition.

In addition, Bikker and Haaf (2002) examine the relationship between competition and market structure in the banking sector. They apply a Panzar-Rosse model for twenty-three countries from 1988 until1998. To evaluate competition, they group banks as small or local, medium-sized and large or international banks. Their findings confirm monopolistic competition, which is makes local markets weaker and international markets stronger. Beck, Demirgüç-Kunt, and Maksimovic (2003) looked at both developed and developing countries

to analyse the impact of concentration on credit availability while having some regulations and barriers for example, new entry, monitoring ownership structure, and maintaining some restrictions on bank activities. Their results confirm a negative impact of concentration on banking performance. However, they argue that having a well-developed financial system, efficient legal systems, and presence of foreign banks can always eliminate the negative impact of concentration.

Furthermore, Laeven (2001) considered Russian banks and developed a model for insider lending with different rates of interest. The reason for developing such a model was due to the extensive enterprise ownership of banks in Russia during the 1990s when new financial reforms were being introduced. He used firm-level survey data from the World Bank in mid-1994. This rich seam of data enabled Laeven to evaluate the relationship between firms, banks, and credit in Russia. The insider lending model illustrates the situation wherein a bank makes a loan to its shareholders. In this model, the bank provides advanced loans to selected shareholders in exchange for controlling the equity of these shareholders. As a result, a borrower can enjoy a loan at favourable rates. Laeven's results indirectly emphasise the importance of regulations and monitoring in banking activities because he failed to categorically show that Russian managers were offering different rates to particular borrowers, because this same action also could also be achieved by changing the amount of loans. The unique aspect of his study is that, rather than focusing on state-owned, foreign or any other commonly discussed ownership, he focused on the possessions of the financial institutions.

To assess the impact of competition and concentration on a bank's performance, Koutsomanoli and Staikouras (2006) examine the degree of concentration and competition in the EU from 1998 until 2002. They used Panzar-Rosse model to measure the competition. They conclude that European banks perform under monopolistic competition. They stress the fact that the competition in the EU-10 countries, (Cyprus, the Czech Republic, Estonia, Hungary,

Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia) is higher in comparison with other EU countries, like France, Finland, and Germany. According to them, considering the competition pressure in a bank's performance, the EU banking sector should improve its cost efficiency.

Likewise, Coccorese (2004) studies Italian banks between 1997 and 1999 using Panzar-Rosse. In addition to confirming that Italian banks can generate more revenue under monopolistic competition, this study also highlights the importance of considering the efficiency levels of a bank. Their findings also support the fact that competition enhances the efficiency of the entire financial market in Italy. The other interesting finding in this study is around the importance of improving microeconomic indicators. The results show that in better economic conditions banks behave more competitively. Similarly, Koutsomanoli and Staikouras (2006) examine the concentration and competition degree in the European banking sector from 1998 until 2002. After discussing the three most common market structure indicators, (namely the number of banks, K-bank CR_k and HHI) and reviewing all the pros and cons of these indicators, they apply the CR_K and HHI to their study for all 25 EU banking sectors. They apply the Panzar-Rosse model to compute the competition scores. Their findings confirm the existence of monopolistic competition in the European banks. They also state that for countries new to the EU, like Poland, Slovakia, Malta, Estonia, Hungary, Lithuania, and the Czech Republic interest revenue increases when the competition degree increases. In their sample, this result is also the same for the larger banks. Athanasoglou *et al*. (2008) also researched the impact of bank and industry structure along with macroeconomic indicators for bank profitability using the SCP hypothesis. To measure bank' profitability, they used the GMM model for Greek banks from 1985 until 2001. As regards Greek banks, their results do not support the SCP hypothesis. Their results illustrate that bank profitability is influenced by

the macroeconomic indicators more than bank-specific variables, like size, capital and labour productivity.

Investigating the relationship between market structure and bank performance is attractive for policy makers and researchers in developing countries as well. Uchida and Tsutsui (2005) examine whether competition in Japanese banks increased in the late 20th century. They focus on regional banks and city banks in their sample. Their results show that initiating the government bond market enhanced loan market competition in Japan. They could not find any changes in competition following the deregulation of deposit interest rates. They also find that city banks compete more than regional banks. According to their results, the only macroeconomic indicator that can influence on competition is inflation rate. Similarly, Al-Muharrami *et al*. (2009) considers the market structure of the Arab GCC banking sector from 1993 until 2002. To measure for market structure, they used concentration ratio and HHI. They also evaluate bank monopoly using Panzar-Rosse. They find less market concentration in Saudi Arabia, Kuwait, and the United Arab Emirates compared to Qatar, Bahrain, and Oman. Their results confirm the perfect competition market for the less concentrated counties and monopolistic competition market for more concentrated countries in the GCC area. Fu and Heffernan (2009) examine the relationship between market structure and Chinese banks' performance from 1985 until 2002 using panel data estimation techniques. They consider both the SCP and the efficiency structure hypotheses. They are the first ones to investigate market structure and bank performance in China. They test the market power hypothesis, including the SCP and relative market power along with the X-efficiency and scale efficiency versions of the efficiency structure hypothesis following Berger (1995) and Goldberg and Rai (1996). Fu (2009) report that relative market power is the best hypothesis to describe the Chinese banking sector. Although their results support the X-efficiency version of the efficiency structure hypothesis, they fail to find any positive impact of efficiency on market structure. They believe

that the competitive structure of the Chinese banking sector needs to be improved by opening the market for new entrants, reducing the concentration, and developing the joint stock banks in China. Isik and Hassan (2003a) consider the relationship between the performance of Turkish banks and market structure between 1988 and 1996. They apply different types of models, including cost and production functions, and DEA. Their results do not support either of the structural hypotheses in relation to Turkey. However, their results do support the impact of ownership on bank performance and profitability. They also illustrate the positive impact that more educated employees have on bank performance.

There are some studies that consider both developing and developed countries while examining the relationship of market structure and bank performance. For instance, Mirzaei *et al*. (2013) evaluate the impact of market structure on the bank profitability by considering 1929 banks across forty emerging and advanced economies from 1999 until 2008. They apply the SCP and the relative market power hypotheses. Their results show that in more developed economies a greater degree of the market share leads to higher profitability for the banks. Similar to Goldberg and Rai (1996), their results support the relative market power more than the SCP hypothesis. They also fail to confirm any relationship between market concentration and profitability. However, there emerges a different story for developing economies. There is no support to demonstrate that in emerging economies market share influences bank profitability. In addition to evaluating the relationship between market structure and bank performance, Goldberg and Rai (1996) evaluate both a bank's stability and its characteristics. Their results suggest that, in developed economies, stability declines in more concentrated markets. Their results do not support the SCP hypothesis for emerging economies. Generally, emerging economies operate in a less competitive environment and the results vary in different countries. Another piece of research which considers both developed and developing countries while examining the relationship between market structure and bank performance is that of

Claessens and Laeven (2004b). They use bank-level data and apply Panzar-Rosse to measure the competition degree across fifty countries. They also consider the impact of ownership. Their results fail to find a relationship between concentration and competition. This is particularly true for those countries that allow for the presence of foreign banks. They argue that previously competition in the financial market could have been influenced by market concentration or by the nature of banks. However, after deregulation and removing the barriers, the competition paradigm has changed. According to Claessens and Laeven, one can still use some factors of the traditional competition paradigm, however more attention should be given to the networks and network externalities in financial services.

In addition to changing the market structure and financial performance of participants, boosting the efficiency of financial markets and banking systems are the key consequences of financial globalisation. Efficiency has always been one of the key factors in the banking sector as can be seen in Fujii *et al*. (2018); Degl'Innocenti *et al*. (2017); Chortareas *et al*. (2012); Bonin *et al*. (2005a); Berger *et al*. (2001); Shaffer (1993). However, by introducing new concepts such as derivatives tools, e-commerce, different types of bank services, and technological developments, these bank characteristics lost their importance. It was only after the 2008 financial crisis that efficiency came back into consideration as both regulators and researchers began to re-evaluate banking performance, paying significant attention to balance sheet quality.

Financial globalisation, however, caused some issues. This is perhaps why Berger *et al*. (2003) investigated two different dimensions of bank globalisation. They named one of these dimensions "bank nationality" and the other, "bank reach". They used a two-stage nested multinomial logit model to analyse these dimensions across over 2000 foreign affiliates of multinational corporations operating in twenty European nations. In their study, they defined bank nationality as host banks and bank reach as global, regional or local banks. According to

their discussion these foreign affiliates of large multinational corporations use bank nationality to provide the required cash in order to support management services.

Moreover, using capital sources from different banks can be considered as a factor which may determine to what extent a banking sector can become globalised. In 2007 Berger did another investigation around the global banking sector which took into consideration the performance of the European banks before and after globalisation. He explained in his research that previous to globalisation only 15% of European bank ownership was foreign, while this ratio increased to around 70% among the transition nations of Eastern Europe. The result of his study highlights a very interesting point: more foreign bank ownership can be detected in developing countries than in developed countries. This shows how, after introducing globalisation and removing the barriers, financial parties started to use other investment and finance potentials in the other markets around the world. Another interesting aspect of their study is bank ownership. Ownership influences bank performance and the strategies imposed in banks. This feature is one which this thesis also focuses on. In chapters three, four and five when developing new contributions and questions, ownership always is one of the main factors to be considered.

In 2009, the IMF published a piece of research declaring that the share of foreign banks in different countries has grown continuously over the last two decades. The research outlines that the structure of globalised banking is improving because it now covers cross-border capital flows and has also become more internationally diversified with regard to bank ownership. This IMF research has motivated scholars to research the impact of bank ownership on bank performance and soundness.

Shaban and James (2018) study the impact of ownership changes on risk across sixty Indonesian commercial banks between 2005 and 2012. They find that state-owned banks are less profitable in comparison to private and foreign banks. Badunenko and Kumbhakar (2017)

outline how banks with different ownerships react differently to changes in the policy and regulatory environment. Their contribution is to control for bank-heterogeneity in predicting cost structure and efficiency using a panel stochastic cost frontier model. They also consider the impact of ownership and conclude that there was an increase in the number of private banks with economies of scale. They also mentioned that state-owned banks operating at optimal scale during deregulation increased. Micco and Paniza (2006) investigate on bank ownership and lending behaviour. They compare public against private and foreign against local banks and investigate if bank ownership can be related to bank lending policy. Their findings indicate that state-owned banks play a significant role in the transmission mechanism of monetary policy because their lending is less sensitive to macroeconomic shocks compared to private banks. Badunenko and Kumbhakar (2017) discuss how banks with different ownerships react differently to changes in the policy and regulatory environment. Their contribution is to control for bank-heterogeneity in predicting cost structure and efficiency.

Bank efficiency is a key characteristic, so it is important to consider this while reviewing the competition hypotheses and the banking sector literature. Hasan and Marton (2003) use data from all commercial banks in Hungary from 1993 to 1998. They apply the SFA approach to examine the efficiency scores of the banks. Their results show that the Hungarian banking sector (following its transition from a centralised economy to a market-oriented system) demonstrates an improvement in its cost and profit inefficiency scores. The results also confirm the positive impact of foreign banks in the Hungarian banking sector.

Likewise, Sathye (2003) assesses the productive efficiency of Indian banks using DEA approach from 1997 until 1998. The results represent a higher efficiency score for public sector banks in comparison to private and foreign ones. The Chinese banking sector and its banking system reforms is evaluated by Berger *et al*. (2010). They evaluate the efficiency of thirty-eight Chinese banks from 1994 to 2003. Their empirical results indicate that China's banking

reforms have instructed a significant decrease in state-ownership and increases in the presence of foreign banks. They report that the majority of foreign banks are most profit efficient, which has resulted in a shift in resources from state-owned banks to foreign banks.

Similarly, Lin and Zhang (2009) take a group of Chinese banks between 1997 and 2004 to study the impact of bank ownership on the performance of Chinese banks. Their results suggest that state-owned banks demonstrated a weaker performance over a longer period of time compared with domestic banks and foreign banks. As a fast-growing economy, China has received significant attention around evaluations of its banking system. As with the aforementioned two studies, Jiang *et al*. (2013) assessed the static impact of ownership on the performance of Chinese banks over a longer period of time – from 1995 until 2010. They contribute to both the international and Chinese literature by investigating the impact of reforms on the performance of Chinese banks, and focus particularly on bank ownership and the dynamic effect of privatisation. They also measure profit efficiency by imposing interest income efficiency and non-interest income efficiency. They conclude that the privatisation of banks has led to an improvement in their performance. In their results foreign banks also demonstrate better long-term performance.

Fujii *et al*. (2014) study around technical efficiency and productivity growth in Indian banks between 2004 and 2011 applies a weighted Russel directional distance model to compute technical inefficiency. Their study is interesting because in addition to ownership they also calculate for the impact of NPLs. The results prove that, in Indian banks, there are different behaviours between different ownerships. Foreign banks show strong market competitiveness in India, so being more efficient is crucial for them. Unlike for foreign banks, the results for Indian banks indicate high inefficiency scores for both private and state banks.

Reviewing the literature demonstrates the importance of evaluating market structure, concentration, competition and efficiency. In summary, different countries have different

economic environments and so adjust the policies and structures around these environments. Banks operating within a variable market structure reflect different kinds of behaviour and perform differently. This thesis mainly focuses on the Turkish banking sector. In addition to measuring and evaluating banks' efficiency, this thesis considers efficiency as one of the key characteristics of banks, while also evaluating the monetary transmission mechanism, competition, and stability in Turkey.

Prior to examining the aims of this thesis, it is important to know more about the Turkish economy and its banking sector. Reading more about the Turkish banking sector, the different financial crises Turkey has undergone, and its economic environment makes the findings of this thesis more relatable. Hence, section 2.2 provides more information about the Turkish banking sector and its main economic indicators.

2.2. The Turkish economy

The Turkish economy has been discussed at length and especially since the 1970s when Turkey was characterised by a high degree of inefficiency in its financial and banking systems. Numerous reasons led to the inefficiency of Turkey's banking and financial systems. To address these inefficiencies, the Turkish government and the CBT imposed various structural and technological changes which helped improve resource allocation. Imposing new reform programmes combined with the introduction of some fundamental and novel concepts, such as globalisation and technological developments, both positively and negatively influenced the Turkish economy. The importance of the Turkish banking system and its main role in the wider Turkish financial system is undeniable. Over 70% of financial services are offered through Turkish banks. As in other economies, the majority of monetary policies are delivered through banks, and this is particularly true for Turkey which has experienced long-term hyperinflation, from 1977 until 2001. Bank-based financial markets in Turkey also enabled the government to achieve their targets through the banks' performance and services. Hence, a significant part of

Turkish economic history is about its banking system and the decisions the Turkish government and its CBT have made to overcome fragile financial and economic circumstances.

In short, this thesis begins its evaluation with a summary of the Turkish financial system and its associated issues from the 1970s onwards. The banking system has always played a central role in the Turkish financial system. Before financial liberalisation, the Turkish banking sector operated a monopolistic approach in terms of determining the interest rate. In other words, banks were not free to set the interest rate. Hence, the sector was tightly regulated, conservative towards financial innovation, and protected from foreign competition. During this time, inflation was not only high but also higher than the interest rates set by the banks. Additionally, there was very low competition in capital gain and the lending process. During this period, inflation in Turkey grew from approximately 7.92% in 1970 to nearly 94.26% in 1980. Due to the gap between inflation and the interest rates charged for credit, there was a mismatch between people who were willing to deposit their money in a bank, and people who wished to borrow from commercial banks. Due to the monopolistic behaviour of commercial banks, they kept the interest on deposits low and the interest on lending high. Insufficient monitoring and supervision during that decade meant that Turkish commercial banks could make significant gains. Moreover, since there was no possibility of competing internationally, local banks were used to competing with each other. So, there was an oversupply of physical branches in the Turkish banking sector. The Turkish banking system had an oligopolistic structure during the 1970s and retained this pattern of performance until the early 1980s when the Turkish government announced its economic stabilisation and reform plan. This reform plan was concerned with introducing trade and financial liberalisation.

Financial and trade liberalisation improved the Turkish economy by promoting and developing financial markets through deregulation. Opening the market and following a liberalisation and deregulation programme enhanced competition across financial markets and

the banking sector. The number of foreign banks increased in Turkey, which led to an increase in cash flow in the economic cycle. Taking advantage of the liberalisation programme enabled Turkey to apply novel financial instruments like CDs along with other innovative financial tools. As expected, the newly introduced plan had a significant and positive impact on the Turkish economy. The inflation rate declined from 94.26% in 1980 to 29.13% by 1982. Moreover, due to deregulation and trade facilitation, the average annual growth of GDP from1982 to1988 was 5.8%; quite remarkable in the context of Turkish economic history. Furthermore, unprofitable banks were closed down and overall banking income and profitability increased.

One of the targets of the liberalisation reforms was to control the high rate of inflation in Turkey, thus in December 1983 the CBT was authorised to set and review interest rates. The aim was to monitor the rate of interest and evaluate it based on the inflation rate. From 1984 to 1987 the rate of interest on deposits was always above the rate of inflation. Another improvement during those years was the establishment of the CMB, which was an institution with responsibility for supervising and monitoring the primary and secondary markets in Turkey.

In 1984, due to some changes in the parliament and new elections in Turkey, the inflation rate started to increase again, reaching 48.39%. Consequently, as Turkish banks play a crucial role in its economy, in 1985 there was a new set of banking laws which aimed to strengthen the banking system and decrease inflation through monetary policies. Thus, new ratios for banks' reserves, the capital adequacy ratio and uniform accounting standards were announced. Moreover, to address the budget deficit and overcome the lack of liquidity, the Interbank Money Market was created by the CBT in 1986 to resolve the issue of short-term liquidity.

The previous cycle of inflation was repeated after 1986 when the inflation rate started to increase in 1987, reaching 68.81% in 1988. The main reason for this increase was the

establishment of a foreign exchange and banknote market in 1988 to determine exchange rates. Foreign exchange performance and related activities along with international trade became entirely liberalised in 1989. This process of liberalisation continued until 1990 when banks were given full authority to determine their exchange rates.

Although liberalisation and open markets enhanced competition and improved the Turkish economy for a while, because the Turkish government and policymakers did not completely achieve fully free markets, the disinflationary and liberalisation reform plans failed when inflation reached almost 105% in 1994. It is worth mentioning that Turkey was also somewhat unlucky as it was affected by external shocks. For example, the Persian Gulf crisis, the Russian financial crisis, and two massive earthquakes in 1999 had a negative influence on the Turkish economy through output volatility and reductions in the total income of the country.

To address these issues, after the 1999 election, the Turkish government began another restructuring programme. The programme's main aim was again to reduce the inflation rate from almost 64% to single-digits by the end of 2002. Turkey made a second agreement with the IMF in December 1999. To eliminate inflation and inflationary expectations in Turkey the CBT, with assistance from the IMF decided to amend the exchange rate system to a crawling peg regime according to which the percentage change in the value of the TL was fixed for a year and half. To encourage disinflationary decision-making, they increased tax and changed the level of public wages. They also made some small changes in the banking sector through structural reforms.

As with previous reform plans, the new programme was successful in achieving its defined aims and targets. The history of IMF programme implementation in Turkey has been characterised by delays in introducing structural measures, particularly in the areas of privatisation and financial sector reforms. And this, coupled with the false impression that Turkish authorities had no strong desire to address long-standing economic issues and

challenges, local and international participants became concerned. Gradually, high-risk positions taken by private banks led to a short-term crisis in 2000. This issue was quickly resolved by an additional guarantee and the promise of IMF funding. The crisis in 2000 indicates the fact that overcoming inflation and economic issues in Turkey in the short-term depends to a large extent on capital inflows. Hence, the CBT and the Turkish government were asked to provide a comfortable environment for direct investment, and to ease the conditions for international trade.

The unstable economic conditions of 2000 were followed by a political crisis in early 2001. In 2001 a currency crisis occurred due to market participants' expectations around market sustainability and the stability of the financial and banking sectors. Both foreign and domestic investors developed many speculative attacks against the value of the TL. Simultaneously, Turkish foreign exchange reserves dropped sharply. Therefore, the government and the CBT allowed the implementation of a floating regime for the TL. Consequently, the TL lost one-third of its value against the dollar.

After addressing several challenges in its economy since the 1970s, Turkey has experienced a stable and sustainable economic situation during the last three decades. During 2002-2007, Turkey enjoyed annual economic growth of 7.2%. Since the 1970s, despite experiencing numerous ups and downs, Turkey remained stable for a long period of time after implementing the 2001 banking reforms. Turkey demonstrated appropriate action in controlling the stability and profitability in its banking sector, especially during the 2008 financial crisis. Despite a decline in GDP between 2008 and 2009, its economy recovered strongly and produced 8.48% growth in 2010 and 11.11% growth in 2011. After 2011, GDP fluctuated continuously due to internal and global instabilities and shocks. Turkey was faced with numerous difficulties in 2016 due to many global, regional, and local negative factors that influenced its economic performance.

A number of revolutionary attempts, an increasing number of terror incidents, the decline in tourism revenues, and steps towards limiting expansionary monetary policy by the US Federal Reserve, which accelerated the depreciation of the TL, combined to change predictions for future growth Turkey's financial ranking. However, the Turkish GDP growth rate remained close to 4% per annum in 2016 and 2017. Turkey achieved a better financial performance (particularly during 2017) which generated significant hope for improved financial stability and development by 2023. In 2017, after more than a decade of efforts to become a member of the European Union, the EU and Turkey began to move away from each other. There is a more stable path towards growth in European countries with almost all countries enjoying stable economic and political conditions, whilst Turkey continues to operate in a volatile and unsustainable economic and political environment.

Turkey still depends to a large degree on foreign investment. A considerable amount of this investment comes from European countries. There are more concerns regarding the political situation in Turkey which directly and indirectly influence its economy and financial markets. Moreover, to become a member of the EU, Turkey needs to build sound and stable economic conditions. Being bank-oriented, Turkey needs to ensure its banking sector is sound. One of the main factors that needs controlling is the NPLs ratio, which influences the efficiency and profitability of Turkish banks. Due to all the challenges that Turkey has failed to address, it is now acting more in a partnership with the European Union, rather than as a member.

2.3. The Turkish banking system

The Turkish banking sector is special in that has been carrying out restructuring plans almost continuously. Since the foundation of the Turkish Republic in the 1920s, the country's banking sector has gone through numerous stages of development to meet required standards and targets. The Turkish banking sector and its financial system owes its inception to the

establishment of the republic in the 1920s and to the development of the system that continued until the 1980s (Baum *et al*., 2010).

The evolution of the Turkish banking sector can be divided into five phases. During the first two phases (the 'foundation period' of 1923 to 1945 and the 'privatisation period' from 1945 to 1980) Turkey had begun to strengthen the foundation of its banking sector (BAT report, 2019). The main focus during these two periods was building the required foundation and privatisation. Since this was only the start of Turkish banking development, most of the banks that were established during this period were state-owned banks whose main target was to boost the Turkish economy and address the depression. The 'National Banks Period' of 1923 to 1932 saw the development of strong banks, introduced by the Izmir Economic Congress. During this period the Turkish state, believing that private banks lacked the proper tools to support the banking sector (BAT report, 2019), extensively controlled and interfered in banking activities.

Turkish government control enhanced inefficiency levels in the banking sector. The period between 1923 and 1945 is called the "period of foundation of state-owned banks". The reason for strengthening the foundation of state-owned banks in this period was due to a government failure to encourage the private banks to support agricultural and industrial investment and development. In the other words, during this period, the government made all the required and necessary investments to support industrialization. In addition, during this period, the Turkish government prohibited the issuing of licences to establish foreign banks within the country. This caused a decrease in market competition. Accordingly, banks started to increase the number of branches in order to increase deposits. This strategy was not successful because they failed to collect the required savings to support their operation in the late 1960s and industrialisation in the 1970s. Although industrialisation was implemented using some inflationist methods, it was used by domestic customers only in a hyperinflation mark which

caused a major issue in Turkish foreign exchange. The issue in the Turkish foreign exchange increased foreign debt, which got worse due to Turkey's very restricted market.

In fact, Turkey failed to address its financial issues at all during 1970s. The 1980s saw Turkey begin to address its problems by clearing foreign debt, rectifying industrialisation strategy errors, and the hyperinflation economy. Accordingly, a policy to open up the economy had been agreed which was intended to encourage production, export, and upgrading of industrialisation strategies for the domestic and global markets. In order to do this, the Turkish government and CBT started to impose policies to restructure the economy based on free market principles to increase savings and provide all the requirements for stable growth in the financial and banking sectors. Hence, this third phrase started in early 1980s and aimed to prepare and strengthen Turkey's financial institutions for liberalisation.

The 1980s began with the aim of imposing liberalisation principles and opening the Turkish market. Accordingly, the majority of policies and strategies around Turkey's financial market began to be adopted and adjusted based on the new target of liberalisation. Turkey experienced a significant improvement in its exports and imports during this time as it started to change its financial and trading approach. In 1985, international banking strategies and principles along with international supervision and regulations were introduced and the uniform chart of accounts began to be used and external auditors were given a permission to assess internal financial statements, like balance sheets. After announcing these new rules which enforced a greater degree of reliability, Turkey experienced an improvement in its banking sector. One of the main results of these actions was a considerable decline in the ratio of NPLs to the total loan. This ratio declined from 6% in 1986 to 1.2% by 1990 and decreased again to 1% between 1990 up until 1997. The period of a flourishing economy was short-lived. Turkey was not successful in building a strong and comprehensive foundation for its banking sector, and consequently its financial market. Hence, the Asian and Russian crises negatively influenced

the performance of the Turkish banking sector and the ratio of NPLs after provision again increased to 4% in 1998. Other positive achievements that Turkey gained by applying these new regulations and opening up its financial market were not restricting interest rates, increasing competition, introducing new services and products like consumer loans and credit cards, off-balance sheet activities like using swap, forward, future, and option contracts, and so forth. (BAT report, 2019). Capital movement was another important achievement for Turkey which was a result of imposing liberalisation principles.

In addition to these achievements, there were several fundamental issues (high rates of inflation, extensive financial support from the state and the CBT, a lack of supervision and balance sheet issues) which built on the foundations for turmoil laid in 1989 and resulted in the crisis of 2000. Budget deficits were partially being cleared by the CBT, which was enhancing the inflation, and partially by the government. However, capital movement and the open market made it very difficult for the CBT to monitor and control the payment balances which led interest rate increases. As a result, the Turkish government, the CBT, and all participants in the market were faced with significant macro imbalances, increases in borrowing and uncertainty. To address these issues, a monitoring agreement was signed between Turkey and the IMF in 1998 to increase supervision and regulation and solve Turkey's macroeconomic problems. This agreement again limited the foreign exchange market and financial transactions for the financial participants. A fear of lack of liquidity was an immediate sign to foreign investors. Hence, they took their capital out of the Turkish financial market. The Russian crisis and Turkish political disagreements during that time increased the financial risks tow-fold. As a result, in 1999, economic activities in Turkey again declined. The main reasons behind this decline were capital movement, beginning in the second half of 1998, Turkish political issues, and the imposition of new regulations and policies to fix the macro imbalances and foundation of the economy. The main lesson for Turkey during this time was that it needed to recognise

that, before implementing any new theory, (like liberalisation) the foundation for applying that theory should be considered. Financial liberalisation requires very strong institutional and supervisory circumstances which guarantee sound banking regulations, policy enforcements and efficient control of private and public sectors. The key reason behind Turkey's continued failure in its restructuring plans was that began practising liberalisation principles without providing the necessary conditions.

To improve the economy and solve its attendant issues the Turkish government signed another agreement with the IMF in 1999, the Stand-by agreement. The main aim was to improve and address the structural problems of the economy, ignoring the losses accruing by the banking sector and the limitations of economic activities due to imposed restrictions and regulations. Although this action was welcomed from almost all financial entities in Turkey, during the second half of 2000 the market was faced with several serious issues such as the failure to fully restructure the state-owned banks, failure to address increasing inflation, failure to control domestic demand and banking shocks. As the main target was fixing the main macroeconomic indicators, like inflation, some disinflationary programmes were imposed. This meant that banks increased their liquidity risk as inflation and interest rates started to decrease and increased their loan risks in line with economic expansion. These actions caused Turkish banks to experience several issues during the volatile period of November 2000, which in turn led to the financial and currency crisis of 2000-2001. The issues in 2000 worsened in 2001, as there was little real progress in enforcing the structural regulations, especially as far as the state banks were concerned.

The era of growth and restructuring for Turkey began in 2002. The "programme for a transition to a strong economy", introduced in April 2001, was put into action in 2002. The well-considered targets and visions made a significant positive impact in both the Turkish economy and its banking system. Restructuring the state-owned banks, strengthening the

private banks and improving the regulation and supervision framework along with imposing budget discipline, managing the private sector's net savings in order to control the deficit, and improving macro indicators via appropriate policies, all resulted in improved economic performance and an improved banking sector.

Imposing and implementing this restructuring programme between 2003 and 2014 made for extensive improvements. For instance, there was an almost constant increase in the Turkish GDP which increased from 311,823 million dollars in 2003 to 934,186 million dollars in 2014. Moreover, inflation which had experienced a downturn since 1998 continued to decrease between 2003 and 2014. Although the slope of this decrease was sharper between 1998 and 2004 as inflation decreased from 84.64% in 1998 to 8.59% in 2004, this key macroeconomic indicator (always an issue for Turkey) remained almost constant between 2004 and 2014. Inflation with a tiny fluctuation during this period reached to 8.85% in 2014. Following the introduction of the new regulations, the ratio of NPLs to total gross loans declined between 2002 and 2007; the establishment of economic stability policies and enhanced bank capital within the new framework of restructuring assisted this change in ratio. However, similar other economies, this ratio increased again in 2008 as a result of the 2008 global financial crisis. Between the onset of the crisis and 2014, this ratio was in flux. In particular, the Turkish balance sheets reflected a decrease in this ratio from 2009 until 2011 and an increase after this until 2014 when NPLs reached 2.74%. Per capita income also increased from 3296 million dollars in 2002 to 9333 million dollars in 2007 and 10203 million dollars in 2014.

After 2011, the Turkish economy and its banking system experienced several ups and downs. The growth rate slowed for a short period during 2016 as a result of some internal and external shocks, and recovered in 2017. GDP declined from 8.5% in 2013 and again to 3.2% in 2016. This rate increased again in 2017, reaching 7.4%. In addition to this improvement, Turkey experienced a boost of 0.5% in its saving ratio, reaching 24.9% in 2017. There was an

improvement in the rate of employment by 7.64% in 2017 comparing to the rate of unemployment in 2002. Inflation again increased after 2014, reaching 11.9% in 2011. The main reason for this was the Lira's volatility during this period, coupled with domestic political issues (BAT report, 2019). During these years capital adequacy in the banking sector was high at 95 million dollars. The amount of loans between 2013 and 2017 increased by 21%. Turkey also experienced an increase of 19% in its total assets. In off-balance sheet items during 2013-2017, there was an increase of 28% in contingencies and commitments and increase of 19% in non-cash loans and liabilities. According to BAT reports (2019), NPLs before provision increased by 10% between 2016 and 2017. Additionally, the number of employees and the number of bank branches has decreased slightly since 2014.

Previously, only eighteen banks were operating in Turkey. One of these banks was Ziraat Banksi, a state bank which still exists today and continues to be the largest bank in the sector with 115,134 million dollars in total assets in 2017. This bank was founded in 1863. The second-largest bank, which was established in 1924, is Türkiye İş Bankası A.Ş. with 83,786 million dollars in total assets in 2017. This bank was the first national bank to be established after the declaration of the Turkish Republic. Türkiye İş Bankası A.Ş. is currently the largest private bank operating in Turkey. Overall, Turkish banks can be categorised into two main groups: Commercial banks, who mainly collect deposits and generate money traditionally through lending processes and other types of banks including investment banks who generate money through investment activities. Each type of bank can be state-owned[13], private[14], or foreign.

Turkey is a bank-based country in which the majority of economic activities are carried out through the banking industry, therefore any study of the Turkish banking system cannot be

[13] Banks that are owned by the government.
[14] Private Banks contain personalised financial resources and services that mainly focus on wealth management.

separated from its economy and financial market. The majority of Turkish banks are commercial banks. As in other countries, commercial banks in Turkey, in addition to providing traditional depository and lending services, offer a wide range of financial products and engage in capital market transactions using new technologies. There are thirty-five commercial banks in Turkey, three of which are state-owned banks, eighteen are privately owned banks, and the rest are foreign banks. The widest networks of branches throughout Turkey belong to the state-owned banks. This is not surprising since state banks are the oldest ones. Moreover, previously, almost all the banks in Turkey were state-owned banks. However, during the years following the Second World War the state encouraged the establishment of private banks in order to support the country's economic recovery. Even more emphasis was placed on private banks when the restructuring of the banking sector got underway in the late 1970s. The speed with which reform was implemented was slow until 1980, when the banking system was liberalised and banks were given the right to determine interest rates in a free market. Since that point not only has the number of private banks increased, but so too has the number of foreign in the Turkish financial market.

The majority of private banks in Turkey are commercial banks, which provide almost every kind of service to their customers. After implementing the liberalisation policy and freeing the market for foreign entry, foreign banks started to establish their branches in Turkey. These foreign banks are subject to the same regulations as other commercial banks in Turkey. During the period 1980-2000, as the entry barriers to the Turkish banking sector were lowered with the purpose of boosting competition in the market, banks grew both in asset size from 20 billion dollars to 150 billion dollars and in number from forty-three to seventy-nine. Despite changes in the market structure and principles, most banking activities were still focused on gathering deposits and lending to the Turkish government. Despite all the fluctuations in the total assets held in the Turkish banking sector and numerous decreases in total assets, in 2013 the total

amount of assets increased by 11% from 736 billion dollar and reaching 864 billion dollars in 2017. The ratio of total assets to GDP also increased by 105% in 2017. The reported number of banks operating in Turkey in 2017 was fifty-two, of which forty-four were deposit banks and the rest investment and development banks. During the last thirty years, along with the changing number of banks and their branches, the number of people employed by banks has also changed. The number of branches in Turkey increased from 134,000 in 2002 to 181,000 in 2012. Accordingly, the number of employees also has increased from almost 120,000 to 186,000 from 2002 to 2012.

This upward trend reversed after 2015 and the total number of branches and employees in the Turkish banking sector reached 10,550 and 193,504 respectively in 2017. Another significant change in the Turkish banking industry during recent years has been the contribution of women. In Chapter Three of this thesis there is a specific focus on the role of female employees in relation to bank efficiency. Due to the political and currency crises in 2000 and 2001, the Turkish banking sector experienced a significant collapse as there was a huge concern regarding its safety, stability, and soundness. This concern and participants' expectations regarding Turkish economic trends made many withdraw their capital from the market and sell off treasury bills and risky securities. Consequently, there were no opportunities for some private banks, such as Demirbank, to borrow in the interbank market to increase their liquidity (Akyüz and Boratov, 2003). Thus, to secure more liquidity they sold off a portion of their holdings of government securities, which caused a greater decline in these securities and increased interest rates in the secondary market. This market practice introduced more uncertainty regarding the sustainability of the Turkish economy, crawling peg exchange rate regime, and the policies of the Turkish government and the CBT (Özatak and Sak, 2002).

To address the issue the government started to merge weak banks with the SDIF, which is a government-based organisation responsible for providing insurance for saving deposits, with

the aim of strengthening the banks. During 2000 and 2001, the IMF also took an important role in assisting the Turkish economy by promising a package of 10.5 billion dollars to prevent a decline in Turkish banks' reserves. All these actions helped the Turkish government and its CBT to control the economy and market once again. They decided to implement more reform and restructuring plans in 2001, which resulted in a speedy improvement in the Turkish banking system and its economy.

Initially, Turkey had a very weak and fragile banking system. There were four fundamental issues: First, without establishing an effective supervisory system or an institution to monitor the activities of financial entities or to provide enough guarantees for bank deposits, Turkey started to implement deregulatory policies, which was obviously very risky for bank deposits (Akyüz and Boratav, 2003). Second, to provide enough funding and financial resources, the government used banks to provide short-term borrowing in the form of short-term capital inflows.

During the 1990s, decisions made by the Turkish government and CBT caused economic growth to fluctuate between -5.5% and 9.3%. Economic growth was not the only issue in Turkey as its interest rates, exchange rate regime, and its financial market overall were very volatile during that period. In particular, the Turkish government and CBT were using short-term capital inflows as a source of financing the account deficit in Turkey. Moreover, another source of this short-term borrowing came from deposits by investors and random customers. Since the government's plans during that time were not very successful, it was left with high levels of debt to both the local and international banks. Since the banks were earning interest from local government securities, earning this interest was highly dependent on the yield curve of treasury bills (Özatay and Sak, 2002). Moreover, the quality of these securities was highly dependent on public expectations about economic sustainability, which was the other issue. Due to the unreliability of the Turkish banks and its financial market, the inflation rate from

1976 until 1998 increased often, resulting in the imposition of severe monetary policies and monetary financing during this period.

Furthermore, the Turkish banking system was also highly dependent on foreign funding, making banks vulnerable to any sudden capital shocks (Akyüz and Boratav, 2003). A high reliance on foreign funding and a high level of foreign currencies in the Turkish banking sector exposed these banks to exchange rate risks. Lastly, there was a large maturity mismatch in the Turkish banks. These banks were not able to borrow for long period of time in the domestic currency while they were lending to the government and other companies for long periods. Therefore, the NPLs ratio increased considerably, which led to additional illiquidity and liquidity risks in the Turkish banking sector.

Prior to the 2000-2001 political and currency crises, the Turkish banking system was very sensitive and there was a crucial need to have appropriate plans to overcome considerable issues. In November 2000 and February 2001, the Turkish economy was faced with significant shocks which caused a devaluation in the Turkish Lira over the course of a year. Due to the unpleasant economic and financial environment, several banks and financial institutions either collapsed or closed as they were not able to cope with the financial crisis. As a result, eighteen banks stopped operating or merged with other stronger banks. During that period, the rate of NPLs before provision increased by 36% in the banking sector and reached 5.9 billion dollars (BAT report, 2009).

To address the currency crisis, the BRSA was established in September 2000 as the main institution intended to solve the crisis of 2000-2001. The initial fundamental programme they announced called for three main restructuring programmes. Initially, they asked for the restructuring of state-owned banks and private banks since they were identified as the main sources of inefficiency in the Turkish banking sector. Specific attention was given to the banks under the SDIF. The aim was to ensure that these weaker banks under the protection of SDIF

were operating appropriately in the market. Hence, the BRSA aimed to strengthen the private banks and monitor the performance of state-owned banks and transparency of SDIF. Moreover, the BRSA finalised the necessary restructuring plans for the entire Turkish banking system to achieve further improvements in banking regulation and a supervisory system to promote efficiency and productivity in a competitive environment. This was intended to guarantee Turkish economic growth. Furthermore, the BRSA imposed some regulations on the Turkish financial market. Between 2000 and 2003, the BRSA was very effective in cleaning up the sector. After 2003, the Turkish banking sector was reconstructed under the tight supervision of the BRSA and reoriented to provide more financing to both the banks and other financial institutions in the market. As a consequence, the ratio of loans to GDP doubled from 15% in 2003 to 29% in 2006. From 2006 to 2008 Turkey experienced a boost in its economic and banking system. There were many investment opportunities supported by positive annual growth rates and an increase in return on equity of more than 20% which was attractive to both local and foreign investors. The profitability of Turkey fell steadily during 2010-2015. The last two years of this period were particularly concerning as ROE for the sector declined below the threshold rate that investors would expect. However, this rate has been recovering since 2015, reaching 18.84% in 2017.

As discussed, one of the main objectives of the BRSA was to improve the efficiency and competition in the Turkish banking sector. Applying the BRSA's restructuring programmes resulted in a permanent increase in overall efficiency in Turkey in the period 2002-2017. In addition to a continuous increase in the efficiency of the Turkish banking system, imposing the restructuring programmes also made the banking sector more concentrated. The importance of having an efficient sector, particularly after the crisis in 2008, has attracted the attention of scholars interested in evaluating the soundness of a financial market. As a result, an improvement in efficiency and competition in the banking sector in Turkey has been extremely

beneficial for this country as its economy is highly reliant on its banking performance. Therefore, boosting efficiency and the creation of a dynamic competitive environment can be viewed as a considerable achievement for the Turkish banking sector. This was the target of the 1970s deregulation and liberalisation era, and of the policies adopted since 2000. All studies on efficiency in Turkey (for example, Isik *et al*., 2018; Kasman and Kasman, 2016; Assaf *et al*. 2013; Yilmaz, 2013; Kasman, 2012; Fukuyama and Matousek, 2011; Bayraktar *et al*., 2010; Aysan and Ceyhan, 2008a; El-Gamal and Inanoglu, 2005; and Isik and Hassan, 2002, 2003a, 2003b) highlight the fact that the Turkish banking system is some distance from being efficient enough and that there is much room for improvement the sector's efficiency levels. In addition, studies around Turkish competition indicate that Turkey experienced monopolistic competition over the entire period after 2002, and at least up to 2007 (Abbasog˘lu *et al*., 2007). Hence, it can be stated that despite the imposition of merger and acquisitions and other restructuring programmes on the banking sector during the last three decades, the Turkish banking system still reflects a degree of monopolistic competition and is not yet fully concentrated. The failure to achieve these desired goals provides the motivation behind this thesis, namely to investigate competition in the Turkish banking sector from a unique perspective, taking efficiency into account. Accordingly, this thesis uses the Boone indicator to measure competition. Following Boone (2008), efficiency is going to be considered as an independent factor in the discussed equation by Boone (2008).

Chapter 3

Bank Efficiency and Non-Performing Loans: Evidence from Turkey

Abstract

This study analyses technical, allocative, and cost efficiencies in Turkish banks from December 2002 to December 2017, under the assumption of constant returns to scale. We apply a modified version of the Data Envelopment Analysis (DEA) approach introduced by Aparicio *et al*. (2015), which employs a directional distance model to provide estimates of efficiency, with a focus on NPLs as an undesirable output. In addition, we examine the determinants of efficiency by applying quantile regressions to panel data. The results obtained support the thesis that NPLs exert a negative impact in terms of technical efficiency, which confirms the "bad management" hypothesis in the Turkish banking sector. We also find that the level of efficiency of Turkish banks differs, depending on the ownership structure in place.

3.1. Introduction

The Turkish banking sector is the backbone of the financial system in the Turkish economy. Over the past 30 years, a variety of structural and organisational reforms have been implemented, such as the establishment of the BRSA and making the CBT independent from the government in order to enhance the efficiency and stability of the Turkish banking sector. Several studies have examined the profitability and efficiency of Turkish banks across different time periods that include differences in political climate, financial liberalisation, market sentiment (for example, global financial crises), and ownership status (for example, Gunes and Yildirim, 2016; Hermes and Meesters, 2015; Assaf *et al*., 2013; Yilmaz, 2013; Kasman, 2012; Fukuyama and Matousek, 2011; Baum *et al*., 2010; Bayraktar *et al*., 2010; Aysan and Ceyhan, 2008a; El-Gamal and Inanoglo, 2005; Isik and Hassan, 2002, 2003a, 2003b). A variety of

parametric and non-parametric methods were deployed in these studies that confirm the positive impact of financial liberalisation on the efficiency of the Turkish banking sector over the past three decades. Studies that have evaluated Turkish banking efficiency during the most recent global financial crisis confirm that this crisis had a strong and negative impact on bank efficiency. In addition, the various ownership statuses of Turkish banks and related bank characteristics are reflected in the efficiency scores (for example, Assaf *et al.*, 2013; Kasman, 2012). However, there is no consensus amongst studies that have investigated efficiency determinants. In particular, following a cross-comparison of studies that have looked at Turkish bank efficiency, we fail to find a consistent relationship between bank size and efficiency level. Moreover, credit risk in the Turkish banking system – the factor to which we gave particular attention during the period we examined – is only considered in one study.

Over the past three decades, the Turkish banking sector has experienced a sharp increase in NPLs that has triggered prolonged instability and an economic downturn. The regulatory response has been to introduce differentiations in loan loss provisions, loan restructuring rules, and the bailing-out of troubled banks (Athanasoglou *et al*., 2008; Isik and Hassan, 2003a). Despite these regulatory reforms, the NPLs ratios of Turkish banks have not been reduced, and even after the restructuring plan of 2002 and the subsequent short-lived decrease of NPLs, significant increases were recorded following the 2008 global financial crisis. In particular, the NPLs to total loans ratio increased by approximately 54% during the period 2011-2016, reaching 13.11 million dollars in 2016. In contrast, the average NPLs ratio dropped continuously in all European countries and in the US, reaching, in 2016, 5.4% in the former, and 1.1% in the latter. In addition to NPLs, there was a sharp increase in the restructured credit held by Turkish banks from approximately 1% percent to 3% of gross loans, while the low recovery rates on problem loans caused further pressure on the Turkish banking sector.

Overall, the credit risk component of Turkish banks, as reflected in the dynamics of NPLs, can be said to be too important to ignore, and therefore the main motivation behind this paper is to evaluate the technical and allocative efficiency of Turkish banks, while accounting for the impact of NPLs. The study by Assaf *et al*. (2013) is conceptually the closest to ours; however, our study uses a considerably longer time-period of quarterly frequency, introduces two novel efficiency determinants, and makes use of quantile regression in the second stage of the analysis. Another notable distinction is that although both Assaf *et al*. (2013) and our paper consider NPLs as an undesirable output in the production function, Assaf *et al*. (2013) do so via a Bayesian stochastic frontier approach, while we build on the non-parametric technique of DEA.

This study contributes to empirical research on bank performance in four ways: First, we use an innovative method of estimating technical and allocative efficiency in banks by deploying the DEA approach introduced by Aparicio *et al*. (2015), which defines a new directional distance function with endogenous directions to accurately measure technical and allocative efficiency. The advantage of this non-parametric approach is that it allows for a simultaneous expansion of desirable outputs and contraction of undesirable outputs (for example, Fujii *et al*., 2014; Barros *et al*., 2012; Fukuyama and Matousek, 2011). Our choice of undesirable output is NPLs, which is consistent with the literature in this field. Second, our second-stage analysis includes more efficiency determinants than previous studies, and in particular we investigate the impact of two additional efficiency determinants – employee education and gender. There is only one study in the current literature (Isik and Hassan, 2003a) that investigates the impact of employee gender. They find having a more educated staff has a positive impact on bank efficiency. However, to the best of our knowledge, no study has attempted to analyse the impact of employee gender on the efficiency of Turkish banks. An analysis of these two features is worthwhile since it has the potential to not only improve

management decisions, but also bank performance. Moreover, we examine differences in bank efficiency via a consideration of various ownership statuses, based on which investment and development banks were found to be most efficient. Third, we examine the drivers of efficiency in a second-stage regression, using a quantile regression technique. The advantage of quantile regression over standard regression analysis is that it provides a more accurate representation of the efficiency dispersion across banks and/or time. Here, the use of quantiles is superior to other methods because it allows data to be modelled with heterogeneous conditional distributions (Chen, 2005). To the best of our knowledge, in the literature surrounding the Turkish banking industry, this is the first time that quantile regressions have been applied to evaluate the efficiency determinants of Turkish banks, even though it has been employed to evaluate risk and efficiency in the Central and Eastern European banking industries, (Mamatzakis *et al*., 2013). Fourth, our study contributes to the Turkish banking literature by examining quarterly data over a long time period, 2002-2017, thereby encompassing a number of currencies, financial and economic crises. Quarterly data are known to reduce the problem of the "window dressing" of financial statements that frequently occurs in annual data presentations (Evanoff and Segal, 1997).

As a preview of our findings, we can say that our analysis shows that banks with a high percentage of NPLs tend to be less efficient, meaning that controlling NPLs is of crucial importance to the management of banks. Furthermore, similarly to Fukuyama and Matousek (2011) and Athanasoglou *et al*. (2008), we find that a far-reaching restructuring program implemented in Turkey led to higher efficiency, while we hope that the fact that employee education has a positive impact on both technical and allocative efficiency scores might lead to increased investment in human capital in Turkish banks.

The remainder of this paper is structured as follows: Section 3.2 provides an overview of the Turkish banking sector; Section 3.3 reviews the relevant literature; Section 3.4 presents the

methodology; and Section 3.5 describes the data and discusses the empirical results. This section also represents the robustness tests. The final section presents a conclusion.

3.2. The Turkish banking sector: An overview

Both the Turkish financial sector and banking system have undergone continuous legal, structural, and international changes over the last three decades. The country's banking system in particular was prevented from becoming competitive by severe regulations in the 1970s and early 1980s. Before the introduction of the stabilisation programme in the 1980s, the government imposed a solid "licensing policy" and "interest rate ceilings" on the banking system by both restricting new entities from operating and regulating interest rates. Although designed to bring about banking stability, such regulations and policies led to a deterioration in competitiveness, efficiency, and effective credit distribution throughout the Turkish banking sector as a whole.

The introduction of financial reforms in Turkey, which started in the 1980s, had two broad aims: to reduce government intervention, and to widen the role of market forces in the Turkish financial market, including both the financial and banking sectors. The main purpose of these financial policies, exemplified by the 1980s' stabilisation program, was to improve and enhance the competitiveness, credit allocation, and the efficiency of the Turkish banking sector. The initial stages entailed the implementation of liberal regulations and principles such as relaxing interest rates, commissions, and fees, while they also codified the rules for new entries including foreign banks that wished to establish branches in Turkey. The sector response to the programme was fast. There was growth in both the number of employees and branches of banks, and the country's banking sector advanced quickly after the implementation of the post-1980s' policies and reforms. Furthermore, more flexible interest rates and increases in competition motivated banks to eliminate their total cost of operations to be able to survive in the financial market. Consequently, loss-making and unsuccessful banks were either closed

down or merged with other banks, while there was also a reduction in the number of employees in Turkish banks.

In the liberalisation era, banks began to participate in capital markets by purchasing treasury bonds and government debt securities, operating in foreign exchange markets and providing new products and services to clients such as customer loans and foreign exchange deposit accounts. In addition to enhancing efficiency and fulfilling the aims of the liberalisation programme, these improvements helped local banks to work more in line with the practices of EU members, aiding Turkey's wish to eventually become a full member of the Union.

Despite all such efforts, the uncontrolled liberalisation policies, combined with steady macroeconomic and microeconomic imbalances, brought about currency and banking crises in 1994 and then again in 2001. The economic crises Turkey experienced in 2000 and 2001 indicate a strong correspondence between weak performance and a deregulated banking system, in combination with the unexpected macroeconomic crises. Undoubtedly, Turkish banks have contributed significantly to the spread of economic crises because they play a crucial role in the Turkish financial market. One of the consequences of these crises was a dramatic decrease in the efficiency level of the banking sector and as a result, in 2001, the Turkish government introduced its BSRP. The BSRP was designed to ensure further improvements to banking regulations, as well as the necessary supervision to develop efficiency in the Turkish banking sector (Bayraktar *et al.*, 2010). Moreover, the government also implemented a policy of full deposit insurance in order to restore confidence in the Turkish banking system. Despite government expectation that this would stabilise the Turkish financial market and banking system, this decision led to concerns that some banks were starting to report declines in the quality of their assets in order to obtain more capital injections from the government, or for bail-out purposes. The second financial crisis was managed and completed by 2001 because the government, together with the IMF, introduced systemic actions to

restructure the Turkish economy via Turkish banks and through a proposed Rehabilitation Programme. The four most important priorities that this program aimed to address were: (1) shore up private banks; (2) a determination of which banks would be transferred to the SDIF through methods such as mergers, sales, and liquidation; (3) the operational and financial restructuring of state banks, with the end goal of privatization; and (4) the establishment of a legal and institutional framework that would enjoy improved supervisory capacity over the sector in order to increase sector efficiency and competitiveness. The authorities planned their main strategies to ensure regulatory and supervisory improvements, normalise different operational rules, and implement principles to promote sensible behaviour by banks.

In 2002, the programme was again revised in order to evaluate the financial crisis of 2000-2001 and take its causes and consequences into consideration. The most persistent macroeconomic problem in the country was high inflation rates. To address and control the high rate of inflation, in 2002, the government decided to introduce "inflation accounting" to detect inaccurate financial reporting (Arsoy and Gucenme, 2009). The main purpose of this was to protect the economy against unexpected issues such as external shocks or fluctuations in inflation rates. The implementation of this well-designed and appropriate plan led Turkey to experience a period of economic stability between 2002 and 2007.

Furthermore, the restructuring of state and private banks improved both the profitability and stability of the Turkish banking system because the NPLs on banks' balance sheets were matured against government debt securities (Aysan and Ceyhan, 2008a). As a result, the ratio of NPLs to total gross loans declined from 4.3% in 2005 to 3.5% in 2006, and then to 3.4% in 2008. Furthermore, from 2006 onwards, there has been a constant increase in the size of assets owned by Turkish banks, while operational efficiency improved by about 25% between 2006 and 2013, entering a state of flux since 2013. The BSRP played a central role in reorganising the sector by imposing strict supervision policies, according to which banks were required to

make available more details and reports to sector authorities and other individuals. The ratio of loans to GDP increased enormously from 15% to 29% during 2003-2006, as Turkish banks offered attractive opportunities to investors with returns on equity of more than 20% annually. Banking regulations were again reconsidered in 2005, this time on the basis of international standards, and as a result, the profitability of the Turkish banking sector increased, while there was also a decline in the rate of inflation, from 54.2% in 2001 to 8.8% in 2007, and a consistent improvement in the government's budget balances (Alper and Anbar, 2011). Like other economies, the recent financial crisis of 2008 had a considerable impact on the Turkish economy and the banking sector, but this impact was relatively limited, in comparison to other developing and developed countries (Aras, 2010; Yorukoglu and Atasoy, 2010), which could be due to the restructuring programme implemented after the 2001 crisis, and the macroeconomic policies of the CBT (Yuce, 2009). Although the literature indicates that the actions taken by the Turkish government and the IMF successfully limited the extent of the financial disaster for both banks and the broader Turkish economy, the risk of potential instability and a financial crisis arose when market interest rates decreased from 25% in 2004 to 11% in 2015, competition intensified, and regulation became even stricter, particularly in wholesale banking, which is traditionally the greatest source of Turkish banks' revenue. Concerns about Turkey's economic sustainability have increased since 2012 as its growth has slowed, per capita income has fallen to around 9,000 dollars per year, and the country's unemployment rate has increased.

The majority of Turkey's macroeconomic successes after 2007 have come into question, given the country's unstable and volatile circumstances. The amount of NPLs on Turkish banks' balance sheets fluctuated significantly in the period 2006-2017, which affected their profitability and efficiency. There was a considerable increase from 2007 to late 2010, when the percentage of NPLs to total loans increased from 3.32% to 4.97%, and although banks and

managers were able to successfully control the sudden increase in the rate of NPLs, reducing it to 2.5% by 2011, the trend continued, with fluctuations occurring until December 2017, when it reached 2.8%. The ratio of NPLs after provision to total loans during the period 2011-2016 increased by around 54%, reaching 13.11 million dollars in December 2016, dropping in 2017 to about 27%. Considering the importance of NPLs and their impact on banks performance, this study pays particular attention to this output while measuring technical, allocative, and cost efficiency.

3.3. An efficiency literature review

One of the main aims of this study is to compute technical, allocative and cost efficiency whilst considering the impact of NPLs. This enables us to evaluate the main source of inefficiency in the Turkish banks. We measured these scores using a non-parametric method, which will be explained in depth in section 3.4. However, it is crucial to know the definition of efficiency first. Lovell (1993) defined efficiency as an assessment based on the experiential and optimum values of outputs, which can be generated from a given level of inputs. Efficiency can also be defined and explained as the distance between the existence and optimal quality of inputs and achievable outputs (Coelli and Perelman, 1999). Estimating efficiency is relatively easy when there is only one input and one output in a study; however, when there are several inputs and outputs, maintaining the efficiency as a ratio between two scalars that have been aggregated from inputs and outputs is not an easy task. Efficiency can be distinguished from partial efficiency only when a single production factor is concerned, and full efficiency is only achievable when all factors are considered. Moreover, efficiency can be studied in many forms, such as technical and allocative efficiency, which is the main focus of this study. Farrell (1957), and later Charnes and Cooper (1978), treated technical efficiency as a concept that is relative to the best detected action. While this is a method of distinguishing efficient units from inefficient ones, it nonetheless fails to clarify the extent of the inefficiencies of the inefficient

units, and the efficiency of the efficient vectors. Conversely, allocative efficiency is when all produced outputs are not only at their maximum level considering the given inputs but are produced until their last unit satisfies a marginal utilisation need for customers, and at the same time satisfies the marginal cost for producers; in other words, there is no waste on either the production or the consumption side (Grosskopf, 1993).

To continue, first we review the available international efficiency studies with consideration given to different methods that have been used, different efficiency determinants that have been studied, and various financial phenomena. Later, we provide a revision on the available efficiency studies in Turkey over the last three decades, after which we will explain the gaps in the literature.

3.3.1. An overview of efficiency studies

Due to the importance of efficiency in banking sectors all over the world, there are many studies that have looked at various dimensions of bank efficiency, profitability, and productivity. The rapid growth rate of financial markets, technological innovation, and new financial and banking concepts, like Islamic banking and Islamic products, make it necessary to keep investigating banks' efficiency and productivity, especially for economies in transition and less developed countries.

Reviewing the literature shows that available studies investigate and examine different efficiency determinants and efficiency types using various econometrics models including parametric and non-parametric ones in different time periods. While evaluating efficiency and its determinants, studies have paid specific attention to different economic phenomena like deregulation, new regulatory frameworks, different financial crises, mergers and acquisitions, and the economic environment in which banks are performing in the form of structural and non-structural competition and concentration analysis.

In this study, before focusing on the literature around the Turkish banking sector we will review the efficiency studies for both developed and developing countries to provide a better understanding of the concept and its importance. For instance, Fukuyama and Matousek (2018) introduce the two-stage network revenue decomposition analysis focusing on the slack-based directional inefficiency measurement framework. In their study the efficiency performance on has been investigated during the years following the financial crisis of 2008. They confirm that the difference between optimal and actual NPLs level, optimal revenue, and bank efficiency are clearly linked. Hence, they conclude that there was a serious attempt to reduce the NPLs in Japanese banks. Their results show that the main source of bank inefficiency in Japan is related to its allocative inefficiency. Peng *et al*. (2017) study the impact of "bancassurance business" on the efficiency and profitability improvement of Taiwanese banks from 2004 to 2012. According to them when an insurance company uses banks as a distribution channel it is known as "bancassurance business". They discuss this activity as one of the consequences of deregulation in Taiwan. Hence, evaluating the impact of it is important. They deploy DEA to investigate this relationship. They measure technical, allocative, and cost efficiency for Taiwanese banks. Their results confirm the positive impact of "bancassurance business" on the Taiwanese banks' efficiency and profitability. Their results reflect the positive impact of this business on cost and technical efficiencies: These kinds of activities helped Taiwanese banks to utilise their fixed costs significantly.

Moreover, Delis *et al*. (2017) assume that risk is endogenously related to efficiency. Hence, they develop a framework to combine bank risk, which is driven from the variance of profit/return, with a frontier efficiency model. They examine their framework running panel data and Bayesian techniques. They consider the US banks from 1976 to 2014. Their results show that ignoring risk from the efficiency model can result in inaccurate efficiency scores for the US banks. Ignoring risk results in a misrepresentation of the banks on the basis of their

competitive advantage. Moreover, Feng and Serletis (2010) represent measures for technical efficiency and return to scale changes for the large US banks running a Bayesian approach. Their purpose of running a Bayesian approach is to impose some regulatory conditions on the parameters while defining for prior and posterior. According to Feng and Serletis (2010), imposing the regulatory condition leads to the most accurate findings about technical efficiency and productivity growth. Similarly, Simper *et al*. (2017) apply DEA model with consideration given to desirable and undesirable outputs on South Korean banks from the third quarter of 2007 to the second quarter of 2011. Their aim is to estimate the South Korean bank efficiency whilst considering the risk variable. Hence, in their model efficiency is a dependent variable and there are three different risk control variables – loan loss provisions, equity, and NPLs. They conclude that efficiency declined in 2009 due to the financial crisis in 2008. They also outline that it is crucial to consider the risk management control variable if one wants to have no bias in the banks' efficiency scores. Degl'Innocenti *et al*. (2017) examine the relationship between a bank's geographical location and its performance. To measure for efficiency, they apply the probabilistic approach introduced by Daraio and Simar (2005) and then they use the unconditional and conditional efficiency scores by applying non-parametric test for equality of distribution used by Li *et al*. (2009). They collect data from the world's top 1000 commercial banks from the Bureau van Dijk's Bankscope from 2004 to 2010. Their results show that a bank's location influences technical efficiency. Their results also reflect that the number of more efficient banks, during the span of their study, reduced, particularly after the financial crisis in 2008.

Furthermore, Mamatzakis *et al*. (2016) investigated Japanese banks' efficiency considering the impact of NPLs on bank efficiency. They distinguish between the bankrupt and restructured loans while investigating the relationship between these loans and efficiency. They measure technical efficiency by modifying the translog enhanced hyperbolic distance function while

considering two undesirable outputs, namely problem loans and problem other earning assets. Their findings highlight that the efficiency of Japanese banks is low and they fail to fully improve the NPLs ratios. According to their findings, Japanese banks could increase their good outputs by 63.4% and deduct their bad outputs by 38.8% simultaneously. Asmild and Zhu (2016) suggest a method to assess the banks efficiency based on weight restricted DEA. This method prohibits banks from exaggerating risk adjusted prices on funding sources and assets. They collect data from seventy-one European banks between 2006 and 2009 across twenty different states. Their results suggest that there is a bias in the results of the unrestricted DEA model while evaluating for bank efficiency. This bias is not only reflected in the efficiency scores of banks but also in the bail-out banks. Bos *et al.* (2009) investigate the impact of heterogeneity on German banks' efficiency scores between 1993 and 2005. They impose stochastic frontier cost and profit model with baseline specification. Their results indicate the importance of heterogeneity consideration while measuring the cost and profit efficiency scores for German banks.

Several studies also have been done in China to investigate bank efficiency. For instance, Zha *et al*. (2016) outline that the banking operational process in China can be categorised into two groups: productivity and profitability. They use the two-stage slacks-based model to measure the efficiency scores for twenty-five Chinese banks from 2008 to 2012. According to their model, NPLs is a carry-over variable that is linked to the banks' profitability. Hence, the internal structure of a bank's operational process can be considered simultaneously with the dynamic effect of NPLs. Their results suggest that carrying-over NPLs has an impact on operational efficiency in Chinese banks. According to their results, ignoring the dynamic impact of NPLs leads to an underestimation of the efficiency score. They state that Chinese banks, overall, perform inefficiently during the span of the study. Tan and Floros (2013) examine the relationship between Chinese banks' efficiency and risk and capital from 2003 to

2009 using the three stage least square method. Their findings confirm the negative relationship between the risk and capitalisation. However, the relationship between the ratio of loan loss provision to total loan and technical efficiency in Chinese banks is positive. Their results also show the larger banks reflect higher technical efficiency scores. Moreover, the relationship between bank concentration and technical efficiency in Chinese banks is negative, which means more concentration leads to lower efficiency scores.

Fu *et al*. (2014) evaluate the relationship between shareholder value and efficiency scores considering the commercial banks of fourteen Asia-Pacific economies from 2003 to 2010. They apply GMM estimates to investigate whether changes in cost or profit efficiency in the commercial banks can also change the shareholder value. Their results confirm the positive impact of cost and profit improvement on the shareholder value. Sun and Chang (2011) investigate the impact of risk on the cost efficiency of eight emerging Asian countries applying a heteroscedastic stochastic frontier approach. They collect data from 1988 to 2008 for eight Asian countries, namely China, India, Indonesia, Korea, Malaysia, the Philippines, Taiwan, and Thailand. The three main kinds of risks they consider are credit, operational risks, and market risks. Their findings confirm the significant role of risk on a bank's efficiency. Additionally, Vivas and Pasiouras (2010) examine the role of non-traditional activities, like off-balance sheet activities, on bank efficiency. They collect data from 752 commercial banks across eighty-two countries from 1999 to 2006. To measure cost and profit efficiency, they run the stochastic frontier approach. Their results show that cost efficiency for banks increases even with considering non-traditional activities, like off-balance sheet and non-interest income activities. However, when evaluating profit efficiency, the results are mixed. Their results also emphasise the importance of improving supervisory protocols and regulations as improving these can encourage both cost efficiency and profit efficiency. Similarly, Fethi and Pasiouras (2010) review 196 studies with different methodologies (including operational research and

artificial intelligence techniques) to examine bank performance. According to their survey, researchers investigate different aspects of a bank's performance, like ownership, different efficiency determinants, and the efficiency of a bank's branches.

Among all these studies that investigate the different bank-specific characteristics, (ownership and financial crises) some of them extend their scope by considering some novel efficiency determinants. For instance, gender diversity is one of the most interesting efficiency determinants that has attracted the attention of scholars and researchers recently. Before reviewing the available literature on the impact of gender diversification on the bank efficiency, it is important to review some of the main theories. In the majority of recent studies all the discussed theories relate to the board structure, which focuses on gender diversification on the management board. Cabo *et al*. (2012) explain that there are two kinds of discussions around gender diversity on the management board. One focuses on the ethics and the other focuses on economic factors. The ethics discussion is about improving equality in the workplace and utilising human resources. Conversely, economic discussion focuses on performance, which can be improved by improving gender diversification. There are several theories that support the economic value of gender diversification. Carter *et al*. (2010) state different theories, including dependence theory, human capital theory, agency theory, and social psychology theory. All these theories emphasise the relationship between the financial performance of a financial institution and the management board's gender diversity.

The resource dependency theory considers that financial institutions are operating in an open market, which allows the exchange of necessary resources to survive and stay active. Hence, to operate, there is a dependency between the financial firms and external sources. Accordingly, a greater degree of board diversity provides more network opportunities, which in turn help firms stay well connected to one another and generate more money (Hillman *et al*., 2000). The opportunities that can be achieved by having a more gender-diverse board are not

limited to communication and networks; more capital sources can also be obtained (Van der Walt and Ingley, 2003). A more diverse management board also helps information and knowledge dissemination. Carter *et al*. (2010) outline the notion that resource dependence theory emphasises the importance of diversification in general, and gender in particular. One of the results of this diversification would be a unique set of information that can be used to improve the management decision-making process. It would also improve the problem-solving process by using novel and non-traditional approaches (Forbes and Milliken, 1999). This theory also emphasises the fact that women make up almost half the world population. Thus, more diversification would bring more talent into the board structure (Biggins, 1999). Hillman *et al*. (2007) assert that financial institutions are operating in a very complicated environment with numerous environmental dependencies. Therefore, more perspectives are always beneficial and appreciated. According to them, following a growth-oriented strategy and having more women would benefit the performance of any financial institution significantly.

The second theory is 'agency theory'. This theory provides some explanations and rationales for critical monitoring of the board on behalf of the shareholder, customers, suppliers, and other boards in an institution (Eisenhardt, 1989; Fama and Jensen, 1983). The necessary requirement for the board then is to perform effectively. The board is responsible for defending the interests of shareholders and minimising the conflict between managers and shareholders. Hillman and Dalziel (2003) explain that for the board to practice the monitoring function, they need a mixture of experiences and capabilities to assess management and business strategies. Adams and Ferreira (2009) argue that women directors represent more independent thinking. Levi *et al*. (2014) and Huang and Kisgen (2013) state that women are more risk averse and so they pay more attention to the details of monitoring activities. As a result, improving gender diversification and hiring more women can add to the experience and capabilities of monitoring

activities. Combining female and male characteristics can improve the performance of a financial institution.

The third main theory is 'human capital theory'. Burke (2000) argues that one of the reasons why there are fewer women on boards of directors is down to the wrong belief that women are less qualified than men. However, Terjesen *et al*. (2009) assert that women are just as qualified as men education wise. The only issue is that they have not had an equal chance to participate in business activities, so they are potentially not as experienced in business activities in comparison to men. According to Carter *et al.* (2010) human capital theory can be linked to resource dependence theory as it focuses on utilising the available human capital to use their talents, qualifications, and networks. Human capital theory also can be described using the other theories in banking. For instance, Shrader *et al*. (1997) discusses the leverage resource-based theories of competitive advantage of a financial institution. In this regard, human capital is one significant source that an institution can use to improve the problem-solving process. Brown and Brown (2002) argue that because women have a different approach to risk, managers' attitudes to risk can be improved by recruiting more women to senior roles. However, Carter *et al.* (2010) argue that it is important to consider the contingency theory while considering gender diversity. According to them some environmental and institutional characteristics, like size and age, are also important when assessing the impact of gender diversity. For example, young institutions may require more to board's knowledge and sources to develop rather than having a perfect monitoring structure. This can be investigated more via a consideration of the growth phase and the environmental condition that the firm is performing in. However, reviewing the previous discussion demonstrates no conflict between female staff and the age of the firm.

The fourth theory is 'social psychological theory'. This theory discusses how the majority make the final decision. In other words, if the majority of board members are men, they

influence the structure and decision-making process the most. This phenomenon is called "tokens". It simply means that if an organisation were to add some women to a group where majority of members were men, the cost and stress for women in that group increases. Fan *et al*. (2019) argue that the tokenism issue is quite important as it isolates women and creates suspicion around them. As a result, tokenism has a negative influence on gender diversification and weakens performance by discouraging women in business.

Considering all of these theories, the current literature provides some key analyses regarding the role of gender diversification and bank performance. For instance, Karavitis *et al*. (2021) test the relationship between female board members and the cost of lending from 1999 to 2013. They collect their data from four different databases, including the Thomson Reuters LPC's DealScan database, the Call Reports from the "Federal Reserve Board of Governors", Compustat, and BoardEx. Their findings are mixed. They evaluate how gender diversity can influence the cost of lending. Their results show that the sensitivity of loan spreads to gender diversification is higher for independent female directors. According to them gender diversity reduces information asymmetry and improves transparency. However, gender diversity does not significantly help with lending. Sood (2021) examines the impact of women on the risk attitude of US banks. He uses a sample of 195 US commercial banks from 2002 to 2018. Sood's results show that investment on more risky assets by women will increase if they gain rewards from their risk-taking. These results show that controlling board participation, the ownership structure of a bank and bank-specific characteristics can influence the risk-taking attitude of female directors. Cardillo *et al*. (2020) examine the impact of gender diversity on bank profitability and size of public bailout. They collect data from 2005 to 2017 from European banks. Their results confirm the fact that banks with more gender diversity are less likely to receive public bailouts. According to their results an increase of one standard deviation in gender diversity can reduce the probability of bailout by at least 2.44%. Their findings also

suggest that more diversity improves bank performance by improving the ROA. Their results are in line with the resource dependency and human capital theories. Moreover, Fan *et al*. (2019) discuss the same theories while evaluating the impact of having more women on the board of directors of 6231 US banks. Using the BoardEx database, they collect different quarterly data on age, gender, nationality, education, employment, and social activities from 2000 to 2014. Their main aim is to investigate the impact of the presence of women on the boards of US banks and their impact on the banks' earning management. As they discuss, unlike in previous studies, they find that women impact non-linearly on the banks' earning management and monitoring processes. They demonstrate that changes brought about by the inclusion of more female staff can only be seen when their numbers increase to two or three in a group. These findings confirm the tokenism issue, which has been discussed under the social psychological theory. According to the aforementioned results, the impact of having more women on a bank's earning management board is more evident if women take on audit or nomination committee responsibilities, and if they have had a university education. Obviously, these results show no changes in gender diversity from 2007 to 2009.

Furthermore, Owen and Temesvary (2018) apply the instrumental variable method across 90 US banks from 1999 to 2015 to investigate the relationship between female participation on the boards of banks and bank performance. They discuss that missed results are due to the non-linear and U-shape relationship between gender diversity and various banks' performance measures. Their results show that the positive impact of female participation can only be found in better capitalised banks. According to them achieving the main targets of a financial institution, which is maximizing the owners' wealth and profit, are important. For instance, a bank can improve its performance by expanding networks, which may include hiring more women. Meca *et al*. (2015) study the impact of employee gender and nationality on banks performance. They collect data from 159 banks in nine countries, including Canada, France,

Germany, Italy, the Netherlands, Spain, Sweden, the United Kingdom, and the United States over the period between 2004 and 2010. Their results confirm the positive impact of gender diversity on a bank's performance. These results confirm the negative impact of nationality on a bank's performance. They also state that in some countries a firm with more relaxed regulations and weaker supervisory systems, board diversity works less effectively.

Furthermore, Pathan and Faff (2013) study the impact of board structure, with particular focus on the impact of board size, independence, and gender diversity, on the bank performance. They use data from the large US banks between 1997 and 2011 applying GMM estimation. They conclude that gender diversity can improve a bank's performance. Their results also suggest that the board structure can be relatively important for the banks with lower market power. Hangendorff and Keasey (2012) evaluate the role of board diversity in improving the decision-making capabilities in the US banking sector. They use a sample of bank mergers to examine this role. They conclude that although the value of shareholders' wealth declines through mergers and acquisition, the value recovers by occupational diversity. Their results show the market trusts the monitoring power of the board in the banks. Their results fail to support the argument that gender diversity impacts on the value of shareholders' wealth and capital and on a bank's performance. Their findings significantly emphasise some general factors which do have an impact such as an employee's experience and their knowledge rather than their gender, race or education. Dwyer *et al*. (2003) examine the influence of gender diversity on the financial institution's management performance. They consider the configuration and contingency approaches to evaluate the impact of gender diversity's interactions with two organisational variables – organisational culture and growth orientation – on the organisational performance. Their results support both the configurational and contingency approaches. Moreover, their results show that the impact of gender diversity depends on the firm's strategic orientation, its culture, and on firm-specific characteristics.

Reviewing the literature on the impact of diversity in general, and gender in particular whilst evaluating the theoretical discussions in the available literature clearly reflect the importance of considering these determinants when evaluating a bank's performance and its efficiency. These determinants are comparably well-investigated for more developed countries, like the US. However, in the case of transition economies and less developed countries these determinants along with many other aspects should be investigated more thoroughly. Hence, one of the main contributions of this paper is to evaluate the impact of employee gender on Turkish banks' efficiency scores. Due to the lack of data regarding different genders, education, CEOs' genders and education, and information about the genders and education of the management boards of Turkish banks, this study only considers the total number of female and male employees in 44 Turkish banks over the time period of this study. The following section reviews the efficiency studies carried out on the Turkish banking sector.

3.3.2. Efficiency studies: The Turkish banking sector

Empirical research on the efficiency of Turkish banks has been rather limited, in comparison to more developed economies and European countries.

Ertugrul and Zaim (1999) and Onis (1995) used the DEA approach to assess the impact of liberalisation on the efficiency of Turkish banks, and confirmed that the financial liberalisation that took place in the 1980s positively influenced efficiency. Likewise, other studies such as Fukuyama and Matousek (2011), Denizer *et al*. (2007), Ozkan-Gunay and Tektas (2006) analysed the efficiency of Turkish banks before and after various financial crises. These studies covered different time horizons and used different datasets to evaluate efficiency and agree that bank efficiency has been negatively influenced by the crises that have occurred over the last three decades. Some studies, such as Denizer *et al*. (2007), have shown that this negative impact on efficiency is due more to Turkey's unstable macroeconomic environment than to banking activities. Other comparable studies have not only come to the same conclusion, but have also

evaluated how a selection of outputs can influence efficiency values in terms of ownership types; they found that a selection of outputs can directly and positively influence foreign banks' efficiency scores, especially during periods of instability.

Ozkan-Gunay and Tektas (2006) researched the technical efficiency of non-public commercial banks in Turkey from 1990 to 2001 using a DEA approach. Due to the financial crisis of 2000-2001 and the weak financial market in Turkey, their findings suggest that the efficiency scores of Turkish banks declined during the time period of their study. Later, Denizer *et al*. (2007) emphasised the impact of liberalisation on Turkish banks' efficiency. They investigate Turkish banking efficiency before and after liberalisation from 1970 until 1994 using a DEA approach. Their results illustrate serious banking issues Turkey during the timescale of the study. They also discuss how efficiency scores in Turkish banks declined after introducing liberalisation. According to the authors, the main reason for this decline was the significantly unstable macroeconomic conditions in Turkey. Fukuyama and Matousek (2011) analysed the cost, technical, and allocative efficiency of the Turkish banks from 1991 until 2007. Their study is an important research about the Turkish experience, not only because their dataset captures all changes in Turkish bank efficiency before and after the 2008 crisis and the Turkish financial crisis, but also because they consider deposits differently than other available studies for this country. Their suggested two-stage network model addressed what Holod and Lewis (2011) called 'deposit dilemma'. Fukuyama and Matousek (2011) used bank inputs to produce an intermediate output, which is 'deposit'. In the second stage they used deposit as an input to produce final outputs, which are loan and securities. Running this model enables them to achieve better efficiency scores for both pre and post financial crises. Their results also fail to support the idea that foreign banks in Turkey demonstrate higher efficiency scores.

De Jonghe *et al*. (2013) evaluate the bank efficiency by considering the impact of corporate governance improvement. They collected unbalanced panel data for 63 Turkish banks from

1988 until 2009. Their results show that a better corporate governance structure improves the risk/return efficiency for Turkish banks – when a country enjoys a stable economic and regulatory environment, it has a more efficient banking system. Their study indirectly, and similar to the other studies on Turkey, emphasises the importance of having a stable economic environment. Assaf *et al*. (2013) evaluated the productivity and efficiency of Turkish banks from 2002 to 2010 using a new measure, a Bayesian estimation method. While computing for efficiency scores they specifically focused on NPLs. The results reflect that productivity improved for Turkish banks over the period of their study. They argue that this improvement mainly comes from an improvement in technology in Turkey. Moreover, in their study efficiency scores continued to decline for Turkish banks. Furthermore, they stated that NPLs as a bad output should be studied separately as the results with and without this variable reflect significant differences and are biased.

Another key feature that has been examined in the literature around Turkish banking is type of ownership. The main four ownership styles that have been investigated are foreign, private, state-owned, and investment banks. Of scholars who have looked at the relationship between ownership and bank efficiency, Bonin *et al*. (2005a) studied the efficiency scores of banks on the basis of their ownership between 1996 and 2000, applying the stochastic frontier method, and found that government-owned banks (which are equivalent to state-owned banks) are not meaningfully less efficient than private banks. They also confirmed that foreign banks offer better services to customers, and have higher efficiency scores. Finally, they suggested that privatisation alone would not be enough to boost the efficiency of the banking sector. Another study that has evaluated the impact of ownership on efficiency is that of El-Gamal and Inanoglu (2005), who found that "state-owned banks" were not unusually inefficient; however, they did find a high level of labour inefficiency in the period 1990-2000. Similarly, Isik and Hassan (2002) studied the possible impact of the ownership structure of Turkish banks on efficiency

in the period 1988-1996, applying a series of parametric and non-parametric techniques, and found that foreign and private banks were more efficient than other banks in Turkey, a finding that was also confirmed by Fukuyama and Matousek (2011). Another study that considered ownership type as a factor that influences the efficiency of Turkish banks is Yilmaz (2013), who looked at 30 commercial banks and applied the DEA approach between the years 2007 and 2010. This study concluded that the efficiency scores of both domestic and foreign banks decreased during 2008 and 2009 due to the global financial crisis, rising again in the years after the crisis. Later, Bayraktar *et al*. (2010) evaluated the efficiency of Turkish banks between 2007 and 2010 and found that foreign banks are more efficient than domestic banks. The majority of recent studies take ownership style into account, like that of Assaf *et al*. (2013); they did this not as a factor for evaluation, but rather as a determined condition that can lead to a better analysis of banks' performance.

Furthermore, Kasman (2012), El-Gamal and Inanoglo (2005) and Isik and Hassan (2002 and 2003a) have investigated some additional determinants of efficiency such as the impact of bank size, capitalisation, and the number of branches. The studies that have evaluated the impact of bank size have not reached a consensus on how this factor influences efficiency. For instance, Isik and Hassan (2002) found a negative correlation between bank efficiency and size, whereas according to Kasman (2012), larger banks are more efficient. Similarly, to UÇAN *et al*. (2009), Kasman (2012) applied DEA to assess the technical and scale efficiencies of Turkish commercial banks from 1988 until 1998, and concluded there is a positive relationship between profitability, bank size, and the level of efficiency. This was confirmed later by Assaf *et al*. (2013), who focused on the impact of NPLs on the technical efficiency of Turkish banks.

Aysan and Ceyhan (2008a) evaluated the relationship between the number of branches of a bank, its capitalisation, and level of efficiency, and found a positive correlation between capitalisation and efficiency; however, they found no meaningful relationship between the

number of branches and the level of efficiency. Capitalisation was also investigated by Fukuyama and Matousek (2011), who found a positive relationship between capitalisation and technical efficiency in Turkish banks.

Reviewing the current Turkish literature about banks' efficiency illustrates that this topic has been investigated significantly, considering almost all aspects and efficiency determinants. However, an evaluation of the impact of some aspects of human resources is absent from the literature. The only study that examines the impact of education on Turkish banks is Isik and Hassan's study (2003a). They outline five types of efficiency for Turkish banks: cost, allocative, technical, pure technical, and scale using a DEA model for 1988, 1992, and 1996. They find that more educated employees improve the cost efficiency in Turkey. According to their results, banks with more educated employees employ the available financial resources more effectively and manage operational costs better compared to the banks with less educated employees. Moreover, having a more educated staff can also provide a greater degree of investment opportunities for the bank. Hence, more money will be generated. The other important efficiency determinant that has been discussed recently in the literature is gender diversification. This study uses employee gender to evaluate the impact of gender diversity on the Turkish banks' efficiency score. To the best of our knowledge, no previous study amongst the literature concerning Turkey considers the impact of employee gender. This determinant is particularly important since, according to published data, women make up almost 50% of the world's total human capital. Hence, ignoring this high share of a country's capital resources can lead to a significant loss for a country. Hence, considering this efficiency determinant is one of the main contributions of this study. It is worth mentioning that the theories related to gender diversification have not been discussed in the Turkish literature. Further study around gender diversification could investigate the subject as it relates to the performance of the Turkish banking sector through human capital theory, social psychological theory or resource

dependency theory. Previously, in section 3.3.1. we discussed the importance of considering this determinant in the world literature. Later, in section 3.5.1 we will discuss further the importance of gender diversification and its role in the efficiency scores of Turkish banks during the time horizon of study.

3.3.3. Bank efficiency studies: Using non-performing loans (NPLs)

The quality of a bank's assets is a significant indicator of bankruptcy and can influence efficiency and stability. The importance of NPLs has been discussed by Berger and DeYoung (1997) and Mester (1997), while many studies have found that NPLs negatively affect the efficiency and stability of banks because they reduce the quality of the bank's assets. In the current literature, NPLs have been categorised as either a controlled variable (for example, Fukuyama and Matousek, 2017; Kumbhakar *et al*., 2015; Fukuyama and Weber, 2015; Podpiera and Weill, 2008; Fries and Taci, 2005; Berger and DeYoung, 1997; Mester, 1997) or as a bad output (for example, Hajialiakbari *et al*., 2013; Fukuyama and Weber, 2008; Park and Weber, 2006). The studies all provide evidence that NPLs contribute to bank inefficiency. Berger and DeYoung (1997) argue that the main drawback of studies that consider the impact of NPLs is their assumption that NPLs are a controlled variable, rather than an undesirable output, which directly affects the process of production. This being so, in this study, NPLs will be considered an undesirable output, while measuring efficiency scores.

3.3.4. Current gaps

As illustrated above, a number of studies since the 1980s have examined the issue of bank efficiency and its determinants. They have been done this not only to improve our general understanding of the impact of Turkey's financial liberalisation agendas, but also to provide more information about the impact of various financial crises on the Turkish banking sector. However, the majority of these studies are limited to a basic topic like impact of liberalisation and financial crises. Hence, the Turkish literature discussed above suffers from some

considerable gaps. For instance, there is a lack of study to evaluate the relationship between the bank efficiency and technology.

There is also a lack of studies on neural networks in the Turkish banking sector and its financial system. Current Turkish literature focuses on a bank's different characteristics to evaluate the efficiency determinants. Hence, the requirement of introducing new efficiency determinants, like employee diversity, can be detected in Turkish literature. Furthermore, Turkish banks have an interesting feature in that they offer both conventional and Islamic banking services (dual banking). However, there are only a few reliable studies that have evaluated this dual banking system in Turkey, for example Abedifar *et al*. (2016). The main aim of this study is to measure the efficiency scores by paying particular attention to the impact of NPLs. Later, we concentrate on the key variables that can influence Turkish banks' efficiency scores, like NIM and NNIM as a proxy of profitability. We also introduce a unique efficiency determinant, which is employee gender, to investigate the impact of having a greater degree of gender diversity on Turkish banks' efficiency.

Reviewing the literature illustrates the fact that there is only one current study that has considered NPLs as an undesirable output while measuring bank efficiency. Due to the importance of this parameter, the present study accounts for NPLs as an undesirable output while measuring its impact on the efficiency of Turkish banks. Furthermore, we use quarterly data which makes this study different to previous studies because it provides more recent qualitative and quantitative efficiency determinants to capture a wider picture of the Turkish banking sector. Considering novel efficiency determinants (such as employee gender) provides useful information on human resource management. It can thus improve the management structure and provide more human and capital sources.

Finally, the methodology in this research is new to the literature. In this research, we deploy a modified version of the DEA introduced and applied by Aparicio *et al*. (2015) in which a

separate vector is defined for the undesirable variable in order to be able to study the impact of it individually to find the main source of inefficiency in Turkish banks. Using this method also enables us to separate the random errors from inefficient errors thereby clarifying the sources of inefficiency. This method is flexible enough to address potential issues related to noise in the dataset. It also gives the research a flexible form of function to estimate the distance function. To evaluate the impact of efficiency determinants, this study applies quantile regression to a panel that has been developed recently in the area of banking and finance by scholars such as Behr (2010), and is very new to the literature around Turkish banking.

3.4. Methodology

3.4.1. Model description

DEA is a non-parametric approach to estimating production frontiers; through this method, there is no need to impose any hypothesis regarding the functional form of the production function, which makes the analysis more flexible. This approach was first introduced by Charnes *et al.* (1979). In this model, inefficiency is defined as any aberration from the defined frontier. DEA can also compute efficiency measures when there are multiple inputs and outputs, without any requirement to establish pre-specified weights for each variable.

The efficiency of decision-making units (DMUs) in this model is calculated based on the assumption that all these units are located at a point below or above the frontier line. Obviously, all the DMUs that are on the frontier line are considered efficient units, and any deviation from the line illustrates inefficiency. The chief beneficial aspect of the application of DEA is that it can identify and illustrate the source and level of inefficiency for each of the inefficient inputs and outputs.

DEA accepts the taken inputs X_i and outputs Y_i, with i= 1,2,…,N as the assumed constants, and determines the weights of these assumed inputs and outputs for a specific DMU i_0, taking into consideration the fact that the efficiency of the unit should be maximized less than for

constraints. These constraints confirm the best selected weights for DMU i_0 do not illustrate efficiency more than the one in the obtained function.

We follow a constant return to scale in our study, in which we assume that if a combination of (X,Y) is a possible function, then for all the positive scalers t ∈ $\mathcal{R}$, the combination of (tX, tY) is also possible. According to this given production function, the above assumption is represented as ray unboundedness (Banker *et al*., 1984).

To measure the technical and allocative efficiency of every given Turkish bank, we use a modified version of DEA introduced and applied by Aparicio *et al*. (2015). This version offers a new directional distance function with an endogenous direction to measure efficiency, at the same time as considering the undesirable outputs.

It is difficult but necessary to decide on the technology production function, especially when looking at undesirable variables to estimate the efficiency; the disposability of a chosen technology function is also an important factor. The inputs/outputs disposability can be defined as the possibility of any reduction or exposure of inputs/output during the production process, by any desired amount. Following this definition, technology disposability can be defined as weak or strong, in order to shrink the undesirable output by a given amount of inputs. An ideal production/technology function is then supposed to demonstrate a strong and free disposability regarding undesirable outputs, according to which the amount of these undesirable outputs can be reduced, without any changes to the other desirable outputs or the given inputs. In contrast, weak and not free disposability illustrates a reduction in the undesirable outputs that is more difficult and dependent on a reduction in the other desirable outputs or changes in the proportion of the given inputs (Zofio and Prieto, 2001). We define the variable vectors in our study as follows:

1) $X_{ij} \in \Re_+$: ith input taken by the jth DMU, i=1,2,…,m , j=1,…,n.

2) $Y^g_{rj} \in \Re_+$: rth "desirable" output which produced by the jth DMU, r=1,…,q, j=1,…,n.

3) $Y^{b}_{kj} \in \Re_{+}$: kth "Undesirable" output which produced by the jth DMU, k=1,…,p j=1,…,n.

Accordingly, the DEA technology function can be defined as follows:

$$T = \{(x, y^{d}, y^{u}): \sum_{K=1}^{K} z_k y_{qk} \geq y_m, \quad q = 1, \ldots, q, \sum_{K=1}^{K} z_k y^{u}{}_{rk} = y^{u}{}_{j}, r = 1, \ldots, J, \sum_{K=1}^{K} Z_K x_{nk} \leq x_n, n=1,\ldots,N, Z_K \geq 0, k = 1, \ldots, K\} \quad (3.1)$$

where $Z_K$represents the main variables that are used to enlarge or squeeze a particular perceived combination of functions of DMU i_0 in order to create the U-shaped combination from the achieved inputs and outputs.

Based on the defined technology function T, which is indicated in (3.1) for each DMUi_0, i = 1,…,N, which is the directional distance function, efficiency can be achieved by resolving the following:

$$D(x, y^{d}, y^{u}; g) = \max \rho^{i'}$$

$$\sum_{i=1}^{I} z_i y_{qi} \geq y_m + \rho^{i} g_{y^{d}} \qquad q = 1, \ldots, Q \quad (3.2)$$

$$\sum_{i=1}^{i} z_i y^{u}_{ri} = y^{u}_{j} - \rho^{i} g_{y^{u}} \qquad r = 1, \ldots, R \quad (3.3)$$

$$\sum_{i=1}^{I} Z_i x_{ni} \leq x_{ni} - \rho^{i} g_{x_n}, \qquad n = 1, \ldots, N \quad (3.4)$$

$$Z_I \geq 0 \qquad i = 1, \ldots, K \quad (3.5)$$

In the above formulas, $\rho^{i'}$estimates the maximum possible increase of desirable outputs/inputs from the maximum possible decrease of undesirable outputs/inputs in order to accurately measure technical inefficiency in DMUs. Consequently, $\rho^{i'} = 0$ illustrates that DMU i_0 is operating on the frontier, and is technically efficient. However, when $\rho^{i'} > 0$, then DMU i_0 operates inside the frontier. This makes it possible to distinguish the technical inefficiency associated with both the desirable and undesirable inputs and outputs; i.e. $\rho^{k}(q = 1, \ldots, Q) \neq \rho^{k}(n = 1, \ldots, N) \neq \rho^{k}(r = 1, .., R)$. Indeed, the concern in this current

study is only related to technical and allocative inefficiency from the undesirable output (NPLs).

3.4.2. The directional distance function approach: The use of the undesirable output

In its initial formulation by Fare *et al*. (2003), the directional output distance function is a substitute technique that can assess efficiency. In this approach, efficiency is assessed as the ability to expand the desirable outputs, while simultaneously reducing undesirable outputs, assuming that the proportion of inputs remains constant or decreases.

Similar to the above approach, we assume T to be the function:

$$T = [(X, Y^g) : X \text{ can produce } Y^g] \tag{3.6}$$

The directional technology distance function takes a broad view of both the inputs and outputs in Shephard's distance function, providing a comprehensive illustration of the production technology function. Assuming d= $(-d^x, d^g)$ is a direction vector, then the function can be formulated as:

$$\overrightarrow{D_T}(X, Y^g; d) = \sup [\, \delta : (X - \delta d^x, Y^g, \delta d^g) \in T] \tag{3.7}$$

The above equation attempts to maximize attainable growth in the desirable outputs in d^g direction, with the maximum amount of input reduction in d^x directions. Considering the assumptions, we make about technology the above directional technology distance function (3.7) can be measured for bank i_0 by resolving the following formula:

$$\max_{\delta,\lambda} \delta$$

$$\text{s.t.} \sum_{j=1}^{n} \lambda_j Y_{rj}^g - \delta d_{ri_0}^g \geq Y_{ri_0}^g \,, \qquad r = 1, \dots, q \tag{3.8}$$

$$\sum_{j=1}^{n} \lambda_j X_{ij} + \delta d_{ij_0}^x \leq X_{ij_0} \,, \qquad i = 1, \dots, m \tag{3.9}$$

$$\sum_{j=1}^{Kn} \lambda_j = 1 \qquad j = 1, \dots, n \tag{3.10}$$

It is important to note that in the directional distance function approach, δ = 0 represents efficiency, which is the same as θ =1 in the standard DEA formulation.

The direction vector d = (-X,Y^g) helps to analyse technology, bearing in mind the decided targets about expanding desirable outputs and diminishing undesirable outputs and, if possible, inputs.

This approach encompassing undesirable outputs results in measurements of efficiency by simultaneously increasing desirable outputs, reducing undesirable outputs, and applying a constant amount of inputs (for example, Mandal and Madheswaran, 2010; Fare and Grosskopf, 2004; Fare *et al*., 2003).

Accordingly, the technology function that encompasses undesirable outputs can be modified and redefined as:

$$T = [(X,Y^g,Y^b) \text{ X which then can yield: } (Y^g,Y^b)] \quad (3.11)$$

Let $\rho(X)$ represent all the possible outputs vectors (Y^g,Y^b) for a specified inputs vector:

$$\rho(X) = [(Y^g,Y^b): (x = X,Y^g,Y^b) \in T] \quad (3.12)$$

The output is then expected to have the following conditions:

(1) $\left(\mathrm{Y^g},\mathrm{Y^b}\right) \in \rho(\mathrm{X});\ \mathrm{Y^b} = 0 \implies \mathrm{Y^g} = 0$ (null-joint-ness);

(2) $\left(\mathrm{Y^g},\mathrm{Y^b}\right) \in \rho(\mathrm{X})$ and $0 \leq \delta \leq 1$, then $\delta\left(\mathrm{Y^g},\mathrm{Y^b}\right) \in \rho(\mathrm{X})$ (joint weak disposability);

(3) $\left(\mathrm{Y^g},\mathrm{Y^b}\right) \in \rho(\mathrm{X})$ and $\widetilde{\mathrm{Y}}^{\mathrm{g}} \leq \mathrm{Y^g}$, then $(\widetilde{\mathrm{Y}}^{\mathrm{g}},\mathrm{Y^b}) \in \rho(\mathrm{X})$ (strong disposability of desirable output).

Under the first condition, we endeavour to illustrate that producing desirable outputs may also lead to undesirable outputs. However, under the second condition, the determinants of shrinking the undesirable output must occur along with a proportional decline in desirable outputs, for which weakly disposable criteria are needed.

The directional technology distance function that encompasses the undesirable factor – in our case, undesirable output (NPLs) – is then formally defined as:

$$\overrightarrow{D_T}(X, Y^g, Y^b; d) = \sup [\, \delta : (Y^g + \delta d^g, Y^b - \delta d^b) \in \rho(X - \delta d^x)] \quad (3.13)$$

where $d = (-d^x, d^g, -d^b)$.

Based on the three outlined conditions, the value δ accounts for technical inefficiency, while the directional technology function (3.13) follows to gain the maximum achievable increase in the desirable outputs in direction d^g, and the greatest achievable decrease in the undesirable outputs in direction d^b. When a correct technology function is defined, then equation (3.13) can solve the below optimisation formula to measure the level of efficiency.

$$\max_{\delta, \lambda} \delta$$

$$\text{s.t.} \sum_{j=1}^{n} \lambda_j Y_{rj}^g - \delta d_{ri_0}^g \geq Y_{ri_0}^g \,, \qquad r = 1, \dots, q \quad (3.14)$$

$$\sum_{j=1}^{n} \lambda_j Y_{kj}^b + \delta d_{kj_0}^b \leq Y_{kj_0}^b \,, \qquad k = 1, \dots, l \quad (3.15)$$

$$\sum_{j=1}^{n} \lambda_j X_{ij} + \delta d_{ij_0}^x \leq X_{ij_0} \qquad i = 1, \dots, m \quad (3.16)$$

$$\sum_{i=1}^{n} \lambda_i = 1 \quad (3.17)$$

$$\lambda_j \geq 0 \quad j = 1, .., n \quad (3.18)$$

Similarly, to the model described by equations (3.8) - (3.10), we adopt a direction vector d= $(0, Y^g, -Y^b)$ that enables us to expand the desirable outputs and reduce the undesirable outputs, without needlessly boosting the amount of inputs. With this specific direction vector, the measured distance functions do not rely on the units and magnitude of the variable alone, so the value of δ will fit the interval [0,1].

3.5. Data and empirical results

The sample comprises 44 banks operating in Turkey between 2002 and 2017. All data has been collected from the BAT. Using BAT enables this study to collect all the required data for evaluating the aim of this study for all the available commercial banks in Turkey. Moreover, it

prpvides the most up-to-dated data. This study uses data from almost all commercial banks in Turkey over the fifteen years between December 2002 and December 2017. Our sample is very comprehensive and covers a longer time-period than other available studies in Turkish literature Table 3.1 presents the variables included in this study along with their definitions. In Table 3.2 we present the descriptive statistics of these selected variables.

This study takes a number of inputs and outputs into consideration. Following the current literature (for example, Fukuyama and Matousek, 2017; Stewart *et al*., 2016; Fujii *et al*., 2014) capital and deposits are the two main inputs used to compute both technical and allocative efficiency. Correspondingly, the desirable outputs will be total loans and receivables, total securities, total off-balance sheet activities, and total non-interest income[15]. NPLs are an undesirable output. This includes due loans in arrears for three to six months, and loan debts of longer than six months. Since we need to define two different vectors as input and output prices to compute allocative efficiency, this study calculates the price of capital by dividing total operating expenses by total fixed assets (Berger and DeYoung, 1997) and the price of deposits by dividing interest expenses on deposits by total deposits (Fukuyama *et al*., 2020). Additionally, following Fukuyama and Matousek (2017), the price of securities is calculated by dividing the other operating expenses by the total securities, while the price of total loans and receivables is calculated by dividing net interest income/expenses by the total loans and receivables. Lastly, the price of NPLs is calculated by dividing net interest income/expenses by the total amount of NPLs. Given the fact that any correlation between an undesirable output and the inputs, or a desirable output, can lead to a misspecification in the distance function (3.13), there is a correlation coefficient matrix, which is presented in Table. 3.10.1[16].

[15] Non-interest income represents how well a bank can generate money from its non-deposit activities.
[16] The correlation coefficient matrix presented in Table 3.10.1 indicates that correlations among the variables in this paper are mainly negligible, showing that the model applied in this paper is unlikely to suffer from the issue of considerable multicollinearity.

The extraordinary inflationary environment in Turkey can misrepresent the data and results. Therefore, all our inputs and outputs are denominated in US dollars. According to Assaf *et al*. (2013); Ozkan-Gunay and Tektas (2006); and Isik and Hassan (2002, 2003a, 2003b), the denomination of variables in US dollars instead of the TL benefits the literature by managing the possible impact of inflation on real magnitudes and can also allow a direct adjustment of inflation in the variables. Due to the unstable Turkish macroeconomic environment, it is crucial and rational to adjust inflation for variables since the high inflationary environment in Turkey can falsify the potential results of studies (Fukuyama and Matousek, 2011). We also cleaned our dataset because some variables were omitted. Moreover, some outliers and "zero" variables have also been taken out of the sample since in some cases, they did not match an efficiency target.

According to Berger and Humphrey (1997), there are three main approaches to estimating efficiency: production approach, intermediation approach, and value-added approach. Production approach means banks are using capital and labour to produce various types of deposits and loans. With this method the outputs are measured by the number of transactions over a period of time, which is the main shortage of this approach. The true number of transactions can be difficult to collect, and this is a limitation for this approach. The second approach is the intermediation approach. According to this approach, banks act as an intermediary between savers and investors. In this approach the value of loans and investments are measured on the basis of outputs, which is a measure of labour, capital, and deposits. Hence, all the inputs generate these three main outputs. The third approach is the value-added approach. The main difference between this approach and the intermediation approach is that with the former all items on both sides of the balance sheet can be taken as an input or an output. The manner of deciding is based on the value generation. Berger and Humphrey (1997)

state that with this approach all types of deposit, including demand, savings, and time, in addition to loans generate value added to a bank.

All these approaches have advantages and disadvantages. The production approach may be preferred when the aim is to evaluate the efficiencies of branches of financial institutions. On the other hand, the intermediation approach is more appropriate for assessing the entire financial institution because in this approach, cost is a figure of total operating expenses plus interest expenses; both physical input prices and financial input prices, such as interest rate paid, are considered. Hence, it is more inclusive and captures the nature of a financial intermediary. Moreover, the sample of this study focuses on the Turkish commercial banks. Hence, considering and concentrating on interest expenses can provide more accurate results.

The current paper follows the intermediation approach of Berger and Humphrey (1997) and Casu *et al*. (2004) since it is the best way of assessing bank efficiency as a whole in Turkey, and not only that of individual branches.

With regard to analysing the elasticities of the inputs and outputs, this study follows Mamatzakis *et al*. (2013) and applies a simple OLS, which is represented in Table 3.3. The results illustrate that all the inputs and the off-balance sheet activities from the desired outputs are statistically significant. The positive coefficient for the deposit (x_2 = 0.0012) shows a positive relationship between this variable and technical efficiency. The coefficients are also statistically significant for allocative and cost efficiency and are equal to 0.0067 and 00.0071, respectively. Since efficiency explains how successful a bank is at transforming its inputs to desirable outputs, the positive relationships between deposits and technical and allocative efficiency illustrate that banks are performing quite well in their decisions regarding their sources. Evaluating this relationship is important as a manager's decision on deposits can influence the bank's lending quality and consequently any return or loss that may occur in the process of the money generation of the commercial banks. Similarly, this result can be

confirmed for capital (x_1). A positive result for the relationship between capital with technical, allocative, and cost efficiency illustrates that managers do have good control of capital allocation and on their costs as well.

The reported coefficient of the total off-balance sheet activities (y_3) is negative and indicates a decrease in the amount of off-balance sheet activities in the Turkish banks. Considering the volatile interest rate environment of Turkey, and the possible financial risks, such as interest-rate risks, it can be beneficial for Turkish banks to take advantage of off-balance sheet activities and to boost them (Segura and Zeng, 2020). In terms of undesirable outputs, NPLs (Y_5) are found to have a negative and statistically significant impact on all kinds of efficiency, and this is in line with the findings of Fukuyama and Matousek (2017) and Assaf *et al*. (2013).

This finding suggests that these outputs can directly influence the level of technical efficiency in a Turkish bank. Allocative and cost efficiency also performs inversely in response to a variation in NPLs. NPLs react negatively to changes in allocative and cost efficiency in Turkish banks, with a significance level of 0.14% and 0.17%, respectively. This being so, it can, perhaps, be concluded that the source of Turkish banks' inefficiency is related to all three kinds of inefficiency – technical, allocative, and cost. Considering these results and due to the unstable financial environment in Turkey, the importance of both outputs[17] should be considered, but neither should be given priority over the other.

Figures 3.1-3.3 map the distribution of the average technical, allocative and cost efficiency scores, organised by bank ownership type[18]. Generally, the three types of efficiency scores of all banks fluctuated considerably over the time horizon of this study. This is consistent with our findings relating to Turkey's economic and banking circumstances.

[17] Both off-balance-sheet activities and NPLs can influence the level of technical, allocative, and cost efficiencies in Turkish banks.
[18] Tables 3.4-3.6 represent the average technical, allocative, and cost efficiency scores per ownership.

Of the four types of bank ownership, there are sharp variations in both upward and downward trends of average technical efficiency. For instance, the scores of foreign banks dropped between September 2006 and early 2008. Surprisingly, all foreign, investment and private banks performed quite well at the beginning of 2008, while declines in technical efficiency can mainly be seen at the end of 2009 for foreign and investment banks. We find that state-owned banks are the least efficient type of bank, with an average technical efficiency of 4.8%. Investment and development banks appear to be the most efficient in Turkey, with approximately 71% technical efficiency. This could be due to their particular structure, which matches their mission and target in the sector, while it could also be due to their unique reactions to the same shocks in the market. Moreover, these banks do not focus on deposits, which makes them very different to other banks. Rather, they are dedicated to other activities such as offering corporate finance, mergers and acquisitions, and foreign exchange to customers, and providing governmental funds to various sectors of the economy (Etkin *et al*., 2000).

3.5.1. The determinants of bank efficiency

There is well-established empirical research that reveals the independent variables that characterise the financial aspects of banks, and are important in determining banks' efficiency (Fethi and Pasiouras, 2010). We investigate two novel determinants of efficiency, namely the gender and education of bank employees. No previous studies have attempted to study the impact of gender on Turkish banks' efficiency. Investigating gender and education is important because not only it could lead to improvements in management decisions, but also to bank performance. The current study investigates the determinants of bank efficiency by applying quantile regressions, which in the case of banking, is a technique that has been applied only recently (for example, Koutsomanoli-Filippaki *et al*., 2009). Of the various determinants that

have been analysed in the literature, some have been selected for investigation in the current study.

In the set of independent variables in our model, in order to control for leverage effect – the fact that the higher the leverage, the more volatile the return (Mamatzakis *et al.*, 2013) – we use the capital ratio, which is measured by dividing the total capital with the total amount of assets. Furthermore, we make use of the NIM, which is measured as net interest income compared to total deposits, and the NNIM, which is defined as net non-interest income compared to total assets (Fukuyama and Matousek, 2011). These two variables control for management quality. To account for specific bank characteristics, we chose to use the performance variable, which is represented by ROA, measured by dividing net income to total assets. Furthermore, this study considers two qualitative determinants, namely employee gender and education. To study the impact of these determinants, this study takes the ratio of total female to total male into consideration, which is represented by F/M. In addition to this ratio, the relationship between the education of an employee and different efficiencies is investigated by taking the ratio of total number of employees with postgraduate degrees to the total number of employees with undergraduate degrees and school certificates[19]. Following Fukuyama and Matousek (2011), we also include the age of a bank as a variable to investigate whether any meaningful relationship can be found between banks' efficiency and their years of operation in the market.

Quantile regression can be particularly advantageous in efficiency analysis studies, especially because this method is applicable when there is extensive heterogeneity in the data collected (Behr, 2010). Moreover, the applied conditional quantile is more robust against outliers and measures means of drawing different slope parameters that describe the production of the most efficient banks, rather than the less efficient ones. Furthermore, as Li *et al*. (2009)

[19] Due to lack of available data only details on all bank employees were collected from BAT during 2002-2017.

have discussed, although quantile regressions require an assumption about the functional form of the production function – which addresses any possible criticism of the use of DEA in the first part of this paper to estimate efficiency scores – it can be used without imposing a particular form on the distribution of the inefficiency terms. This method also yields the random error, which is another reason why DEA has been criticised.

A quantile regression is particularly useful when the conditional distribution is not standard, and its shape instead illustrates asymmetric, fat-tailed, or truncated distribution, making it suitable for our study. This being so, quantile regression has recently begun to be applied in various strands of the finance and banking literature, including banking risk regulation (Klomp and De Hann, 2012), herding behavior in stock markets (Chiang *et al*., 2010), capital structure (Fattouh *et al*., 2005), bankruptcy prediction (Li and Miu, 2010), ownership and profitability (Li *et al*., 2009), and the relationship between stock price index and exchange rates (Tsai, 2012). In the context of our study, a quantile analysis is an ideal way to examine efficiency determinants and bank efficiency heterogeneity. It differs from conditional mean models because it enables efficient or almost efficient banks to apply production relations that may vary from average or inefficient banks by providing the most appropriate benchmark within the chosen quantile (Chen, 2005).

We compute technical, allocative, and cost efficiency scores, considering NPLs as a bad output, for each bank in our sample using the unique DEA model applied by Aparicio *et al*. (2015), and comparing these scores across different quantiles and different types of ownerships. We apply the quantile regression. In order to include as wide a range of quantiles as possible, we run regressions for quantiles 0.1, 0.25, 0.5, 0.75, and 0.90. Following Demir *et al*. (2020), the quantile regression can be represented in the following form:

$$\min \sum_{i\in\{i:y_i\geq x_i'\alpha\}} \alpha|y_i - x_i'\Omega \left| \sum_{i\in\{i:y_i\geq x_i'\alpha\}} 1-\alpha|y_i - x_i'\Omega \right. \quad (3.19)$$

Tables 3.7.1-3.7.3 contain estimates of the impact of selected determinants on technical, allocative, and cost efficiency. The coefficient of the capital ratio is positive and statistically significant, which implies a positive relationship between the capital ratio and all three kinds of efficiency – technical, allocative, and cost. Moreover, the NIM coefficient for all kinds of efficiency is positive and statistically significant, which ignores any misuse of deposits to produce loans and securities in Turkish banks. Unlike NIM, the NNIM coefficients are negative for all three kinds of efficiency, which indicates that banks are suffering from bad management and are unable to effectively control non-interest income. Since NIM and NNIM represent the profitability of a bank, finding them statistically significant with positive and negative signs, respectively, shows that Turkish banks generate profit mainly from their interest sources (for example, deposits) rather than their non-interest activity sources. Detecting this fact emphasizes the importance of reducing the NPLs ratio in Turkish banks.

We also evaluate the correlation coefficient between the obtained scores for each efficiency types and ROA across different quantiles, while the subsequent positive and statistically significant coefficient corresponds to the findings of other empirical studies (Fukuyama and Matousek, 2011; Isik and Hassan, 2003a), indicating that more efficient banks also perform better compared to less efficient banks. When analysing the impact of the age of a bank on the efficiency scores, this study finds that older banks are more efficient, which could be due to experience and customer trust, and because they have adjusted to new technologies more effectively than more recently founded banks.

Moreover, we find that less educated employees can negatively influence all types of efficiency, while more educated employees have the opposite effect. Figure 3.13 demonstrates that in state-owned and private banks, the ratio of employees with postgraduate degrees to other employees with lower degrees is reducing. Evaluating the trend of changes in hiring employees with different levels of education for all different ownerships (represented in figure 3.13) shows

that the number of more educated employees declines in general. For instance, investment banks have been hiring more employees with undergraduate or higher school degrees since 2013. However, state-owned and private banks are hiring more employees with higher school degrees. Foreign banks, on the other hand, have stated to hire fewer employees with both postgraduate and undergraduate degrees. They do not show any significant differences in hiring employees with high school degrees. It is worth mentioning that investment, state-owned, and private banks do have more employees with undergraduate degrees comparing to foreign ownership. More employees with postgraduate degrees can be seen in the foreign banks.

Furthermore, this paper evaluates the relationship between an employee's gender and efficiency. Our results confirm that employee gender does influence efficiency. Figure 3.14 represents the ratio of female to male in Turkish banks. It is interesting to see that since 2014 the number of females has been decreasing compared to the number of male employees in Turkish banks. Before 2014 this ratio was in flux. Some ownerships, like state-owned banks, have fewer female employees. As figure 3.14 illustrates, the slope of the graph for all four types of ownerships is downward. Some ownerships, for example, foreign, represent more fluctuations. However, this does not alter the fact that there are fewer female employees in Turkish banks than there are male employees. This is an important finding, which focuses on the fact that a greater degree of gender equality in Turkish banks can improve the different efficiency scores. More gender diversity could influence the management culture and could optimise the labour resources in the banks. Unfortunately, we cannot find information about the education levels of different genders. It would be interesting to investigate the differences in education level and gender. This can be considered as a future topic for study.

Moreover, figures 3.4-3.6 reveal technical, allocative, and cost efficiency scores across quantiles. There are three interesting findings to evaluate here: First, there is considerable variation across quantiles. Second, technical, allocative, and cost efficiency estimates across

quantiles, and especially in the tail of the distribution, vary noticeably from the conditional mean (OLS) point estimate of efficiency, which is approximated by quantile 0.5, and equals 0.1525, 0.9917, and 0.6924, respectively. This being so, the quantile regression analysis provides more inclusive results of the fundamental range of inequalities in all three types of efficiency than the OLS estimation. Third, all three different types of efficiency monotonically increase as they follow a positive trend at the higher order of quantiles.

Figures 3.7-3.9 present a disaggregation of the estimated technical, allocative, and cost efficiency in different types of ownerships in Turkish banks. Regarding technical efficiency, first, this disaggregation confirms the aforementioned trend of technical efficiency in different quantiles, in that it increases in higher quantiles, irrespective of the level of technical efficiencies for each type of ownership and in each quantile. Second, it illustrates some variability in the underlying relationship between ownership types and technical efficiency; in other words, the influence of different types of ownership on technical efficiency can also be confirmed by quantile regression. For instance, a higher technical efficiency is generally reported in investment banks, compared to other banks.

Moreover, we observe that the largest banks, which are state-owned and private banks, respectively, show lower technical efficiency scores in lower quantiles, and higher technical efficiency scores at higher quantiles. This shows that conducting a simple OLS mean regression analysis would result in a loss of valuable information regarding a bank's performance across the world. Finally, the technical efficiency of investment and development banks is always higher than other bank types in various quantiles, and this result is robust. In Turkey, the most efficient banks are foreign banks. This suggests that the reform programmes for private and state-owned banks put in place since 2001 could have been more advanced and better designed, and thereby more able to improve the bank's performance.

Evaluating allocative and cost efficiency, on the other hand, shows that state-owned banks represent higher scores in allocative and cost efficiency across all quantiles compared to the other banks. After state-owned banks, investment banks represent the highest score in allocative efficiency across all quantiles. The allocative and cost efficiency for all the four types of efficiency improves in the higher quantiles. It is also interesting to note that the private banks reflect a better score in allocative and cost efficiencies in almost all quantiles compared to the foreign banks in Turkey.

It is worth mentioning that the results obtained for this study regarding technical efficiency are similar to those results in other pieces of research. For instance, Badunenko and Kumbhakar (2017) investigated different ownership types of Indian banks from 1992 to 2009. In particular, they controlled for bank-heterogeneity in estimating the cost structure and efficiency. Their results suggest banks of all ownership types have benefited from technical efficiency improvements but that foreign banks have benefited to a greater degree. A later piece of research by Dong *et al*. (2016) evaluated the performance of Chinese banks from 2002 until 2013 considering different types of bank. They used two different efficiencies (cost and profit) for their study. Their findings illustrate that foreign banks are more cost efficient but less profit efficient. According to their findings the profit efficiency gap increased between foreign and domestic banks after the WTO transition period from 2007 to 2013. Tzeremes (2015) studied Indian banks between 2004 and 2012 using conditional and unconditional directional distance models. He also concluded that foreign banks perform better compared to domestic and national banks. Lin and Zhang (2009) investigated a panel of Chinese banks from 1997 until 2004 to investigate the impact of bank ownership and its performance. Their results show that state-owned banks are less profitable and less efficient than other types of ownerships.

3.5.2. Further Analysis

To provide more details and undertake more analysis, this thesis takes two main approaches. Initially, following the same methods and approaches, we assumed various hypotheses. First, we split the sample into pre and post 2008 financial crisis and investigate for any changes in the efficiency determinants and performance of Turkish banks. Splitting the data to pre and post crisis enables us to thoroughly track the impact of the crisis on the efficiency determinants. Before the financial crisis in 2008, Turkey was struggling to return to stability in its financial market and banking sector. NPLs in different Turkish bank ownership decreased after imposing structural changes. However, this ratio fluctuates or increases after the 2008 financial crisis. Although the ratio was constant for a period in 2012, the 2016 political crisis meant that Turkish banks experienced an increase in these undesirable loans. When studying the relationship between technical, allocative, and cost efficiency along with other efficiency determinants, for both pre and post 2008 financial crisis, this study finds the same behaviour as discussed in section 3.4.

The second hypothesis categorises Turkish banks based on their size in order to analyse any emerging patterns between the size of the banks under different ownerships and the level of efficiency in Turkish banks. Following Isik and Hassan (2002 and 2003a, 2003b) we categorised bank size according to total amount of assets. If the total assets stand at less than 100 million dollars, we categorise them in a small group (Small < 100). Total assets of between 100 and 1000 million dollars belong in the medium group (100 ≤ Medium <1000). Finally, if the total assets are more than 1000 million dollars, the bank is classed as large (large ≤1000). This investigation provides more in-depth information with which to evaluate the Turkish banks. The results show that the smaller banks, which are mainly foreign banks, represent higher technical efficiency in comparison to the larger banks which are mostly state-owned.

This result emphasises the fact that restructuring plans should be continued to strengthen the state-owned and private banks in Turkey.

This study also evaluates the banks risk using *Z*-score. Following Fiordelisi and Mare (2014), we calculate *Z*-score as the sum of CAR and ROA divided by standard deviation of ROA ($\sigma(ROA_{c,t})$). The risk in a bank is important since the main target of the banks is not only to maximise their good outputs from the optimal levels of inputs but also to manage their risk level. It is also crucial to check the impact of risk on a bank's behaviour and management. More efficient banks may represent a poorer management of their NPLs as they believe that due to their high efficiency scores they should exert less control over loans, collateral evaluations, and borrower conditions (Mester, 1997). A higher figure of volatility of *Z*-score indicates lower risks in Turkish banks.

Tables 3.8.1-3.8.9 indicate all the results for further analysis. Our findings for further analysis are along the same lines as our previous findings and confirm that: 1) more efficient banks represent higher capital ratios 2) the "bad management" hypothesis in Turkish banks 3) the negative sign for NNIM shows managers do not optimise their non-interest incomes 4) the older banks are the most efficient ones 5) hiring more educated employees enhances all three kinds of efficiency in Turkish banks and finally 6) having more gender diversification and hiring more females can improve different types of efficiency in Turkish banks. Moreover, by adding risk measure we found that there is a negative relationship between efficiency and *Z*-score in Turkish banks. Additionally, all the state-owned banks and the majority of private banks, which are the main source of technical inefficiency over the study's time horizon, are categorised as large.

3.5.3. Robustness check

To do the robustness check, we run a parametric method to measure technical, allocative, and cost efficiency for Turkish banks from 2002 to 2017. To do this, in this section we measure

the efficiency scores using the translog enhanced hyperbolic distance function, which is proposed by Cuesta *et al*. (2009). The reason why this study applies the Cuesta *et al*. (2009) method is that we are interested in comparing the efficiency scores from a parametric method with our initial scores obtained from a non-parametric method. The translog enhanced hyperbolic distance function enables us to keep our main contribution, namely to consider the impact of NPLs as undesirable outputs. It also lets us expand the desirable outputs whilst cutting the input and undesirable outputs. Mamatzakis *et al*. (2016) also use this method to measure Japanese banks' efficiency considering two undesirable outputs, namely NPLs and problem earning assets. Hence, the aim of running this method is to check the robustness of our initial findings on the three types of efficiency using the modified DEA, used by Aparicio *et al*. (2015). Hence, not only will the efficiency scores be measured and evaluated against ownership but we will also examine the impact of bank-specific characteristics on the efficiency scores that are computed using the model of Cuesta *et al*. (2009).

The function of the enhanced hyperbolic distance function can be represented as:

$$D(x, y, b) = \inf\{\emptyset > 0 : (x\emptyset, y / \emptyset, b\emptyset) \tag{3.19}$$

In this method, we represent the input vector as $x_i = (x_{1i}, x_{2i}, \ldots, x_{ki}) \in R_+^K$, desirable output vector as $y_i = (y_{1i}, y_{2i}, \ldots, y_{mi}) \in R_+^M$, and the vector for undesirable outputs as $b_i = (b_{1i}, b_{2i}, \ldots, b_{ki}) \in R_+^R$.

Accordingly, technology T illustrates the production possibility set as;

$$T = \{(x, y, b): x \in R_+^K, (y, b) \in R_+^P, x \; can \; produce \; (y, b)\}. \tag{3.20}$$

Hence, R_+^P represents the set of all $u = (y, b)$ outputs vectors that are obtainable from x. Subscript $i = (1,2, \ldots, N)$ shows a set of all observed producer, which means all the banks that generate both desirable and undesirable outputs. Equation (3.19) represents a simultaneous

expansion of desirable outputs y and reduction of inputs x and undesirable output b by generating a hyperbolic path. If $D\ (X, Y, B) = 1$, the production of the observed figures would be the same as frontier production, which shows efficiency. Hence, if $D\ (x, y, b) < 1$, the producer (banks in this case) are performing inefficiently should improve their performance by enhancing the desirable outputs or reducing the undesirable outputs.

Imposing a translog specification for $D\ (x, y, b)$, we achieve;

$$In\ D = \alpha_0 + \sum_{k=1}^{K} \alpha_k \ln x_{ki} + \sum_{m=1}^{M} \beta_m \ln y_{mi} + \sum_{r=1}^{R} \chi_r \ln b_{ri} + 1/2 \sum_{k=1}^{K} \sum_{l=1}^{K} \alpha_{kl} \ln x_{ki} \ln x_{li} + 2 \sum_{m=1}^{M} \sum_{n=1}^{M} \beta_{mn} \ln y_{mi} \ln y_{ni} + 1/2 \sum_{r=1}^{R} \sum_{s=1}^{R} \chi_{rs} \ln b_{ri} \ln b_{si} + \sum_{k=1}^{K} \sum_{m=1}^{M} \delta_{km} \ln x_{ki} \ln y_{mi} + \sum_{k=1}^{K} \sum_{r=1}^{R} \gamma_{kr} \ln x_{ki} \ln b_{ri} + \sum_{m=1}^{M} \sum_{r=1}^{R} \eta_{mr} \ln y_{mi} \ln b_{ri} \quad (3.21)$$

Applying the homogeneity condition and selecting the Mth desirable output for the purpose of normalising $\mu = 1/y_M$, we can get:

$$D\left(xy_M, \frac{y}{y_M}, by_M\right) = \frac{D(x, y, b)}{y_M} \quad (3.21)$$

With $x_{ki}^* = x_{ki} * y_{Mi} y_{mi}^* = \frac{y_{mi}}{Y_{Mi}, b_{ri}^*} = b_{ri} * y_{Mi}$. Hence the translog function would be presented as;

$$In\ (D/y_{Mi}) = \alpha_0 + \sum_{k=1}^{K} \alpha_k \ln x_{ki}^* + \sum_{m=1}^{M-1} \beta_m \ln y_{mi}^* + \sum_{r=1}^{R} \chi_r \ln b_{ri}^* + 1/2 \sum_{k=1}^{K} \sum_{l=1}^{K} \alpha_{kl} \ln x_{ki}^* \ln x$$
$$1/2 \sum_{m=1}^{M-1} \sum_{n=1}^{M-1} \beta_{mn} \ln y_{mi}^* \ln y_{ni}^* + 1/2 \sum_{r=1}^{R} \sum_{s=1}^{R} \chi_{rs} \ln b_{ri}^* \ln b_{si}^* + \sum_{k=1}^{K} \sum_{m=1}^{M-1} \delta_{km} \ln x_{ki}^* \ln y_{mi}^* + \quad (3.22)$$
$$\sum_{k=1}^{K} \sum_{r=1}^{R} \gamma_{kr} \ln x_{ki}^* \ln b_{ri}^* + \sum_{m=1}^{M-1} \sum_{r=1}^{R} \eta_{mr} \ln y_{mi}^* \ln b_{ri}^*$$

The above formula can be written as;

$$\ln(D/y_{Mit}) = TL\ (x_{it}^*, y_{it}^*, b_{it}^*; \alpha, \beta, \chi, \delta, \gamma, \eta) + v_{it} \quad i = (1,2, \ldots., N) \quad (3.23)$$

Since ln D responses for the one-sided distance component u_i, we can rearrange the above formula to:

$$-\ln(y_{Mit}) = TL\,(x^*_{it}, y^*_{it}, b^*_{it}; \alpha, \beta, \chi, \delta, \gamma, \eta) + \nu_{it} - u_{it} \;\; i = (1,2,\ldots.,N) \tag{3.24}$$

Where $-\ln(y_{Mit})$ represents the log of the Mth desirable output, ν_{it} represents the stochastic error, which follows the normal distribution, and u_{it} is the inefficiency term.

The SFA provides the opportunity to divide the random error term, ε_{it} into two components. One is two-sided random error, and the other is one-sided inefficiency term, which represents the inefficiency scores. We assume that inefficiency follows half normal distribution $N(0, \sigma_u^2)$.

The results obtained from measuring the technical, allocative, and cost efficiency using the translog enhanced hyperbolic distance function are represented in Tables 3.12.1-3.14.1. These results confirm our initial findings, namely that investment banks reflect the highest technical efficiency compared to the other types of ownership in Turkey. Moreover, foreign banks in Turkey perform better compared to state-owned and private banks. The state-owned banks, although representing poor technical efficiency scores, perform better in the case of allocative and cost efficiency. Although there is a fluctuation in the efficiency scores for all banks in Turkey between 2002 and 2017, the total efficiency of Turkish banks declined after 2010. The results from evaluating the impact of bank-specific characteristics on the efficiency scores that we calculated from running the translog enhanced hyperbolic distance function are represented in Table 3.11.1. We find that NPLs negatively influence the technical, allocative, and cost efficiencies with a coefficient of -0.0042, -0.0081, and -0.0026, respectively. The negative coefficient of off-balance sheet activities with technical, allocative, and cost efficiency, which are 0.0071, -0.0095, and -0.0039, respectively also confirms our initial results and emphasises the importance of this bank's output. Our results also illustrate the positive impact of the Turkish banks efficiency with other banks' desirable outputs, including total loan and receivables, net securities, and net non-interest income, and inputs, including deposit and capital.

3.6. Conclusion

Over the last three decades, Turkey has experienced periods of boom and bust in its banking sector. After the financial crisis of 2000-2001, the CBT along with the IMF implemented some important restructuring programmes to strengthen and improve the banking sector since it makes up a majority of the Turkish financial economy. The result of imposing these programmes was a significant improvement in the performance of Turkish banks. Reviewing the Turkish banking literature highlights some key gaps in this area. For instance, the impact of NPLs only has only been researched by Assaf *et al*. (2013). They have analysed the impact of NPLs on bank efficiency and productivity. Their results support the negative impact of NPLs on Turkish banks' efficiency scores.

Consequently, the main contribution of this paper is to compute the technical, allocative, and cost efficiency of Turkish banks giving particular attention to the impact of NPLs. To measure three different kinds of efficiency, this study applies a modified DEA model, as initially used by Aparicio *et al*. (2015). This model uses an exogenous vector for the undesirable output, while the assumption of the underlying technology is non-homothetic. This model eliminates the inconsistencies of the traditional DEA model (Chung *et al*., 1997) and thereby allows us to distinguish the vectors for undesirable outputs (NPLs in our study) from desirable ones, like total loan and receivables, net securities, non-interest income, and off-balance sheet activities. Furthermore, by applying this method, we can distinguish between inefficiency and random errors.

This study also contributes to the current literature by considering two additional efficiency determinants in Turkish banks, namely employee gender and their education. These two additional efficiency determinants along with all other efficiency determinants, including NIM, NNIM, capital ratio, age, and ROA, are going to be evaluated using quantile regression. We also looked at quarterly data over a long period of time (2002 to 2017) and thereby

comprehensively analysed variations in Turkish banks' efficiency, and their response to local and global financial crises. All qualitative and quantitative data is collected from BAT.

Our results indicate that although efficiency improved after the financial crisis of 2001, Turkish banks' efficiency remains rather low, with a mean technical efficiency level of 0.3018. This average is found to be better for the allocative and cost efficiency as they are 0.8796 and 0.6453, respectively. Furthermore, after the global financial crisis of 2008, there was another slight upward trend in all kinds of efficiency, indicating that although Turkish banks do not seem to have fully revived, they managed their risks and performed unexpectedly well. However, this upturn in performance did not continue for long period of time. Many Turkish banks experienced fluctuations in all kinds of efficiency, and mainly in their technical efficiency since 2009. Moreover, it is evident that the rate of NPLs have significantly fluctuated since December 2011, across the three main ownership structures, including foreign, private, and state-owned banks. Our analysis indicates that only investment and development banks have been able to successfully control and reduce their NPLs ratios. In terms of the total loans and receivables, which is another desirable output, Turkish banks should take more steps to monitor them in the proper manner. An increase in the rate of NPLs in the majority of banks could be attributed to a lack of control around these loans and receivables.

The other important contribution of this paper is to evaluate the efficiency determinants using the quantile regression. Quantile regression is a flexible method for panel data, to evaluate the impact of efficiency determinants during a particular time horizon. The results obtained from running a quantile regression on the selected determinants confirm that the coefficients of capital ratios are statistically significant for all three types of efficiency. Hence, banks with higher capital ratios are more effective in allocating credit, and in general in the production process. In other words, the more capital to which banks have access, the higher their efficiency score. The NIM coefficient is positive and statistically significant for all types

of efficiency. Thus, it ignores the potential issue of the misuse of deposits in Turkish banks to produce loans and securities. Unlike NIM, the NNIM coefficient is negative for all efficiency types, which suggests that banks suffer from bad management strategy for their non-interest income courses. Furthermore, the positive and statistically significant coefficient of the ROA corresponds with the findings of other empirical studies (for example, Assaf *et al*. 2013; Fukuyama and Matousek, 2011). It shows that banks with higher efficiency scores are more profitable as well.

In addition, our study finds a positive and statistically significant relationship between the age of a bank and all types of efficiency confirming the fact that older banks are performing more effectively.

Moreover, our study reports an interesting result about employee gender and education and their relationship with the efficiency of Turkish banks. This study confirms the positive relationship between education and all kinds of efficiency. This is important because Turkish banks have started to hire less educated employees during recent years. Our results also confirm the positive impact of gender diversity on bank efficiency. The collected data shows that the number of male employees in all types of bank is greater than female employees. Overall, this ratio represents a downward slope for all banks in Turkey, although there is some fluctuation for some types of ownership, like foreign banks. Considering all the theories, including resource dependency, human capital, social psychological, and agency theories that have been discussed in the literature regarding the diversity in the banks, improving diversity in general and gender diversity in particular, can improve a bank's performance. This is because diversity provides greater knowledge levels, different perspectives, varied management structures, a variety of disciplines, and more financial sources.

We further analyse the impact of ownership on efficiency scores. Our results show that foreign banks in Turkey can be said to represent higher scores for technical efficiency

compared to state-owned and private banks. This study is also in-line with the findings of Isik and Hassan (2003a) and Fukuyama and Matousek (2011), namely that foreign banks operating in Turkey are more efficient than their domestic counterparts. Our paper reveals that the most stable banks in Turkey, which fluctuate the least in the case of technical efficiency, are investment banks. While evaluating allocative and cost efficiency, our results show that state-owned banks are doing fairly well in comparison to the other types of ownership. Regarding the impact of undesirable outputs, NPLs have a greater impact on estimations of technical efficiency than on allocative and cost efficiency. Evaluating three different kinds of efficiency across different ownership provides us some useful information. State-owned banks in particular reflect the highest NPLs ratio and the lowest technical efficiency scores. They are the largest banks in Turkey and have the greatest impact on the whole economy. There are only three state-owned banks in our sample. They also appear to be among the oldest ones. Since they have a high proportion of total assets and strong support from the Turkish government, they appear less cautious about their management strategies and decisions. We can also confirm that the other types ownerships perform better and have larger reserves to cope with potential NPLs. Hence, their technical efficiency is higher.

To provide more details, we did some further studies. Initially, we split the sample to pre and post 2008 financial crisis and examined the efficiency determinants and performance of Turkish banks in these two time periods. Next, we categorised Turkish banks on the basis of size. Lastly, we applied an alternative measure of bank risk which is the *Z*-score. Tables 3.8.1-3.8.9 illustrate the results of our further analysis. These findings confirm that more efficient banks represent higher capital ratios and state that negative sign for NNIM is a signal of wasting the non-interest incomes. Furthermore, these findings confirm that the older banks are the most efficient ones. Also, there is a positive impact across all types of efficiency to be gained from hiring more educated employees. Moreover, we find that gender diversity can improve

efficiency scores. We also categorised banks on the basis of size. Our results show that large banks represent the lowest level of technical efficiency. Investigating further, we found that all state-owned banks and most private banks belong in the 'large' category. Lastly, when we applied the risk measure, we found a negative relationship between efficiency and the *Z*-score in Turkish banks.

We also ran a translog enhanced hyperbolic distance function, following on from Cuesta *et al*. (2009), which is a parametric method to check the robustness of our efficiency scores. This method enables us to expand our desirable outputs at the same time as cutting our undesirable outputs and inputs. It also helps us to distinguish random error from inefficiency. We measure technical, allocative, and cost efficiency by imposing this parametric method. The efficiency scores from running this method confirm our initial finding from a non-parametric method. The average technical efficiency in the foreign banks is higher than state-owned and private banks in Turkey. Running OLS to check the relationship between bank-specific factors and the aforementioned efficiencies also confirms a negative impact of NPLs on the three types of efficiency. In addition, our results also emphasise the importance of improving off-balance sheet activities in Turkish banks.

Our analysis provides suitable directions for regulators and supervisors to evaluate the financial stability of banks. The presence of banks with a riskier portfolio involving a higher level of NPLs can diminish the efficiency level of the Turkish banking system as a whole. This being so, regulators need to sensibly supervise and manage the level of risk in commercial banks, as well as their loan issuance process. Additionally, our findings indicate that drastic regulatory procedures should be implemented to maintain and improve banks' financial stability, reducing their risk of default and improving their performance.

List of tables and graphs:

Table.1.1. List of Currently Operating Banks in Turkey

1	Adabank A.Ş.	Privately-owned Banks	1985
2	Akbank T.A.Ş.	Privately-owned Banks	1948
3	Aktif Yatırım Bankası A.Ş.	Development and Investment Banks	1999
4	Alternatifbank A.Ş	Foreign Banks	1992
5	Anadolubank A.Ş	Privately-owned Banks	1996
6	Arap Türk Bankası A.Ş	Foreign Banks	1977
7	Bank Mellat	Foreign Banks	1982
8	Bank of Tokyo-Mitsubishi UFJ Turkey A.Ş.	Foreign Banks	2013
9	BankPozitif Kredi ve Kalkınma Bankası A.Ş	Development and Investment Banks	1999
10	Birleşik Fon Bankası A.Ş.	Banks Under Depo. Insurance Fund	1958
11	Burgan Bank A.Ş.	Foreign Banks	1992
12	Citibank A.Ş.	Foreign Banks	1981
13	Denizbank A.Ş	Foreign Banks	1997
14	Deutsche Bank A.Ş.	Foreign Banks	1988
15	Diler Yatırım Bankası A.Ş	Development and Investment Banks	1998
16	Fibabanka A.Ş.	Privately-owned Banks	1984
17	Finans Bank A.Ş.	Foreign Banks	1987
18	Habib Bank Limited	Foreign Banks	1983
19	HSBC Bank A.Ş.	Foreign Banks	1990
20	ICBC Turkey Bank A.Ş.	Foreign Banks	1986
21	Intesa Sanpaolo S.p.A.	Foreign Banks	2013
22	İller Bankası A.Ş	Development and Investment Banks	1933
23	İstanbul Takas ve Saklama Bankası A.Ş.	Development and Investment Banks	1995
24	Merrill Lynch Yatırım Bank A.Ş.	Development and Investment Banks	1992
25	Nurol Yatırım Bankası A.Ş.	Development and Investment Banks	1999
26	Pasha Yatırım Bankası A.Ş.	Development and Investment Banks	1987
27	Rabobank A.Ş.	Foreign Banks	2013
28	Société Générale (SA)	Foreign Banks	1999
29	Standard Chartered Yatırım Bankası Türk A.Ş.	Development and Investment Banks	1990
30	Şekerbank T.A.Ş.	Privately-owned Banks	1953
31	Tekstil Bankası A.Ş.	Foreign Banks	1986
32	The Royal Bank of Scotland Plc	Foreign Banks	1921
33	Turkish Bank A.Ş.	Privately-owned Banks	1991
34	Turkland Bank A.Ş.	Foreign Banks	1986
35	Türk Ekonomi Bankası A.Ş.	Privately-owned Banks	1927
36	Türk Eximbank	Development and Investment Banks	1987
37	Türkiye Cumhuriyeti Ziraat Bankası A.Ş	State-owned Banks	1863
38	Türkiye Garanti Bankası A.Ş	Privately-owned Banks	1946
39	Türkiye Halk Bankası A.Ş.	State-owned Banks	1938
40	Türkiye İş Bankası A.Ş	Privately-owned Banks	1924
41	Türkiye Kalkınma Bankası A.Ş	Development and Investment Banks	1975
42	Türkiye Sınai Kalkınma Bankası A.Ş.	Development and Investment Banks	1950
43	Türkiye Vakıflar Bankası T.A.O	State-owned Banks	1954
44	Yapı ve Kredi Bankası A.Ş.	Privately-owned Banks	1944

Note1. The above table represents all the available Turkish banks in our sample along wirg their ownership types and their year of foundation

Table.3.1. Input and Output Definition

x_1	Capital	Capital
x_2	Deposit	Total Deposit
y_1	Loans and Receivables	Total Loans and Receivables
y_2	Total Securities	"Securities" name was changed as "Financial Assets" at the end of 2002.
y_3	Total Off-balance sheet activities	Off-Balance Sheet Activities
y_4	Non-interest income	The total of "Net Fees and Commissions Income/Expenses", "Dividend Income", "Net Trading Profit and Loss", "Other Operating Income" after 2002.
y_5	Non-performing loans	Non-performing Loans" name was changed to "Loans Under Follow-up".
Px_1	Price of Capital	Total operating expenses/Total fixed assets
Px_2	Price of Deposit	Interested expenses on deposit/ Total deposit
Py_1	Price of Loan and Receivables	Total net income/expenses/Total loan and receivables
Py_2	Price of Securities	Total other operating expenses/Total securities
Py_4	Price of NPLs	Total net income/expenses/Total NPLs

Note1. The above table illustrates the variables definitions. X_n represents two main inputs including capital and deposit while y_n illustrate all of the desirable and undesirable outputs. P_x and P_y represents the price of inputs and output to compute for the Allocative efficiency.

Table.3.2. Descriptive Statistics (Mil US. $)

Variable	Mean	Std. Dev.	Min	Max	Obs.
Capital	45.523	82.387	3.623	1169.25	2,575
Deposit	10550.7	16938.73	0.029	83107.24	1,843
Total Loans & Receivables	7461.004	14247.92	0.043	79073.68	2,468
Net Securities	3160.268	7029.979	0.672	50050.32	2,520
Off-Balance Sheet Activities	108527.3	593430.1	0.439	1.2000	2,571
NPLs	266.142	461.196	0.0637	2612.399	2,340
Non-Interest Income	136.861	298.916	-70.966	2514.196	2.682
Price of Capital	4.512	49.204	47.955	826.095	2,416
Price of Deposit	0.054	0.202	0.056	5.697	1,805
Price of Total Loans & Receivables	3.046	57.252	39.6	2378	2,248
Price of Securities	16.104	313.358	0.0415	1225	2,356
Price of NPLs	583.883	9528	74.466	2614	2,136

Note1. The above table represents descriptive statistics with the number of observations for each variable. Capital and deposit are the two inputs. Total loan and receivables, net securities, total off-balance sheet activities, and non-interest income are the main desirable outputs. NPLs is the undesirable output. All variables are in denominated in millions of US dollars.

Table.3.3. Technical, Allocative and Cost Efficiency Elasticities-OLS

Model	**OLS**	**OLS**	**OLS**
Dependent Variable	**TE**	**AL**	**CE**
Capital	0.0018**	0.0025**	0.0071*
	(0.0002)	(0.0002)	(0.0002)
Deposit	0.0012**	0.0067***	0.0093*
	(0.0004)	(0.0002)	(0.0003)
Loan and Receivables	0.0044**	0.0056*	0.0059*
	(0.0003)	(0.0001)	(0.0002)
Total Securities	0.0051*	0.0048**	0.0021**
	(0.0004)	(0.0003)	(0.0003)
Total Off-Balance Sheet Activities	-0.0031***	-0.0013***	-0.0022**
	(0.0001)	(0.0008)	(0.0001)
Non-interest income	0.0062*	0.0039**	0.0029**
	(0.0002)	(0.0002)	(0.0002)
Non-Performing Loans (NPLs)	-0.0075***	-0.0014***	-0.0017***
	(0.0003)	(0.0002)	(0.0002)
Price of Capital	0.0067*	0.0018**	0.0061*
	(0.0004)	(0.0003)	(0.0006)
Price of Deposit	0.0653*	0.0376**	0.0662*
	(0.1789)	(0.0779)	(0.0985)
Price of Loan and Receivables	0.0129**	0.0143**	0.0043**
	(0.0027)	(0.0023)	(0.0029)
Price of Securities	0.0134**	0.0031**	0.0081*
	(0.0035)	(0.0035)	(0.0043)
Price of NPLs	0.0024**	0.0002***	0.0005***
	(0.0001)	(0.0001)	(0.0002)
Constant	0.1829	0.8577	0.5187
	(0.0131)	(0.0096)	(0.0134)
R^2	0.2950	0.2834	0.2232
P-value (*F* –test)	0	0	0

Note1. The above table represents the elasticities of the inputs and both desirable and undesirable outputs for all Technical (TE), Allocative (AL), and Cost efficiency (CE). There is a significant relation between all bank-specific characteristics and all kinds of efficiencies. Off-Balance Sheet activities and NPLs negatively influence on the banks' efficiency. Standard errors in parentheses, ***p<0.001, **p<0.05, *<0.1.

Table.3.4. Technical Efficiency Scores per Ownership

Ownership Type	Private Banks		Foreign Banks		Investment & Development Banks		State-owned	
Year	Mean	Std.	Mean	Std.	Mean	Std.	Mean	Std.
2002	0.2913	0.6341	0.5801	0.5809	0.7223	0.3601	0.0401	0.0212
2003	0.3554	0.2803	0.3001	0.3355	0.6816	0.3456	0.0512	0.0278
2004	0.1312	0.1413	0.2312	0.3987	0.6771	0.3523	0.0311	0.0167
2005	0.1782	0.0945	0.2102	0.2211	0.5914	0.4214	0.0046	0.0032
2006	0.1356	0.0633	0.2933	0.3168	0.7223	0.3765	0.0102	0.0198
2007	0.1501	0.1809	0.2945	0.2946	0.5767	0.3109	0.0021	0.0024
2008	0.1204	0.1013	0.2617	0.3603	0.4567	0.3971	0.0271	0.0267
2009	0.1701	0.2214	0.2887	0.2656	0.4778	0.3678	0.0298	0.0299
2010	0.2467	0.2776	0.2865	0.3212	0.4513	0.3434	0.0187	0.0123
2011	0.1387	0.1589	0.2253	0.1963	0.3678	0.3723	0.0043	0.0057
2012	0.0709	0.1545	0.2546	0.2413	0.3255	0.3388	0.0126	0.0155
2013	0.2255	0.1203	0.2325	0.3017	0.3782	0.3509	0.0024	0.0049
2014	0.1634	0.2341	0.1703	0.2147	0.3109	0.3206	0.0266	0.0123
2015	0.1367	0.2087	0.2567	0.3101	0.3911	0.3517	0.0112	0.0143
2016	0.1102	0.1917	0.2834	0.3503	0.4321	0.3556	0.0028	0.0012
2017	0.1278	0.2221	0.2705	0.3648	0.3109	0.2823	0.0029	0.0021

Note1. The average of Mean and Std. for each year on the basis of quarterly data have been calculated in order to provide a legible table which is presenting technical efficiency measures per ownership.

Table.3.5. Allocative Efficiency Scores per Ownership

Ownership Type	Private Banks		Foreign Banks		Investment & Development Banks		State-owned	
Year	Mean	Std.	Mean	Std.	Mean	Std.	Mean	Std.
2002	0.8211	0.4601	0.7412	0.2917	0.9812	0.0321	1	1
2003	0.8215	0.3121	0.6744	0.3412	0.9909	0.0333	0.9851	0.0113
2004	0.8343	0.2334	0.6356	0.3255	0.9841	0.0356	0.9964	0.0031
2005	0.8716	0.1778	0.7108	0.2967	0.9954	0.0209	0.0021	0.0023
2006	0.8719	0.2345	0.7477	0.2688	0.9967	0.0112	0.9804	0.0055
2007	0.9111	0.1389	0.8219	0.2301	0.9978	0.0145	0.9895	0.0045
2008	0.9245	0.1756	0.8814	0.1867	0.9808	0.0507	0.9882	0.0001
2009	0.8912	0.2443	0.8846	0.1534	0.9823	0.0456	0.9946	0.0036
2010	0.8861	0.2498	0.9401	0.159	0.9962	0.0229	0.9862	0.0066
2011	0.8667	0.2612	0.9523	0.1598	0.9934	0.0267	0.9754	0.0153
2012	0.8901	0.2707	0.9317	0.1404	0.9782	0.0845	0.9803	0.0149
2013	0.9354	0.1534	0.9023	0.1767	0.9961	0.0245	0.9951	0.0077
2014	0.9277	0.1766	0.8901	0.1612	0.9904	0.0176	0.9896	0.0104
2015	0.9212	0.2012	0.8723	0.1919	0.9812	0.0489	0.9982	0.0022
2016	0.9256	0.2134	0.8809	0.2205	1	0.0909	0.9887	0.0096
2017	0.9409	0.1255	0.8544	0.2911	0.98	0.0303	0.9973	0.0021

Note1. The average of Mean and Std. for each year on the basis of quarterly data have been calculated in order to provide a legible table which is presenting Allocative efficiency measures per ownership.

Table.3.6. Cost Efficiency Scores per Ownership

Ownership Type	Private Banks		Foreign Banks		Investment & Development Banks		State-owned	
Year	**Mean**	**Std.**	**Mean**	**Std.**	**Mean**	**Std.**	**Mean**	**Std.**
2002	0.6268	0.2003	0.5703	0.3096	0.3681	0.2999	0.8725	0.8726
2003	0.5837	0.0425	0.5554	0.0145	0.3681	0.2999	0.8284	0.0214
2004	0.5380	0.0123	0.4128	0.0253	0.3739	0.0447	0.7202	0.0206
2005	0.6594	0.0370	0.4418	0.0297	0.5887	0.0209	0.7056	0.0110
2006	0.7665	0.0125	0.4743	0.0269	0.6224	0.0282	0.6984	0.0136
2007	0.8051	0.0155	0.4926	0.0124	0.5193	0.0174	0.7186	0.0126
2008	0.7329	0.0089	0.4799	0.0068	0.3594	0.0483	0.6717	0.0223
2009	0.8548	0.0178	0.5304	0.0156	0.3653	0.0558	0.7239	0.0090
2010	0.8676	0.0163	0.6012	0.0088	0.4243	0.0241	0.7442	0.0078
2011	0.8559	0.0043	0.6443	0.0162	0.5916	0.0122	0.7712	0.0096
2012	0.8596	0.0017	0.630	0.0101	0.7334	0.0288	0.7710	0.0091
2013	0.8365	0.0054	0.7034	0.0148	0.8121	0.0252	0.8230	0.0134
2014	0.8355	0.0055	0.7306	0.0088	0.7274	0.0123	0.7288	0.0034
2015	0.6976	0.0178	0.7760	0.0108	0.7647	0.0150	0.6532	0.0531
2016	0.8870	0.0144	0.5075	0.0108	0.8319	0.0305	0.9432	0.0060
2017	0.8600	0.0200	0.6700	0.0100	0.7400	0.0100	0.8670	0.00200

Note1. The average of Mean and Std. for each year on the basis of quarterly data have been calculated in order to provide a legible table which is presenting Cost efficiency measures per ownership.

Table.3.7.1. Technical Efficiency Determinants-Quantile Regression

Model	**OLS**	**10**	**25**	**50**	**75**	**90**
Dependent Variable	**TE**	**TE**	**TE**	**TE**	**TE**	**TE**
Capital Ratio	0.0267**	0.0021**	0.0107**	0. 0373**	0. 0443**	0.0295**
	(0.0036)	(0.0009)	(0.0023)	(0.0035)	(0.0064)	(0.0120)
NIM	0.0801*	0.0103**	0.0565*	0.0117**	0.0059*	0.0269**
	(0.0161)	(0.0043)	(0.0101)	(0.0156)	(0.0286)	(0.0533)
NNIM	-0.0027***	-0.0089***	-0.0044***	-0.0034***	-0.0031***	-0.0011***
	(0.2549)	(0.0685)	(0.1606)	(0.2461)	(0.4522)	(0.8420)
ROA	0.0071**	0.0007***	0.0020***	0.0044**	0.0062**	0.0066**
	(0.0008)	(0.0002)	(0.0005)	(0.0007)	(0.0014)	(0.0026)
Age	-0.0014***	-0.0001***	-0.0002***	-0.0005***	-0.0012***	-0.0023***
	(0.0002)	(0.0007)	(0.0001)	(0.0002)	(0.0004)	(0.0008)
F/M	0.0135**	0.0137**	0.0227**	0.0457**	0.0108**	0.0153*
	(0.0255)	(0.0068)	(0.0160)	(0.0246)	(0.0452)	(0.0843)
P/O	0.0072*	0.0754*	0.0023**	0.0066*	0.0077**	0.0018**
	(0.0763)	(0.0205)	(0.0481)	(0.0737)	(0.1355)	(0.2502)
Constant	0.2794	0.0274	0.0389	0.0904	0.2149	0.5312
	(0.0315)	(0.0084)	(0.0199)	(0.0304)	(0.0560)	(0.1043)
R^2	0.3411	0.0238	0.0609	0.1579	0.2706	0.3255
p value (*F*-test)	0	0	0	0	0	0

Note1. This table reports the results of quantile regression examining the impact of efficiency determinants on Technical efficiency (TE). F/M represents total number of females to total number of male employees and P/O represents the ratio of employees with postgraduate degree to the employees with any other degrees. NIM presents net interest margin, NNIM represents net non-interest margin and age is the number of banks operation. Robust Standard errors in parentheses, ***p<0.001, **p<0.05, *p<0.1. Note2, number of observations is 1320.

Table.3.7.2. Allocative Efficiency Determinants-Quantile Regression

Model	**OLS**	**10**	**25**	**50**	**75**	**90**
Dependent Variable	**Al**	**Al**	**Al**	**Al**	**Al**	**Al**
Capital Ratio	0.0340**	0.0134**	0.0357**	0.0497**	0.0398**	0.0190**
	(0.0030)	(0.0075)	(0.0075)	(0.0021)	(0.0006)	(0.0008)
NIM	0.0680*	0.0759*	0.0098*	0.0177**	0.0285**	0.0004***
	(0.0114)	(0.0282)	(0.0281)	(0.0081)	(0.0025)	(0.0033)
NNIM	-0.0381***	-0.0062***	- 0.0066***	- 0.0014***	-0.0012***	-0.0010***
	(0.1869)	(0.4592)	(0.4587)	(0.1325)	(0.0417)	(0.0543)
ROA	0.0027**	0.0041**	0. 0028**	0.0009***	0.0002***	0.0005***
	(0.0006)	(0.0016)	(0. 0016)	(0.0004)	(0.0001)	(0.0002)
Age	-0.0017**	-0.0050**	-0.0023**	-0.0003***	-0.0007***	-0.0005***
	(0.0001)	(0.0004)	(0. 0004)	(0.0001)	(0.0003)	(0.0005)
F/M	0.0021**	0.0039**	0.0023**	0.0532*	0.0047**	0.0006***
	(0.0189)	(0.0465)	(0.0464)	(0.0134)	(0.0042)	(0.0055)
P/O	0.0128**	0.0041**	0.0034**	0.0024**	0.0086*	0.0008***
	(0.0576)	(0.1415)	(0.1414)	(0.0408)	(0.0128)	(0.0167)
Constant	0.6010	0.0123	0. 5132	0. 9362	0.9970	1.0004
	(0.0242)	(0.0595)	(0.0595)	(0.0171)	(0.0054)	(0.0070)
R^2	0.3130	0.2720	0.2723	0.1751	0.0768	0.0176
p value (F – test)	0	0	0	0	0	0

Note1. This table reports the results of quantile regression examining the impact of efficiency determinants on Allocative efficiency (Al). F/M represents total number of females to total number of male employees and P/O represents the ratio of employees with postgraduate degree to the employees with any other degrees. NIM presents net interest margin, NNIM represents net non-interest margin and age is the number of banks operation. Standard errors in parentheses, ***p<0.001, **p<0.05, *p<0.1. Note2, number of observations is 1320.

Table.3.7.3. Cost Efficiency Determinants-Quantile Regression

Model	**OLS**	**10**	**25**	**50**	**75**	**90**
Dependent Variable	**CE**	**CE**	**CE**	**CE**	**CE**	**CE**
Capital Ratio	0.0021**	0.0075*	0.0015**	0.0074*	0.0041**	0.0039**
	(0.0036)	(0.0065)	(0.0078)	(0.0039)	(0.0031)	(0.0003)
NIM	0.00412**	0.0583*	0.0931*	0.0891*	0.0407	0.0005***
	(0.0136)	(0.0242)	(0.0293)	(0.0146)	(0.0115)	(0.0014)
NNIM	-0.0066***	-0.0028***	-0.0087***	-0.0090***	-0.0022***	0.0042**
	(0.2228)	(0.0213)	(0.4783)	(0.2387)	(0.1882)	(0.024)
ROA	0.0011**	0.0028**	0.0001***	0.0011**	0.0015**	0.0003***
	(0.0008)	(0.0014)	(0.0017)	(0.0002)	(0.0006)	(0.0008)
Age	-0.0026***	-0.006***	-0.004***	-0.0012***	-0.0003***	-0.0004***
	(0.0002)	(0.0003)	(0.0004)	(0.0002)	(0.0001)	(0.0002)
F/M	0.0024**	0.0031**	0.0029**	0.0012**	0.0044**	0.0001***
	(0.0225)	(0.0399)	(0.0484)	(0.0241)	(0.019)	(0.0024)
P/O	0.0040**	0.0049**	0.0066*	0.0069*	0.0027**	0.0012**
	(0.0687)	(0.1216)	(0.1474)	(0.0736)	(0.058)	(0.0074)
Constant	0.4709	-0.0968	0.2571	0.7764	0.9357	0.9998
	(0.0289)	(0.0512)	(0.0620)	(0.0309)	0.0244	(0.0031)
R^2	0.3148	0.2666	0.2762	0.1968	0.081	0.0268
p value (*F*-test)	0	0.059	0	0	0	0

Note1. This table reports the results of quantile regression examining the impact of efficiency determinants on Cost efficiency (CE). F/M represents total number of females to total number of male employees and P/O represents the ratio of employees with postgraduate degree to the employees with any other degrees. NIM presents net interest margin, NNIM represents net non-interest margin and age is the number of banks operation. Standard errors in parentheses, ***p<0.001, **p<0.05, *p<0.1. Note2. Number of observations is 1320.

Table.3.8.1. Technical Efficiency Determinants before Crisis 2008-Quantile Regression

Model	**OLS**	**10**	**25**	**50**	**75**	**90**
Dependent Variable	**TE**	**TE**	**TE**	**TE**	**TE**	**TE**
Capital Ratio	0.0023**	0.0047**	0.0084*	0.0029**	0.0041**	0.0057**
	(0.0048)	(0.0022)	(0.0031)	(0.0052)	(0.0095)	(0.0134)
NIM	0.0094*	0.0066*	0.0069*	0.0011**	0.0012**	0.0014**
	(0.0185)	(0.0087)	(0.0118)	(0.020)	(0.0362)	(0.0507)
NNIM	-0.0041***	-0.0035***	-0.0052***	-0.0016***	-0.0051***	-0.0076***
	(0.3105)	(0.1459)	(0.1988)	(0.3355)	(0.6076)	(0.8508)
ROA	0.0063*	0.0035**	0.0052*	0.0052*	0.0031**	0.0075*
	(0.0009)	(0.0004)	(0.0005)	(0.0001)	(0.0018)	(0.0025)
Age	-0.0013**	-0.0002***	-0.0005***	-0.0003***	-0.0012***	-0.0017***
	(0.0004)	(0.0002)	(0.0002)	(0.0004)	(0.0008)	(0.0011)
F/M	0.0089*	0.0034**	0.0070*	0.0042**	0.0076*	0.0028**
	(0.0384)	(0.018)	(0.0246)	(0.0415)	(0.0752)	(0.1054)
P/O	0.0089*	0.0043**	0.0342*	0.0921*	0.0971*	0.0504*
	(0.1278)	(0.0653)	(0.0818)	(0.1381)	(0.2501)	(0.3501)
Constant	0.2091	0.0359	0.0809	0.0590	0.2114	0.3971
	(0.0484)	(0.0227)	(0.031)	(0.0524)	(0.0948)	(0.1328)
R^2	0.4231	0.0501	0.0114	0.1091	0.2963	0.3904
p value(*F*-test)	0	0	0.010	0.060	0.027	0.003

Note1. This table reports the results of quantile regression examining the impact of efficiency determinants on Technical efficiency (TE) before financial crisis 2008. F/M represents total number of females to total number of male employees and P/O represents the ratio of employees with postgraduate degree to the employees with any other degrees. NIM presents net interest margin, NNIM represents net non-interest margin and age is the number of banks operation. Standard errors in parentheses, ***p<0.001, **p<0.05, *p<0.1.

Table.3.8.2. Allocative Efficiency Determinants before Crisis in 2008-Quantile Regression

Model	**OLS**	**10**	**25**	**50**	**75**	**90**
Dependent Variable	**Al**	**Al**	**Al**	**Al**	**Al**	**Al**
Capital Ratio	0.0019**	0.0012**	0.0014**	0.0025**	0.0033**	0.0033**
	(0.0045)	(0.0113)	(0.0089)	(0.0055)	(0.004)	(0.0016)
NIM	0.0049**	0.0026**	0.0054*	0.0049**	0.0036**	0.0003***
	(0.0160)	(0.0402)	(0.0316)	(0.0194)	(0.0143)	(0.0056)
NNIM	-0.0022***	-0.0034***	-0.0078***	-0.0079***	-0.0015***	-0.0028***
	(0.2468)	(0.6191)	(0.4870)	(0.2991)	(0.2201)	(0.0875)
ROA	0.0062*	0.0095*	0.0085*	0.0062*	0.0021**	0.0003***
	(0.0008)	(0.0022)	(0.0017)	(0.0010)	(0.0008)	(0.0003)
Age	-0.0028***	-0.0053***	-0.0044***	-0.0026***	-0.0004***	-0.0004***
	(0.0003)	(0.0007)	(0.0005)	(0.0003)	(0.0002)	(0.0001)
F/M	0.0043**	0.0033**	0.0048**	0.00477**	0.0011**	0.0015**
	(0.0332)	(0.0834)	(0.0656)	(0.0403)	(0.0296)	(0.0118)
P/O	0.0014**	0.0019**	0.0038**	0.0021**	0.0088*	0.0091*
	(0.1014)	(0.2544)	(0.2001)	(0.1229)	(0.0904	(0.0359)
Constant	0.2164	0.1186	0.0369	0.2716	0.8439	0.9816
	(0.0439)	(0.1103)	(0.0868)	(0.0533)	(0.0392)	(0.0156)
R^2	0.4259	0.3066	0.3339	0.2511	0.0849	0.0223
p value (*F*-test)	0	0.023	0.016	0	0	0

Note1. This table reports the results of quantile regression examining the impact of efficiency determinants on Allocative efficiency (AL) before financial crisis 2008. F/M represents total number of females to total number of male employees and P/O represents the ratio of employee with postgraduate degrees to the employees with any other degrees. NIM presents net interest margin, NNIM represents net non-interest margin and age is the number of banks operation. Standard errors in parentheses, ***p<0.001, **p<0.05, *p<0.1

Table.3.8.3. Cost Efficiency Determinants before Crisis in 2008-Quantile Regression

Model	**OLS**	**10**	**25**	**50**	**75**	**90**
Dependent Variable	**CE**	**CE**	**CE**	**CE**	**CE**	**CE**
Capital Ratio	0.0002***	0.0003***	0.0004***	0.0008***	0.0014**	0.0007***
	(0.0003)	(0.0003)	(0.0004)	(0.0005)	(0.0005)	(0.0004)
NIM	0.0043**	0.0033**	0.0048**	0.0071*	0.0075*	0.0076*
	(0.0018)	(0.0261)	(0.0378)	(0.0417)	(0.0456)	(0.0383)
NNIM	-0.0019***	-0.0024***	-0.0019***	-0.0055***	-0.0022***	-0.0016***
	(0.0112)	(0.0105)	(0.0152)	(0.0168)	(0.0183)	(0.0154)
ROA	0.0002***	0.0002***	0.0002***	0.0001***	0.0007***	0.0002***
	(0.0008)	(0.0007)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Age	-0.0061***	-0.0314***	-0.0257***	-0.0139***	-0.0454***	-0.0168***
	(0.0243)	(0.0212)	(0.0307)	(0.0338)	(0.0371)	(0.0316)
F/M	0.0006***	0.0001***	0.0009***	0.0006***	0.0002***	0.0001***
	(0.0008)	(0.0007)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
P/O	0.0037**	0.0024**	0.0051*	0.0085*	0.0038**	0.0041**
	(0.0387)	(0.0338)	(0.0489)	(0.054)	(0.0592)	(0.0495)
Constant	0.0514	0.0167	0.0329	0.0538	0.0656	0.0839
	(0.0044)	(0.0384)	(0.0556)	(0.0613)	(0.0675)	(0.0562)
R^2	0.1596	0.2080	0.1909	0.1107	0.0555	0.0346
p value (*F*-test)	0	0	0	0	0	0

Note1. This table reports the results of quantile regression examining the impact of efficiency determinants on Cost efficiency (CE) before financial crisis 2008. F/M represents total number of females to total number of male employees and P/O represents the ratio of employees with postgraduate degree to the employees with any other degrees. NIM presents net interest margin, NNIM represents net non88-interest margin and age is the number of banks operation. Standard errors in parentheses, ***p<0.001, **p<0.05, *p<0

Table.3.8.4. Technical Efficiency Determinants after Crisis in 2008-Quantile Regression

Model	**OLS**	**10**	**25**	**50**	**75**	**90**
Dependent Variable	**TE**	**TE**	**TE**	**TE**	**TE**	**TE**
Capital Ratio	0.0033**	0.0023**	0.0037**	0.0043**	0.0063*	0.0034**
	(0.0048)	(0.0008)	(0.0026)	(0.0047)	(0.0084)	(0.0148)
NIM	0.0062*	0.0017**	0.0012**	0.0075*	0.0043**	0.0049**
	(0.0315)	(0.0055)	(0.0172)	(0.0309)	(0.0547)	(0.0962)
NNIM	-0.0016***	-0.0015***	-0.0033***	-0.0026***	-0.0017***	-0.0027***
	(0.5098)	(0.0889)	(0.2780)	(0.4992)	(0.4837)	(0.5539)
ROA	0.0095*	0.0013**	0.0007***	0.0031**	0.0017**	0.0016**
	(0.0016)	(0.0002)	(0.0008)	(0.0015)	(0.0027)	(0.0049)
Age	-0.0014***	-0.0001***	-0.0002***	-0.0005***	-0.0009***	-0.0016***
	(0.0003)	(0.0002)	(0.0001)	(0.0003)	(0.0005)	(0.0009)
F/M	0.0016**	0.0013**	0.0018**	0.0056*	0.0007***	0.0027**
	(0.0338)	(0.0059)	(0.0184)	(0.0331)	(0.0587)	(0.1031)
P/O	0.0064*	0.0012**	0.0015**	0.0054*	0.0057*	0.0044**
	(0.0943)	(0.0164)	(0.0514)	(0.0923)	(0.0377)	(0.0874)
Constant	0.3108	0.0278	0.0397	0.1001	0.1756	0.6376
	(0.0412)	(0.0071)	0.0224	(0.0403)	(0.07155)	(0.1256)
R^2	0.3033	0.0227	0.0589	0.1539	0.2779	0.3585
p value (*F*-test)	0	0	0	0	0	0

Note1. This table reports the results of quantile regression examining the impact of efficiency determinants on Technical efficiency (TE) after financial crisis 2008. F/M represents total number of females to total number of male employees and P/O represents the ratio of employees with postgraduate degree to the employees with any other degrees. NIM presents net interest margin, NNIM represents net non-interest margin and age is the number of banks operation. Standard errors in parentheses, ***p<0.001, **p<0.05, *p<0.1.

Table.3.8.5. Allocative Efficiency Determinants after Crisis in 2008-Quantile Regression

Model	**OLS**	**10**	**25**	**50**	**75**	**90**
Dependent Variable	**Al**	**Al**	**Al**	**Al**	**Al**	**Al**
Capital Ratio	0.0045**	0.0041**	0.0052*	0.0066*	0.0054*	0.0017**
	(0.0033)	(0.0107)	(0.0067)	(0.0018)	(0.0008)	(0.0003)
NIM	0.0013**	0.0061*	0.0039**	0.0015**	0.0013**	0.0044**
	(0.0027)	(0.0087)	(0.0054)	(0.0015)	(0.0007)	(0.0002)
NNIM	-0.0056***	-0.0045***	-0.0029***	-0.0063***	-0.0016***	-0.0063***
	(0.3337)	(0.0652)	(0.6653)	(0.18334)	(0.0855)	(0.0336)
ROA	0.001***	0.0057*	0.0024**	0.001***	0.0002***	0.0006***
	(0.0011)	(0.0035)	(0.0022)	(0.0006)	(0.0002)	(0.0001)
Age	-0.0011***	-0.0033***	-0.0008***	-0.0009***	-0.0003***	-0.0004***
	(0.0001)	(0.0005)	(0.0003)	(0.0001)	(0.0004)	(0.0001)
F/M	0.0012**	0.0023**	0.0096*	0.0015**	0.0004***	0.0007***
	(0.0191)	(0.0610)	(0.0381)	(0.0105)	(0.0049)	(0.0019)
P/O	0.0022**	0.0024**	0.0022**	0.0012**	0.0056*	0.0003***
	(0.0593)	(0.1896)	(0.1184)	(0.0326)	(0.0152)	(0.0059)
Constant	0.7514	0.3677	0.8037	0.9743	0.9994	0.7721
	(0.0234)	(0.0749)	(0.0468)	(0.0129)	(0.0061)	(0.0023)
R^2	0.2747	0.2798	0.2610	0.1669	0.0769	0.0256
p value (*F*-test)	0	0	0	0	0	0

Note1. This table reports the results of quantile model examining the impact of efficiency determinants on Allocative efficiency (AL) after financial crisis 2008. F/M represents total number of females to total number of male employees and P/O represents the ratio of employees with postgraduate degree to the employees with any other degrees. NIM presents net interest margin, NNIM represents net non-interest margin and age is the number of banks operation. Standard errors in parentheses, ***p<0.001, **p<0.05, *p<0.1.

Table.3.8.6. Cost Efficiency Determinants after Crisis in 2008-Quantile Regression

Model	**OLS**	**10**	**25**	**50**	**75**	**90**
Dependent Variable	**CE**	**CE**	**CE**	**CE**	**CE**	**CE**
Capital Ratio	0.0053*	0.0045**	0.0059**	0.0068*	0.0058**	0.0013**
	(0.0063)	(0.0126)	(0.0094)	(0.0085)	(0.0077)	(0.0023)
NIM	0.0042**	0.0012**	0.0023**	0.0038**	0.0036**	0.0063*
	(0.0643)	(0.1277)	(0.0951)	(0.0861)	(0.0785)	(0.0232)
NNIM	-0.0017***	-0.0037***	-0.0053***	-0.0024***	-0.0039***	-0.0058***
	(0.0391)	(0.0694)	(0.0456)	(0.855)	(0.7757)	(0.2312)
ROA	0.0146	0.0074*	0.0087*	0.0098*	0.0089*	0.0014**
	(0.0016)	(0.0033)	(0.0024)	(0.0022)	(0.0022)	(0.0006)
Age	-0.0009***	-0.0011***	-0.0021***	-0.0014***	-0.0004***	-0.0003***
	(0.0002)	(0.0005)	(0.0004)	(0.0003)	(0.0003)	(0.0009)
F/M	0.0011**	0.0015**	0.0027**	0.0031**	0.0053*	0.0026**
	(0.0291)	(0.0576)	(0.0429)	(0.0388)	(0.0351)	(0.0104)
P/O	0.0015**	0.0013**	0.0005***	0.0028**	0.0059**	0.0047**
	(0.1811)	(0.3598)	(0.268)	(0.2426)	(0.2198)	(0.0655)
Constant	0.7331	0.3025	0.5642	0.7916	0.9268	0.9955
	(0.0383)	(0.0761)	(0.0566)	(0.0513)	(0.0465)	(0.0138)
R^2	0.2143	0.1720	0.1846	0.1426	0.0597	0.0031
p value (*F*-test)	0	0	0	0	0	0

Note1. This table reports the results of quantile regression examining the impact of efficiency determinants on Cost efficiency (CE) after financial crisis 2008. F/M represents total number of females to total number of male employees and P/O represents the ratio of employees with postgraduate degree to the employees with any other degrees. NIM presents net interest margin, NNIM represents net non-interest margin and age is the number of banks operation. Standard errors in parentheses, ***p<0.001, **p<0.05, *p<0.1.

Table.3.8.7. Technical Efficiency Determinants including Risk-Quantile Regression

Model	**OLS**	**10**	**25**	**50**	**75**	**90**
Dependent Variable	**TE**	**TE**	**TE**	**TE**	**TE**	**TE**
Z-score	-0.0058***	-0.0015***	-0.0054***	-0.0087***	-0.0076***	-0.0066***
	(0.0082)	(0.0015)	(0.0047)	(0.0084)	(0.0137)	(0.021)
Capital Ratio	0.0037**	0.0024**	0.0037**	0.0048**	0..0053*	0.0048**
	(0.0048)	(0.0009)	(0.0028)	(0.0047)	(0.0081)	(0.0124)
NIM	0.0045**	0.0093*	0.0038**	0.0052*	0.0047**	0.0018**
	(0.0308)	(0.0057)	(0.0178)	(0.0300)	(0.0513)	(0.0786)
NNIM	-0.0033***	-0.0047***	-0.0089***	-0.0028***	-0.0069***	-0.0052***
	(0.4983)	(0.0093)	(0.2889)	(0.0485)	(0.8306)	(0.2728)
ROA	0.0041**	0.0012**	0.0003***	0.0071**	0.0029**	0.0053*
	(0.0017)	(0.0003)	(0.0013)	(0.0017)	(0.0029)	(0.0045)
Age	-0.0015***	-0.0001***	-0.0002***	-0.0006***	-0.0017***	-0.0021***
	(0.0003)	(0.0005)	(0.0001)	(0.0003)	(0.0005)	(0.0008)
F/M	0.0016**	0.0045**	0.0081*	0.0051*	0.0018**	0.0027**
	(0.0329)	(0.0061)	(0.0191)	(0.0321)	(0.0152)	(0.0841)
P/O	0.0065*	0.0036**	0.0029**	0.0051*	0.0064*	0.0029**
	(0.0916)	(0.0171)	(0.0531)	(0.0893)	(0.0675)	(0.0234)
Constant	0.3451	0.0315	0.0555	0.1255	0.3954	0.6158
	(0.0405)	(0.0075)	(0.0235)	(0.0395)	(0.0675)	(0.1035)
R^2	0.3430	0.0240	0.0609	0.1614	0.3087	0.4096
p value(*F*-test)	0	0	0	0	0	0

Note1. This table reports the results of quantile regression examining the impact of efficiency determinants on Technical efficiency with considering risk factor (*Z*-score). F/M represents total number of females to total number of male employees and P/O represents the ratio of employees with postgraduate degrees to the employees with any other degrees. NIM presents net interest margin, NNIM represents net non-interest margin and age is the number of banks operation. Standard errors in parentheses, ***p<0.001, **p<0.05, *p<0.1

Table.3.8.8. Allocative Efficiency Determinants including Risk-Quantile Regression

Model	**OLS**	**10**	**25**	**50**	**75**	**90**
Dependent Variable	**AL**	**AL**	**AL**	**AL**	**AL**	**AL**
Z-score	-0.0023***	-0.0021***	-0.0038***	-0.0013***	-0.0015***	-0.0002***
	(0.0041)	(0.011)	(0.0094)	(0.0031)	(0.0005)	(0.001)
Capital Ratio	0.0038**	0.0073*	0.0039**	0.0047**	0.0039**	0.0013**
	(0.003)	(0.008)	(0.0068)	(0.0023)	(0.0007)	(0.0007)
NIM	0.0071*	0.0072*	0.0068*	0.0021**	0.0028**	0.0002***
	(0.0113)	(0.0299)	(0.0254)	(0.0086)	(0.0026)	(0.0028)
NNIM	-0.0053***	-0.0049***	-0.0062***	-0.0083***	-0.0094***	-0.0009***
	(0.1856)	(0.4886)	(0.4166)	(0.141)	(0.0436)	(0.0469)
ROA	0.0051*	0.0082*	0.0057*	0.0019**	0.0004***	0.0006***
	(0.0007)	(0.002)	(0.0017)	(0.0005)	(0.0001)	(0.0001)
Age	-0.0016***	-0.0045***	-0.0022***	-0.0003***	-0.0001***	-0.0005***
	(0.0001)	(0.0004)	(0.0003)	(0.0001)	(0.0004)	(0.0004)
F/M	0.0048**	0.0072*	0.0027**	0.0058*	0.0041**	0.0001***
	(0.0186)	(0.0491)	(0.0418)	(0.0144)	(0.0043)	(0.0047)
P/O	0.0026**	0.0011**	0.0025**	0.0031**	0.0015**	0.0001***
	(0.056)	(0.1499)	(0.1278)	(0.0432)	(0.0133)	(0.0143)
Constant	0.6311	0.0846	0.5658	0.9322	0.9988	0.7911
	(0.0243	(0.0641)	(0.0547)	(0.0185)	(0.0057)	(0.0061)
R^2	0.3331	0.2849	0.2882	0.1795	0.0782	0.0184
p value (*F*-test)	0	0	0	0	0	0

Note1. This table reports the results of quantile regression examining the impact of efficiency determinants on Allocative efficiency with considering risk factor (*Z*-score). F/M represents total number of females to total number of male employees and P/O represents the ratio of employees with postgraduate degree to the employees with any other degrees. NIM presents net interest margin, NNIM represents net non-interest margin and age is the number of banks operation. Standard errors in parentheses, ***p<0.001, **p<0.05, *p<0.1.

Table.3.8.9. Cost Efficiency Determinants including Risk-Quantile Regression

Model	OLS	10	25	50	75	90
Dependent Variable	**CE**	**CE**	**CE**	**CE**	**CE**	**CE**
Z-score	-0.0009***	-0.0005***	-0.0003***	-0.0002***	-0.0006***	-0.0005***
	(0.0056)	(0.0059)	(0.0091)	(0.0085)	(0.0068)	(0.0036)
Capital Ratio	0.0041**	0.0018**	0.0028**	0.0025**	0.0027**	0.0002***
	(0.0036)	(0.0044)	(0.0068)	(0.0063)	(0.0051)	(0.0027)
NIM	0.0043**	0.0058*	0.0039**	0.0027**	0.0045**	0.0068*
	(0.0137)	(0.0245)	(0.0376)	(0.0349)	(0.0281)	(0.0148)
NNIM	-0.0004***	-0.0003***	-0.0005***	-0.0009***	-0.0008***	-0.0001***
	(0.2243)	(0.3012)	(0.4634)	(0.4292)	(0.346)	(0.1819)
ROA	0.0019**	0.0028**	0.0013**	0.0051*	0.0003***	0.0005***
	(0.0009)	(0.0011)	(0.0017)	0.0015	(0.0012)	(0.0006)
Age	-0.0025***	-0.0018***	-0.0029***	-0.0019***	-0.0003***	-0.0002***
	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.0002)	(0.0001)
F/M	0.0042**	0.0035**	0.0071*	0.0084*	0.0048**	0.0062*
	(0.0225)	(0.0267)	(0.0411)	(0.0387)	(0.0307)	(0.0161)
P/O	0.0002***	0.0008***	0.0002***	0.0005***	0.0006***	0.0005***
	(0.0688)	(0.0828)	(0.1273)	(0.1179)	(0.0951)	(0.0519)
Constant	0.4813	0.3133	0.5585	0.879	0.9559	0.7547
	(0.0294)	(0.0346)	(0.0532)	(0.0493)	(0.0397)	(0.0209)
R^2	0.3163	0.1331	0.1366	0.0981	0.0521	0.0027
p value (*F*-test)	0	0	0	0	0	0

Note1. The above table reports the results of quantile regression examining the impact of efficiency determinants on Cost l efficiency considering the risk factor *(Z*-score). F/M represents total number of females to total number of male employees and P/O represents the ratio of employees with postgraduate degree to the employees with any other degrees in Turkish banks. NIM presents net interest margin, NNIM represents net non-interest margin and age is the number of years that banks operation. Standard errors in parentheses, ***p<0.001, **p<0.05, *p<0.1.

Table.3.9.1. Average Efficiency by Bank Size

Bank Size	Technical Efficiency			Allocative of Efficiency		
	Average Efficiency	**No.Banks**	**Obs.**	**Average Efficiency**	**No.Banks**	**Obs.**
Small	0. 5239	4	202	0. 7489	4	200
Medium	0. 3815	11	464	0. 8012	11	526
Large	0. 2230	29	1039	0. 9223	29	1576

Note1. Following Isik and Hassan (2002 and 2003a) we categorized banks size according to their total amount of assets. Small < 100, 100 ≤ Medium <1000, and large ≤1000 ($Million).

Table.3.10.1. Correlation Coefficient Matrix

	Deposit	**Capital**	**Total loans & receivables**	**Net securities**	**Off-balance sheet activities**	**Non-interest income**	**(NPLs)**	**Price of deposit**	**Price of capital**	**Price of loans &receivables**	**Price of securities**	**Price of NPLs**
Deposit	1.0000											
Capital	-0.1959	1.0000										
Total loans & receivables	0.9370	-0.2302	1.0000									
Net securities	0.9197	-0.1114	0.7439	1.0000								
Off-balance sheet activities	0.7616	-0.2170	0.8496	0.5512	1.0000							
Non-interest income	0.7679	-0.1551	0.7550	0.6959	0.5933	1.0000						
Non-performing loans (NPLs)	0.8108	-0.1822	0.8408	0.6379	0.7553	0.7208	1.0000					
Price of deposit	-0.0339	0.2215	-0.0587	-0.0039	-0.0634	0.0399	-0.0142	1.0000				
Price of capital	0.0571	-0.0698	0.0559	0.0446	0.0607	0.0690	0.0626	0.0662	1.0000			
Price of loans &receivables	-0.0686	0.4600	-0.0678	-0.0548	-0.0621	-0.0532	-0.0679	0.6293	0.0333	1.0000		
Price of securities	-0.0717	0.0878	-0.0643	-0.0700	-0.0562	-0.0551	-0.0674	0.0248	0.0012	0.0373	1.0000	
Price of NPLs	-0.0392	0.0628	-0.0396	-0.0333	-0.0303	-0.0356	-0.0460	-0.0076	0.0537	0.0343	-0.0003	1.0000

Note1. The above table shows the correlation coefficient Matrix. It indicates that correlations among the variables in this paper are mainly negligible which mean that the model applied in this paper is unlikely to suffer from the issue of considerable multicollinearity

Table.3.11.1. Technical, Allocative and Cost Efficiency Elasticities-SFA-OLS

Model	**OLS**	**OLS**	**OLS**
Dependent Variable	**TE**	**AL**	**CE**
Capital	0.0011**	0.0015**	0.0018**
	(0.0001)	(0.0003)	(0.0004)
Deposit	0.0001***	0.0006***	0.0004***
	(0.0001)	(0.0004)	(0.0005)
Loan and Receivables	0.0008***	0.0004***	0.0003***
	(0.0001)	(0.0002)	(0.0003)
Total Securities	0.0004***	0.0006***	0.0004***
	(0.0002)	(0.0004)	(0.0005)
Total Off-Balance Sheet	-0.0007***	-0.0009***	-0.0003***
Activities	(0.0006)	(0.0001)	(0.0001)
Non-interest income	0.0005***	0.0001***	0.0001***
	(0.0001)	(0.0003)	(0.0004)
Non-Performing Loans (NPLs)	-0.0004***	-0.0008***	-0.0002***
	(0.0001)	(0.0003)	(0.0003)
Price of Capital	0.0016**	0.0026**	0.0047**
	(0.0001)	(0.0004)	(0.0009)
Price of Deposit	0.0259*	0.0173*	0.0411*
	(0.0032)	(0.0011)	(0.0142)
Price of Loan and Receivables	0.0035**	0.0009***	0.0054**
	(0.0011)	(0.0035)	(0.0042)
Price of Securities	0.0024**	0.0078*	0.0077*
	(0.0014)	(0.0054)	(0.0063)
Price of NPLs	0.0005***	0.0003***	0.0005***
	(0.0007)	(0.0002)	(0.0003)
Constant	0.1993	0.2878	0.3878
	(0.0053)	(0.0147)	(0.0194)
R^2	0.2492	0.2264	0.1983
P-value (*F* –test)	0	0	0

Note1. The above table represents the elasticities of the inputs and both desirable and undesirable outputs for all Technical (TE), Allocative (AL), and Cost efficiency (CE). All three types of efficiency are computed running translog hyperbolic distance function. There is a significant relation between all bank-specific characteristics and all kind of efficiencies. Off-Balance Sheet activities and NPLs negatively influence on the banks' efficiency. Standard errors in parentheses, ***p<0.001, **p<0.005, *<0.1.

Table.3.12.1. Technical Efficiency Scores per Ownership-SFA

Ownership	Private		Foreign		Investment & Development		State-Owned	
Year	**Mean**	**Std.**	**Mean**	**Std.**	**Mean**	**Std.**	**Mean**	**Std.**
2002	0.1010	0.2165	0.9865	0.4736	0.9412	0.1212	0.1810	0.0180
2003	0.1989	0.0713	0.9987	0.8153	0.8865	0.4872	0.1985	0.1109
2004	0.1966	0.1074	0.9989	0.0002	0.9075	0.4145	0.1765	0.0706
2005	0.2781	0.0272	0.8689	0.1841	0.9633	0.4987	0.1986	0.0001
2006	0.2897	0.0326	0.7991	0.4757	0.9602	0.4444	0.1956	0.0080
2007	0.2777	0.0412	0.7851	0.0728	0.9826	0.3981	0.1999	0.0222
2008	0.2991	0.0498	0.6656	0.2563	0.9428	0.4731	0.1974	0.0147
2009	0.1987	0.0368	0.6689	0.1533	0.9424	0.4918	0.1999	0.0448
2010	0.1988	0.0412	0.5978	0.5206	0.9457	0.5139	0.1987	0.0251
2011	0.2111	0.0695	0.6161	0.1636	0.9434	0.4741	0.1945	0.0103
2012	0.2567	0.0282	0.7238	0.1788	0.9393	0.4909	0.2456	0.0035
2013	0.2744	0.0138	0.7555	0.9681	0.9413	0.3914	0.2890	0.0047
2014	0.2388	0.0407	0.7661	0.6629	0.9416	0.3871	0.2191	0.0275
2015	0.2341	0.0321	0.6913	0.9945	0.9487	0.4551	0.1989	0.0307
2016	0.2981	0.0328	0.7361	0.9273	0.9428	0.4902	0.1999	0.0431
2017	0.2991	0.0316	0.7112	0.6037	0.9514	0.2917	0.2311	0.0528

Note1. The average of Mean and Std. for each year on the basis of quarterly data have been calculated in order to provide a legible table which is presenting Technical efficiency measures per ownership. Technical efficiency scores are computed by translog hyperbolic distance function.

Table.3.13.1. Allocative Efficiency Scores per Ownership-SFA

Ownership	Private		Foreign		Development & Investment		State-Owned	
Year	**Mean**	**Std.**	**Mean**	**Std.**	**Mean**	**Std.**	**Mean**	**Std.**
2002	0.9201	0.0392	0.1131	0.4543	0.8122	0.1241	0.8503	0.0990
2003	0.9578	0.3558	0.1019	0.4369	0.8542	0.1221	0.8663	0.1164
2004	0.9528	0.3731	0.1101	0.4361	0.8555	0.1981	0.8618	0.0681
2005	0.5326	0.3765	0.1112	0.3739	0.8754	0.0132	0.9221	0.0532
2006	0.2928	0.3611	0.1104	0.3558	0.8831	0.0199	0.9474	0.0399
2007	0.3058	0.3635	0.1621	0.3570	0.8765	0.0981	0.9483	0.0385
2008	0.1083	0.3586	0.1861	0.3530	0.9122	0.0102	0.9693	0.0337
2009	0.1178	0.3593	0.1719	0.3427	0.9164	0.0717	0.9788	0.0476
2010	0.2485	0.3665	0.1109	0.3382	0.8942	0.0546	0.9874	0.0494
2011	0.2361	0.3644	0.1147	0.3392	0.9234	0.0112	0.9886	0.0423
2012	0.1733	0.3702	0.1217	0.3444	0.9187	0.0411	0.9869	0.0340
2013	0.1248	0.3710	0.1139	0.3407	0.9231	0.0218	0.9911	0.0234
2014	0.1108	0.3681	0.1291	0.3361	0.9277	0.0312	0.9851	0.0424
2015	0.1202	0.3601	0.9735	0.3315	0.9331	0.0219	0.9818	0.0307
2016	0.1109	0.3608	0.9821	0.3502	0.8998	0.0241	0.9663	0.0431
2017	0.1105	0.3883	0.9736	0.3814	0.9399	0.0178	0.9513	0.0528

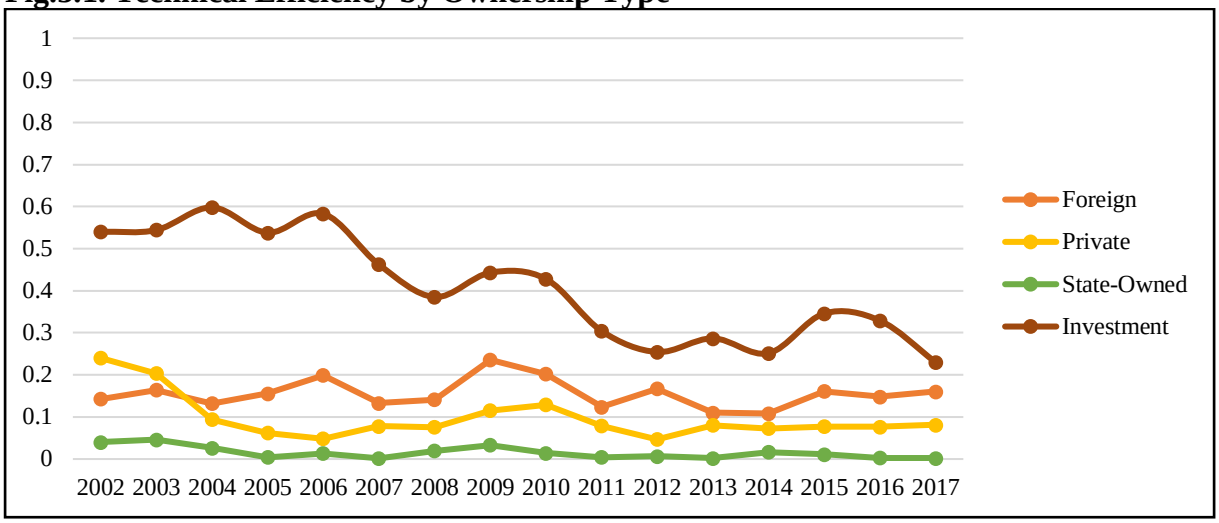
Note1. The average of Mean and Std. for each year on the basis of quarterly data have been calculated in order to provide a legible table which is presenting Allocative efficiency measures per ownership. Allocative efficiency scores are computed by translog hyperbolic distance function.

Table.3.14.1. Cost Efficiency Scores per Ownership-SFA

Ownership	Private		Foreign		Investment & Development		State-Owned	
Year	**Mean**	**Std.**	**Mean**	**Std.**	**Mean**	**Std.**	**Mean**	**Std.**
2002	0.7501	0.5158	0.6988	0.4675	0.6741	0.0821	0.7599	0.1300
2003	0.7461	0.4932	0.7133	0.4490	0.6981	0.0313	0.7768	0.1260
2004	0.7405	0.4784	0.6953	0.4437	0.7152	0.0981	0.7762	0.0929
2005	0.7926	0.4718	0.6807	0.3914	0.7177	0.0671	0.8519	0.0828
2006	0.8611	0.4465	0.7213	0.3782	0.6854	0.0761	0.8702	0.0551
2007	0.9009	0.4399	0.8102	0.3816	0.7961	0.0541	0.8735	0.0423
2008	0.8601	0.4701	0.7418	0.3687	0.6861	0.0222	0.8795	0.0696
2009	0.9102	0.4755	0.7322	0.3714	0.6907	0.0401	0.8953	0.0870
2010	0.9312	0.4782	0.7551	0.3730	0.7431	0.0112	0.8993	0.0460
2011	0.8944	0.4720	0.7124	0.3725	0.7833	0.0361	0.8903	0.0222
2012	0.8817	0.4631	0.7202	0.3717	0.7912	0.0288	0.8931	0.0732
2013	0.8711	0.4569	0.7495	0.3425	0.8321	0.0129	0.9156	0.0633
2014	0.8603	0.4586	0.7534	0.2682	0.8788	0.0311	0.9645	0.0664
2015	0.8308	0.4601	0.7605	0.3435	0.8844	0.0213	0.9167	0.0509
2016	0.8513	0.4667	0.7699	0.3878	0.8605	0.0161	0.8928	0.0573
2017	0.8802	0.5121	0.7791	0.4221	0.8103	0.0261	0.9102	0.0656

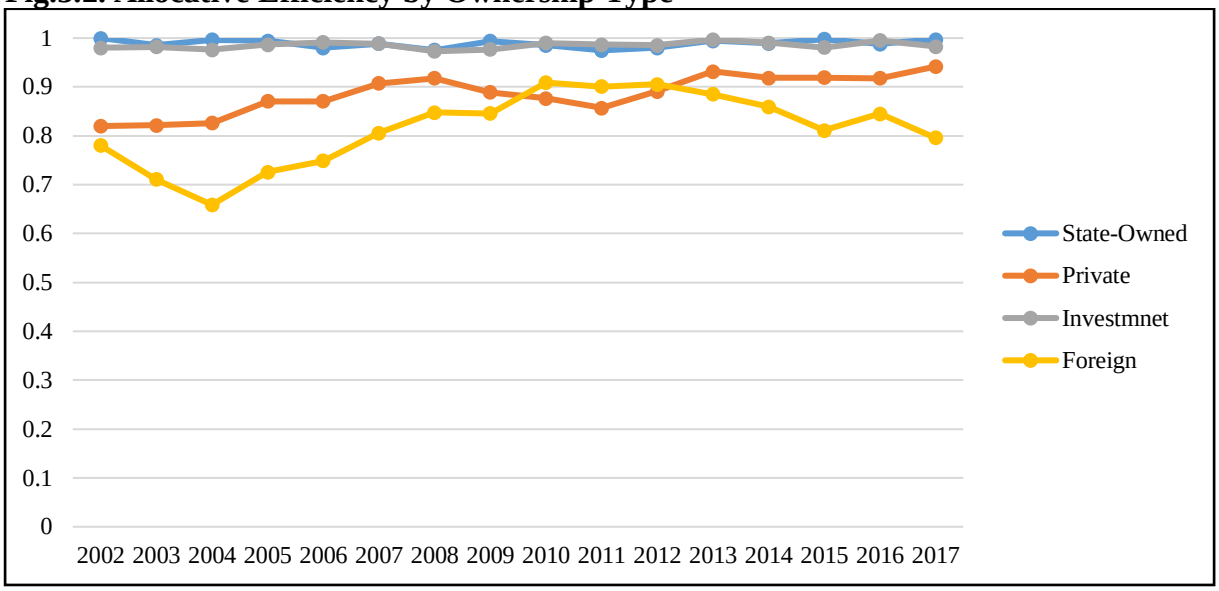
Note1. The average of Mean and Std. for each year on the basis of quarterly data have been calculated in order to provide a legible table which is presenting Cost efficiency measures per ownership. Cost efficiency scores are computed by translog hyperbolic distance function.

Fig.3.1. Technical Efficiency by Ownership Type



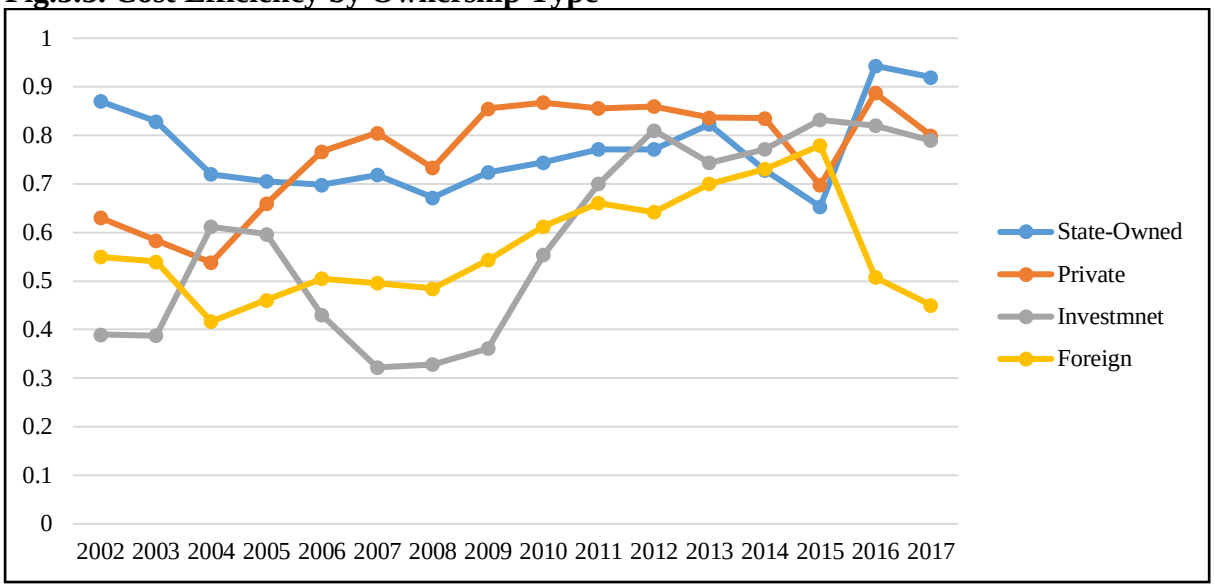
Note1. The above graph represents how annual average Technical efficiency changes during 2002-2017 in each ownership. Investment and development banks represent the highest scores for Technical efficiency during this time horizon while state-owned and private banks show the least measures for Technical efficiency.

Fig.3.2. Allocative Efficiency by Ownership Type



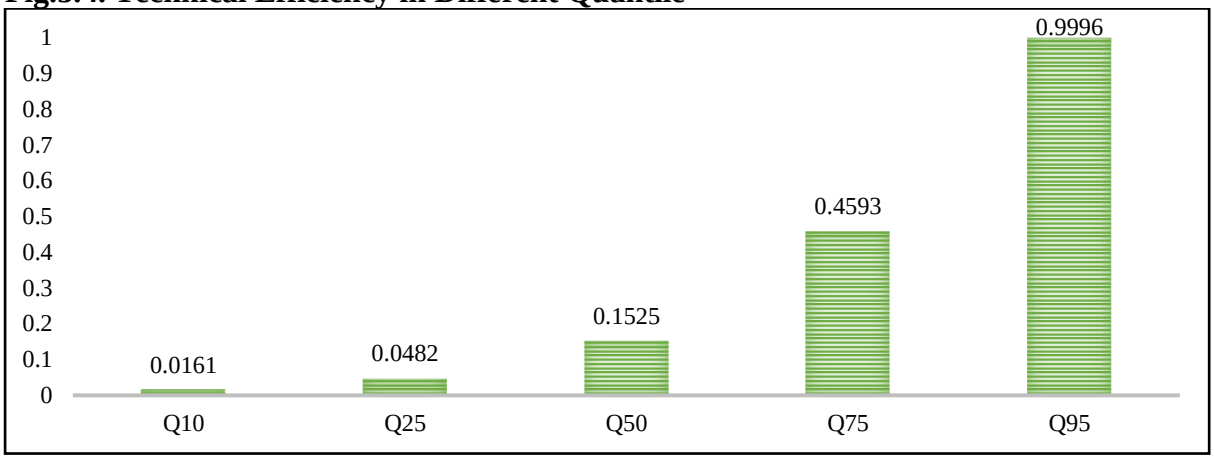
Note1. The above figure represents how an annual average Allocative efficiency changes during 2002-2017 in each ownership. Investment and development and state-owned banks represent the highest scores for Allocative efficiency during this time horizon while foreign and private banks show a lower Allocative efficiency score.

Fig.3.3. Cost Efficiency by Ownership Type



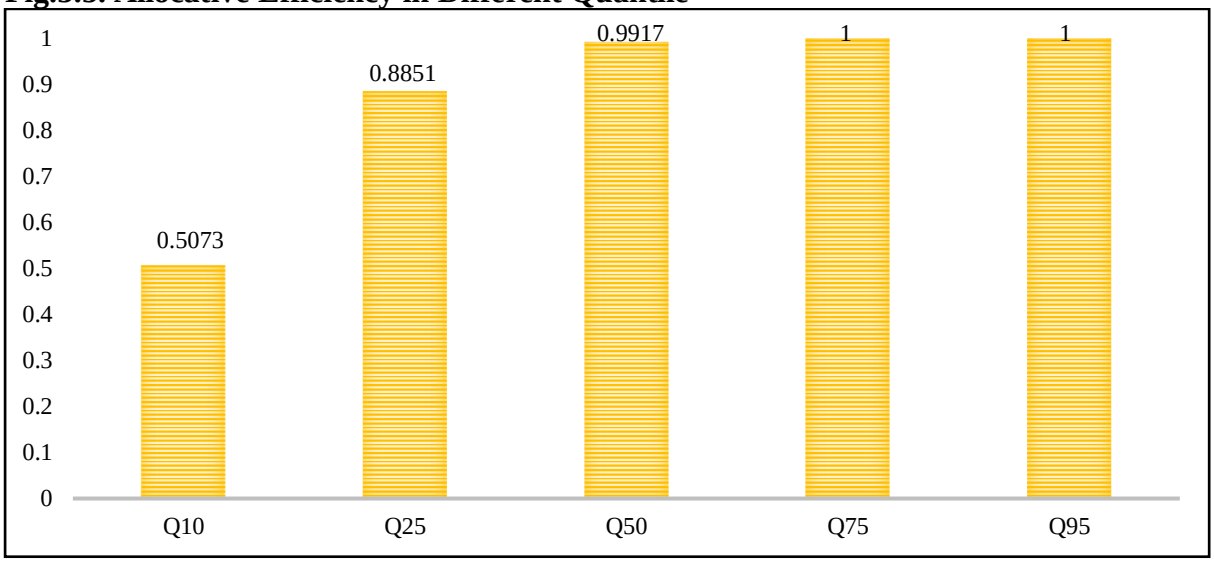
Note1. The above figure represents how an annual average Cost efficiency changes during 2002-2017 in each ownership. Private and state-owned banks represent the highest scores for Cost efficiency during this time horizon. The lowest Cost efficiency score is for the investment and development ownership. The Cost efficiency score flactuate for the foreign ownership during the study time horizon.

Fig.3.4. Technical Efficiency in Different Quantile



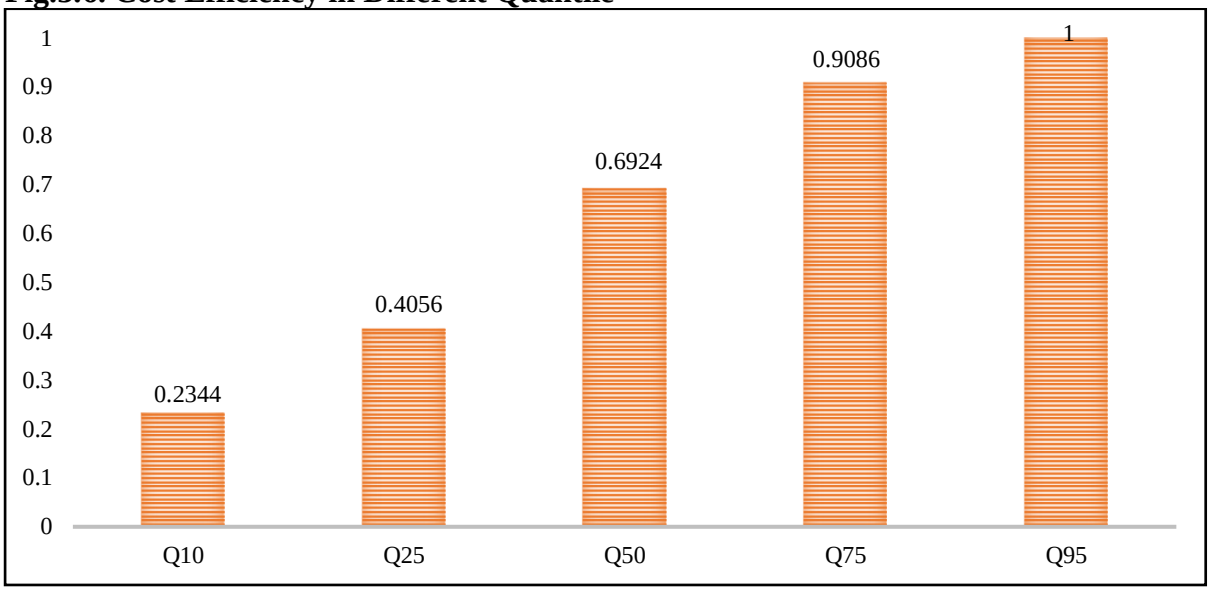
Note1. The above figure shows Technical efficiency scores in each quantile. To have a thorough investigation, regression is tested in 0.1, 0.25, 0.5, 0.75, and 0.95 quantile. As the graph is showing, the score of Technical efficiency increasing in high quantile.

Fig.3.5. Allocative Efficiency in Different Quantile



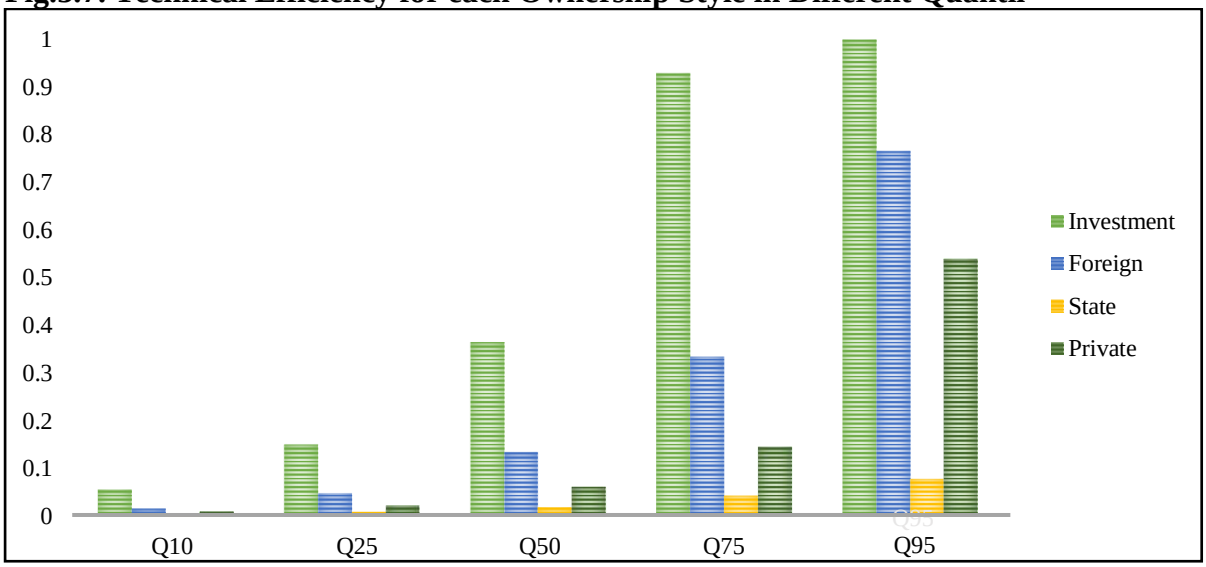
Note1. The above figure shows Allocative efficiency scores in each quantile. To have a thorough investigation, regression is tested in 0.1, 0.25, 0.5, 0.75, and 0.95 quantile. As the graph is showing, the score of Allocative efficiency increasing in high quantile.

Fig.3.6. Cost Efficiency in Different Quantile



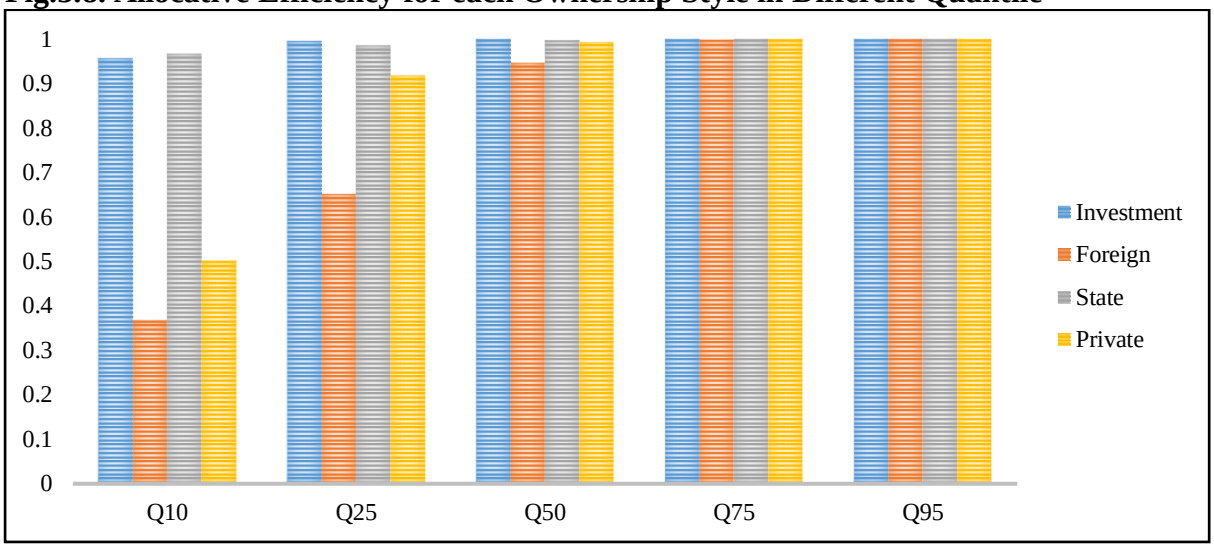
Note1. The above figure shows Cost efficiency scores per each quantile. To have a thorough investigation, regression is tested in 0.1, 0.25, 0.5, 0.75, and 0.95 quantile. As the graph is showing, the score of Cost efficiency increasing in high quantile.

Fig.3.7. Technical Efficiency for each Ownership Style in Different Quantil



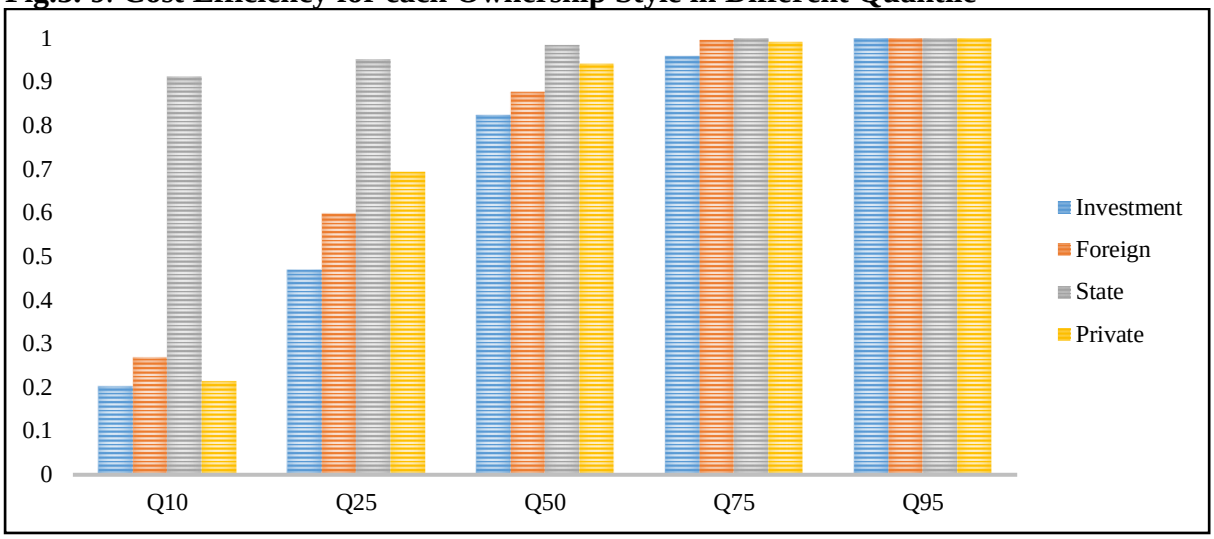
Note1. The above figure illustrates Technical efficiency per ownership in each quantile. Similar to Fig. 3.1, investment and development banks represents the highest degrees for Technical efficiency in every quantile. The Technical efficiency scores increase in the higher quantiles for all ownership tupes.

Fig.3.8. Allocative Efficiency for each Ownership Style in Different Quantile



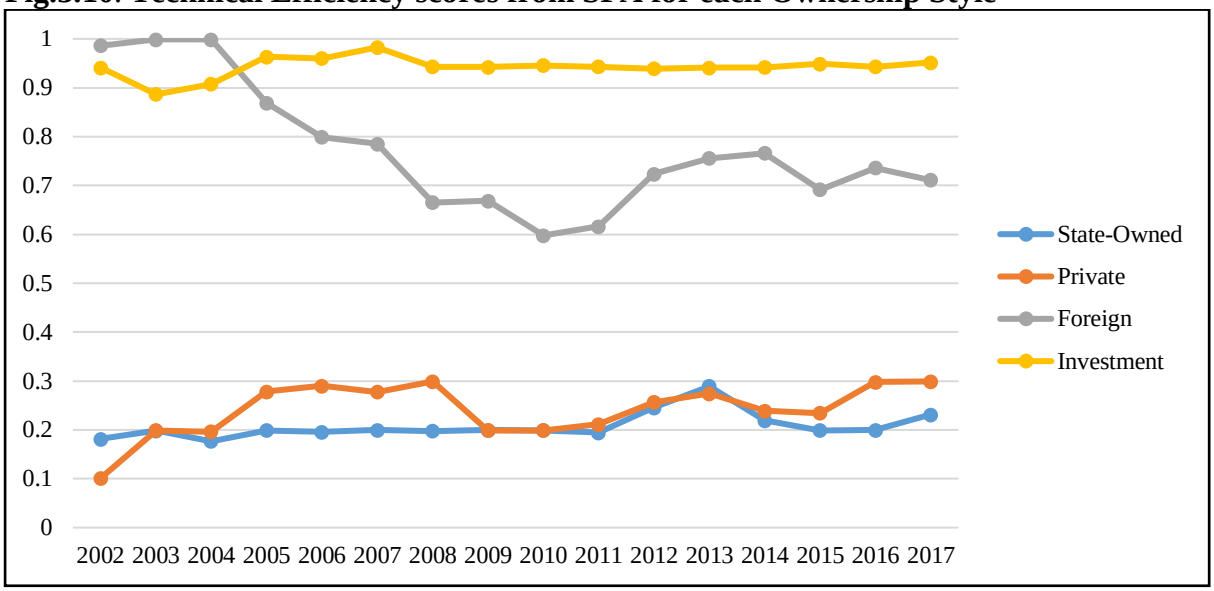
Note1. The above figure illustrates Allocative efficiency per ownership in each quantile. Similar to Fig. 3.2. foreign banks appear to have the lowest Allocatibe efficiency scores in the lower quantiles.

Fig.3. 9. Cost Efficiency for each Ownership Style in Different Quantile



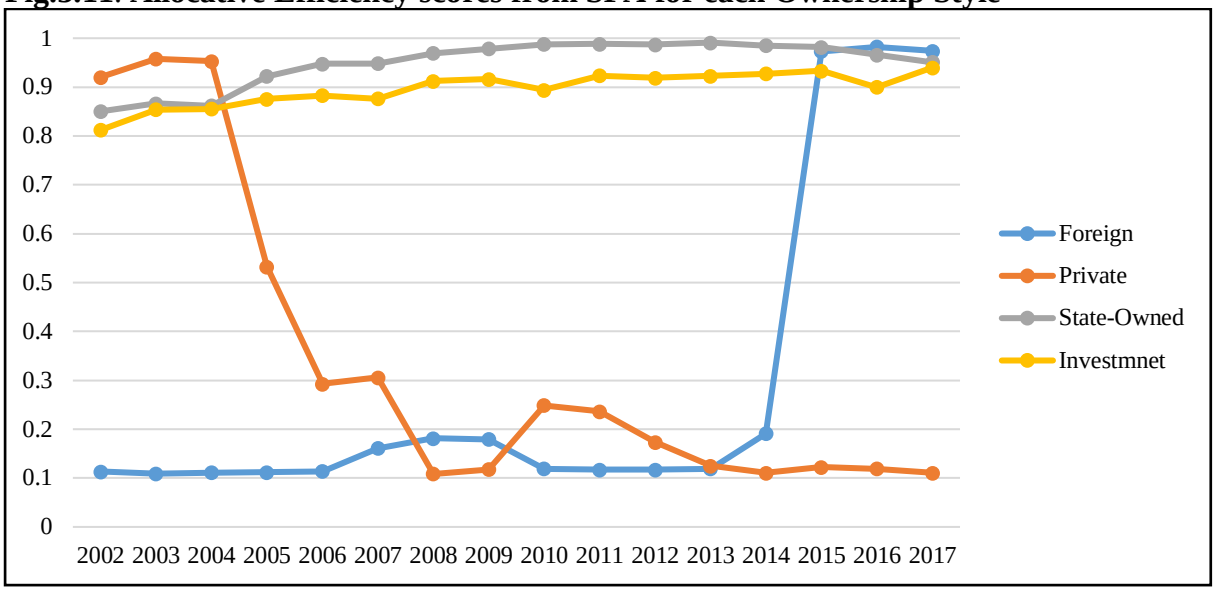
Note1. The above figure illustrates Cost efficiency per ownership in each quantile. State-owned banks are the most Cost efficient ones in all quantiles comparing to the other ownerships. The Cost efficiency is improving for the other ownership in upper quantiles.

Fig.3.10. Technical Efficiency scores from SFA for each Ownership Style



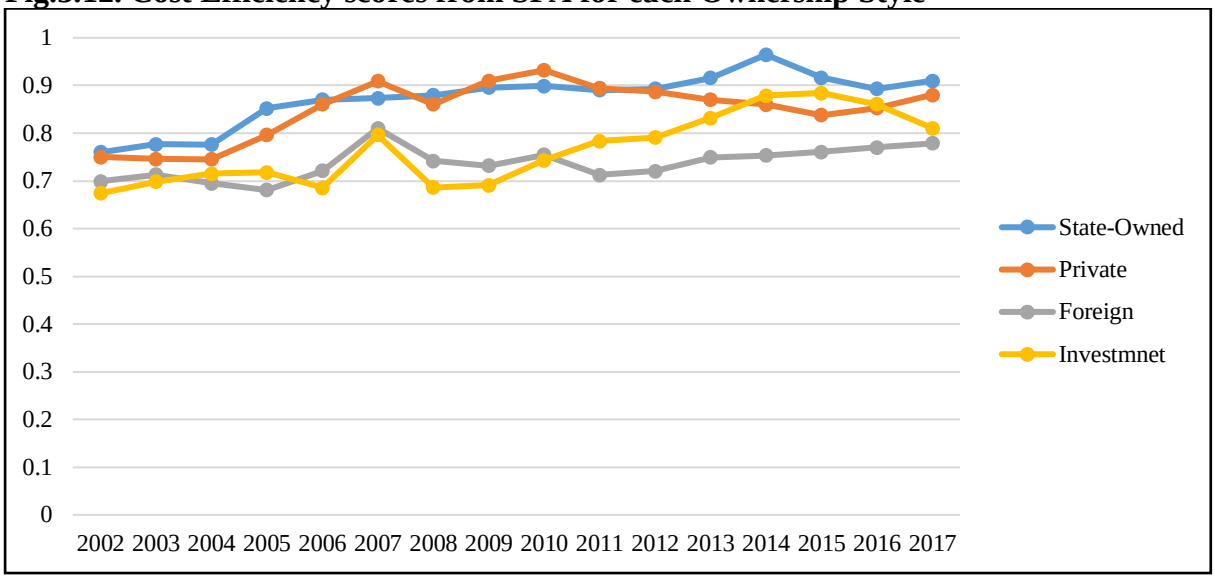
Note1. The above figure represents an annual average of Technical efficiency per ownership during 2002-2017. Technical efficiency score is computed running translog hyperbolic distance function. Investment and development banks represent the highest scores for Technical efficiency while state-owned and private banks show the least measures of Technical efficiency. This graph shows for Turkish banks.

Fig.3.11. Allocative Efficiency scores from SFA for each Ownership Style



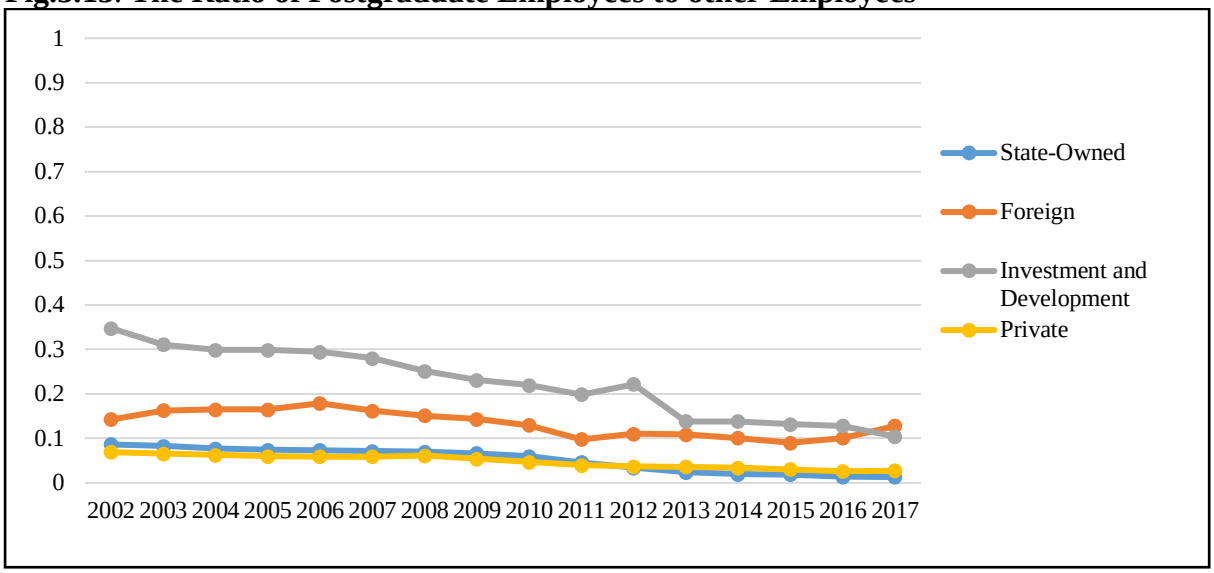
Note1. The above figure represents how Allocative efficiency changes during 2002-2017 in each ownership. Allocative efficiency score is computed running translog hyperbolic distance function. State-owned and investment and development ownerships represent the highest scores for Allocative efficiency during this time horizon while foreign and private banks show the least measures for Allocative efficiency.

Fig.3.12. Cost Efficiency scores from SFA for each Ownership Style



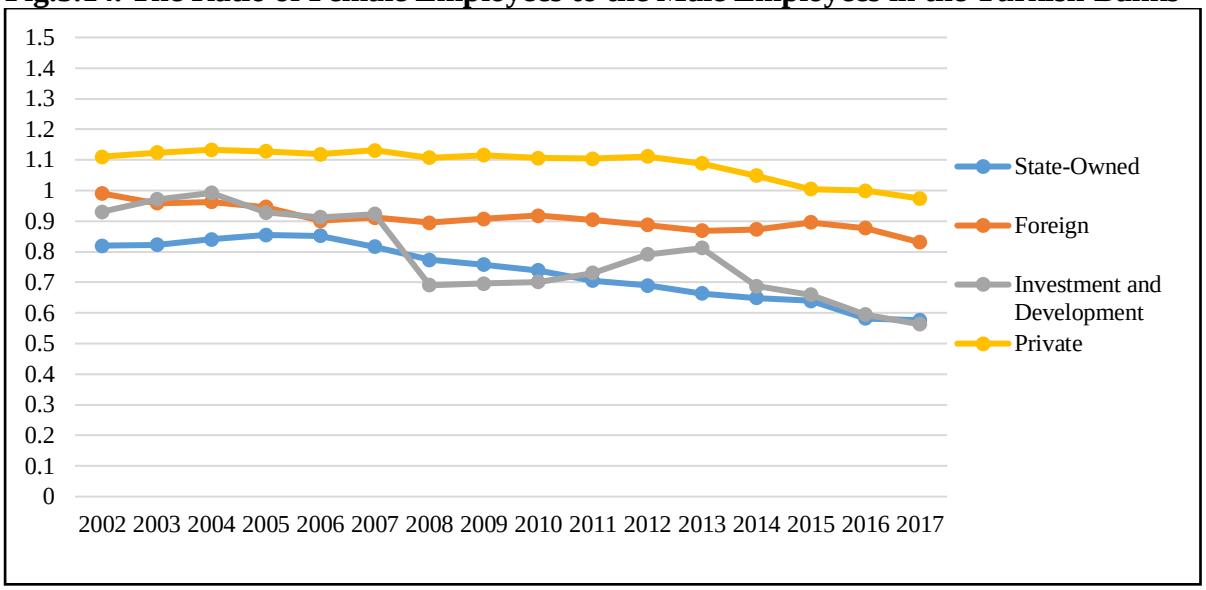
Note1.The above figure shows an annual average Cost efficiency per ownership for Turkish banks during 2002-2017. The Cost efficiency score is computed running translog hyperbolic distance function. Private and state-owned banks represent the highest scores for Cost efficiency during this time horizon. The lowest Cost efficiency score is for the investment and development ownership. The Cost efficiency scores flactuate for the foreign ownership during the study time horizon.

Fig.3.13. The Ratio of Postgraduate Employees to other Employees



Note1. The above figure shows the ratio of employees with postgraduate degree to the employees with other lower certificates in the Turkish banks. In the group of other certificates, this study considers employees with primary school degree, high-school diploma, and undergraduate degree. The slopes of this ratio for all ownerships show that the number of employees with other degrees is more than the employees with post graduate degree in the Turkish banks.

Fig.3.14. The Ratio of Female Employees to the Male Employees in the Turkish Banks



Note1. The above figure shows the ratio of female to male employees in the Turkish banks for all four types of ownerships. The downward slope of state-owned banks shows that the number of male employees is more than female ones in this ownership. The foreign and private ownerships represent almost constant trend during the time horizon of study. Moreover, gender diversity is changing continuously in the investment and development banks. Although the number of females was more than men from 2002 to 2004 and 2011 to 2013 in this ownership, after 2014 always male employees are more than female ones in investment and development ownership.

Chapter 4

How Monetary Policy Affects the Lending Channel in Turkey: Bayesian Estimation

Abstract

This paper investigates the role of Turkish banks in the monetary transmission mechanism, focusing on BLC, over the time horizon of 2002-2017. In particular, this paper introduces efficiency as an additional bank characteristic while examining the monetary transmission mechanism through BLC. We deploy a Bayesian estimation approach to examine the monetary transmission mechanism through BLC in Turkish banks. Specifically, this research considers the crises of 2000-2001 and 2008 to examine how monetary policy shocks influenced the loan supply in Turkey. Our empirical evidence confirms the existence of BLC in Turkish banks during the time horizon of this study. Moreover, based on the results, this is the first study confirming the impact of efficiency on BLC in Turkish banks – the influence of both technical and allocative efficiency, particularly, in a short period of time on BLC, indirectly and positively. As with Akinci *et al*. (2013), this paper finds other bank characteristics which indirectly influenced BLC between 2002 and 2017.

4.1. Introduction

This study examines the extent to which BLC has been affected by the recent financial reforms in Turkey. Continuous economic restructuring within the financial market has caused several systemic disruptions in the Turkish banking system during the last three decades. Moreover, Turkey has experienced a high volatility in its interest rates, which affect both the supply and demand sides of bank credit in the economy. These monetary policy changes are likely to have contributed to a change in the strategies banks use to grant loans, and design their loan portfolios. Despite the extensive structural and legal reforms initiated by the Turkish

government and the CBT, the balance sheets of commercial banks reflect a large volume of NPLs (Assaf *et al*., 2013; Fukuyama and Matousek, 2011). Given that the banking sector is the backbone of Turkey's economy, achieving a robust, well-regulated and effective banking system is crucial for the country. Consequently, considering the destructive impact of a volatile interest rate on NPLs is important because these undesirable loans influence the quality of the banks' balance sheet (Accornero *et al*., 2017; Schiantarelli *et al*., 2016; Ghosh, 2015). Hence, the Turkish government has realised that an efficient and profitable banking sector requires adequate micro and macroeconomic stability and a well-regulated market in order to operate and expand commercial activities.

In recent years, a considerable number of studies have attempted to investigate, through BLC, the impact of monetary policy shocks on bank behaviour. Some examples of these studies are: Ciccarelli *et al*., 2015; Bruno and Shin, 2015; Kishan and Opiela, 2012; Altunbas *et al.*, 2012; and Gambacorta, 2005. Regarding the application of the monetary transmission mechanism in Turkey, there are some studies based on different methods, such as VAR analysis in Gambacorta's (2005) study. The main focus of these studies is to evaluate the monetary transmission mechanism by assessing the loan demand/supply (for example, Ippolito *et al*., 2018; Bayramoglu and Allen, 2017; Duran *et al*., 2012). However, there are only a few studies which investigate the monetary transmission mechanism by considering the change in monetary policy regime in Turkey after 2001 (for example, Akinci *et al*., 2013; and Catik and Karacuka, 2011). Furthermore, due to the importance of measuring bank efficiency, especially after the global crisis in 2008, several research studies have been published on the performance, profitability, and efficiency of the Turkish banking system (Fukuyama and Matousek, 2017; Assaf *et al*., 2013; Fukuyama and Matousek, 2011; Aysan and Ceyhan, 2008a; Ozkan-Gunay and Tektas, 2006; Demir *et al*., 2005). However, amongst these studies on Turkey only Akinci

et al. (2013) attempts to detect the relationship that the monetary transmission mechanism has with the impact of bank efficiency on money supply in Turkish banks.

Efficiency is an important factor which should be considered in monetary transmission mechanism analysis. It is a factor which is discussed in different international studies. For instance, Apergis and Alevizopoulou (2011) estimate the impact of different efficiency scores on monetary policy through BLC analysis. They apply GMM estimator methodology across eight European countries and conclude that there is no relationship between the efficiency scores and the performance of lending channels. Another study is Altunbas *et al*. (2010) which considers the lending channel in the Eurozone countries. They give particular consideration to the risk and bank balance sheet factors in their study. In this latter study, efficiency is defined as a cost-to-income ratio. However, this thesis differs because we compute efficiency using the DEA model. Using modified DEA enables us to define a separate vector to examine the impact of undesirable outputs on efficiency. In our model 'efficiency' is not a balance sheet factor – it is a score showing how well a bank performs. Later in this study, our analysis will consider efficiency as an additional feature of a bank's characteristics and we will investigate what impact it has on lending channels.

Gambacorta (2008) conducted research into Italian banks. Using bank prices, the study attempts to separate the shift in loan supply from loan demand in BLC. Our study differs from Gambacorta (2008) because it is not considering the changes in loan supply and demand. Rather it considers the influence of a bank's characteristics on BLC in Turkey. In Gambacorta's study, efficiency is a balance sheet item whereas we measure technical and allocative efficiency using bank-specific characteristics. To do so, we consider NPLs as an undesirable output along with desirable outputs such as total loans and receivables, net security, off-balance sheet activities, and non-interest income and inputs such as capital and deposit to compute the technical efficiency scores. Evaluating NPLs separately enables us to monitor the changes in

NPLs due to a bank's inability to adjust with monetary policy shocks. To compute for allocative efficiency, we also consider the price of outputs.

Reviewing the banking literature, especially for developing countries and Turkey, there are still some vital gaps to be investigated within the research field of the Turkish banking sector and its monetary policy. This study provides new empirical evidence on BLC in Turkish banks while considering efficiency and NPLs.

This paper contributes to the literature as follows: Initially, it demonstrates how bank efficiency influences the BLC through the monetary transmission mechanism in Turkey. To the best of our knowledge, there is only one study available in which bank efficiency has been evaluated as an additional characteristic of banks when evaluating the existence of BLC, that of Akinci *et al*. (2013). This paper is superior to that study in a number of ways: This study considers both technical and allocative efficiency, which provides a wider picture of the impact of efficiency on BLC. Unlike the Akinci *et al*. (2013) study, the results obtained support the positive and significant impact of technical and allocative efficiency through BLC across long and short time periods. Secondly, this study fills the gap in the literature by imposing a unique method by which to test the existence of BLC in Turkish banks taking the Bayesian estimation into account. Applying the Bayesian estimation is superior to other methods as it provides an opportunity to define the prior and posterior on the basis of real information. Thirdly, this paper investigates whether the BLC depends on other bank characteristics, namely size, liquidity, and capitalisation, as has been discussed by other recent empirical studies for transition economies (for example, Akinci *et al*., 2013; Kashian and Opiela, 2006; and Kashyap and Stein, 1995). Fourthly, the impact of bank ownership is discussed in this paper. It is expected that this study will find foreign banks to be more efficient than state-owned and private banks in Turkey, as they reflect a lower NPLs ratio. This assumption is in contrast to other obtained results from transition economies, like those of Akinci *et al*. (2013). The reason for this expectation is

related to the total amount of NPLs in foreign banks operating within Turkey. Lastly, this paper investigates BLC over a longer period of time than previous studies, providing an appropriate window on to the main economic and financial challenges and crises in Turkey during the last three decades.

Although there is a rich global literature around bank characteristics that can directly or indirectly influence BLC, considering all financial innovations and technological developments, that there is a necessary requirement to expand the analysis by taking into account novel features of banks. Hence, this study takes technical and allocative efficiency as an additional feature in order to evaluate their impact on the Turkish BLC. The BLC mechanism could be changed by an improvement in the efficiency scores of the Turkish banks (Jonas and King, 2008). Due to sharper production functions in an efficient bank, the marginal curve in is flatter. As a result, the loan supply curve is more elastic. A more flexible production process enables an efficient bank to have a faster and greater response to the imposed monetary policy (Jonas and King, 2008). Accordingly, a bank's efficiency must be considered when analysing the functioning of the BLC with regards to monetary policy changes. This study is especially novel in the Turkish banking literature since not only does it take efficiency as an additional feature of banks but measures it using an approach wherein the impact of NPLs as an undesirable output will be evaluated individually. To measure the efficiency scores, as explained in the previous chapter, a modified version of the DEA is applied to compute both technical and allocative efficiency. This point is especially important because any sudden change in monetary policy leads to changes in a bank's loan portfolio. Indeed, changes in the interbank money rate and in a single bank's interest rate along with the willingness of banks to supply loans directly and indirectly influences the potential amount of their NPLs. Hence, emphasising NPLs rates also indirectly and directly indicates many facts regarding the management strategies, strength of the banking system, and effectiveness of a bank's policies.

Secondly, this study assesses the existence of any impact, either directly or indirectly, of monetary policy on Turkish banks' loans through the BLC by deploying the Bayesian estimation method (Belviso and Milani, 2006). Applying this approach enables us to impose more detailed background knowledge while defining prior and posterior, which results in a more accurate definition of the probability condition on the basis of the sample distribution. Advantages of Bayesian estimation make this method superior in comparison to the non-Bayesian methods. Bayesian estimation produces more trustworthy results due to its unique features regarding the ability to consider the prior information in the analysis, an intuitive interpretation of credible intervals as fixed ranges to which a parameter is known to belong with a pre-specified probability, and an ability to assign an actual probability to any hypothesis of interest. The other main advantage of Bayesian estimation compared to the non-Bayesian estimations, such as the GMM, fixed effect, and OLS, is the attribute of the deviations between the sample distributions and prior/posterior distributions.

Thirdly, considering efficiency along with the other bank characteristics, such as size, liquidity, and capitalisation, enriches this paper to provide a more advanced evaluation regarding the ability of Turkish banks to adjust in line with any unexpected monetary policy changes. In order to illustrate the most accurate behaviour of Turkish banks, this paper considers technical and allocative efficiency, since considering the technical efficiency indicates how well a bank can turn its available inputs, including assets and capital, into desirable outputs. In other words, this is how well a bank can generate money with the minimum amount of resource wastage. Allocative efficiency, on the other hand, represents both profit and cost efficiency in a bank. Hence, this study follows Lovell's (1993) explanation that state efficiency indicates a comparison between the optimal and observed values of generated outputs from a given level of inputs. Both efficiencies are computed using the DEA, which was used initially by Aparicio *et al*. (2015). After measuring the efficiencies, this paper investigates

whether the BLC in Turkey depends on the banks' characteristics, such as size, liquidity, and capitalisation. The other empirical studies for transition economies have also used these characteristics (for example, Akinci *et al*., 2013; Matousek and Saranties, 2009). In addition to the discussion around bank characteristics, this paper differs from previous studies by applying a different measure by which to assess the existence of BLC directly and indirectly through two and three interaction terms, and also by taking a longer period of time into consideration. Moreover, to gain a better understanding about the impact of efficiency, this factor is going to be evaluated separately for different types of ownership to detect the possibility of a bank's failure in the event of any sudden shocks.

Finally, this study contributes to the current literature by providing an exhaustive analysis of the Turkish banking system's development over the 15 years since 2002. Quarterly data was collected for 44 Turkish commercial banks from December 2002 to December 2017, from BAT.

The study finds that an operative BLC has existed in Turkey since 2002. In particular, it emerged that monetary policy changes on bank credit supply affects banks differently based on their characteristics. Moreover, our findings confirm that banks with weaker capital positions, greater dependence on market funding and non-interest sources of income restricted the loan supply more strongly in the event of monetary shocks. Ultimately, our results are in contradiction with those of Akinci *et al*. (2013), who found that domestic banks are more efficient than foreign banks.

The information emerging over the course of this study is beneficial for managers and policy makers in strengthening banks and detecting the main sources of inefficiency. It also highlights the characteristics that can help banks to behave more rationally during times of upheaval.

The remainder of this paper is structured as follows: Section 4.2 provides information about the Turkish banking system and its macroeconomic background. Section 4.3 reviews current

studies on BLC in general and in Turkey specifically. It also provides a summary of the previous studies on Turkish banks' efficiency. Section 4.4 outlines data, Bayesian estimation methodology, and the model to measure technical and allocative efficiency in the Turkish banking industry. Section 4.5 discusses the results and Section 4.6 provides some conclusive recommendations for policy makers and managers.

4.2. The Turkish economy and its banking system

One of the main milestones in the development of Turkish banks was their liberalisation in the 1980s. Having a strong and transparent banking system is crucial because Turkey, like many other developing countries, has a bank-oriented financial system. Accordingly, all of the monetary and fiscal policies implemented by the CBT to target inflation are imposed through the banks. Hence, it is important to monitor the quality of Turkish banks' financial statements and their performance. Since implementing the liberalisation policy, Turkey has received enormous capital inflows through various forms of foreign investment (Aysan and Ceyhan, 2008b). During the 2000s, the Turkish economy was planned around some fundamental aspects. The first and most important being to control weaknesses and implement further restructuring programmes to encourage economic activities. One of the most important changes in the development of the Turkish banking system started in 2001, following a currency crisis in that year. This reform plan was based on three main structural changes in the economic policy paradigm: budget control, capitalisation of the banking system, and an independent Central Bank. Due to the importance of the banking system in Turkey, it was decided that both policies for the economy and policies for the banking system would be enacted through banking activities. For instance, the regulatory and supervisory framework provided numerous amendments in banking laws and principles in order to strengthen the banking sector in general. These new amendments were in line with international standards and best EU practice. To proceed cautiously and minimise the financial risks, CBT increased CAR to 12%. This increase

at that time was even more than was common practice in the EU, where CAR was only 8%. From 2002-2006, an effective economic policy was employed with the support of structural reforms. These policies included (a) restructuring of the state-owned banks, (b) quick decisions for the SDIF banks, (c) strengthening of private banks, and (d) improving the regulatory and supervisory frameworks. Thus, Turkey experienced speedy disinflation and high growth rates in this period. Deterioration in economic stability started in Turkey in mid-2006, before the global financial crisis of 2008. Instability in the local market along with the impact of the global financial crisis in 2008 led to an undesirable economic situation in Turkey, which lasted until 2009. Later, after experiencing a negative growth rate of -4.7% in 2009, more reforms and policy amendments, like anti-inflationary plans, were implemented, and as a result of these effective policies and reforms, Turkey became more stable from the third quarter of 2009. Practically, Turkey was under a decade of reform plans. All of these reforms can be divided into two main categories: the first being 'management reforms' and the second, "governance reforms". While managerial reforms were aimed at improving the economy and the efficiency and effectiveness of the public sector, good governance reforms focused on transparency, accountability, responsiveness and participation in public administration.

In 2015, however, Turkey experienced serious local and international shocks regarding political uncertainty stemming from the 2015 parliamentary elections and the depreciation of the TL against the US dollar due to a lack of global liquidity in 2016, which led to fragile business confidence, fewer private investment demands, less tourism income, and the tightening of credit standards. Consequently, economic growth declined to 2.7% in this period. Similar to previous series of boom and bust in Turkey, following an economy slowdown in 2016, Turkey could again manage to address the issues in the financial market in 2017 through imposing fiscal stimulus[20] and policy-driven credit impulse, which boosted consumption and

[20] An increase in spending or reduction in tax level imposed by the government to encourage economic growth.

investments in 2017. According to an IMF assessment, Turkey will become the 13th largest economy in the world by 2026. Economic growth in Turkey increased beyond the predicted rate and reached 2.9% in 2016. The Turkish economic growth was expected to keep increasing until 2025 with an average annual growth rate of 4.9%, which is no longer significant considering the current situation. The most recently released statistics indicate that the growth rate in Turkey has declined, which suggests the failure of this predication. Hence, there is no guarantee that the predications of the IMF regarding the future of Turkey's ranking in the world economy will come to pass unless some massive changes happen.

Another phase of in the 2001 reforms focused on the Turkish banking system. Turkish banks' total assets accounted for 90% and 70% of the total assets in the Turkish financial market in 2002 and 2015, respectively. Hence, improving and strengthening the banking system in Turkey has been important. Accordingly, for the banking sector, the plan after 2002 was to reform the entire banking system progressively with the main aim of being profitable over time. Re-capitalisation of the banking sector was another achievable element of the planned reforms, particularly during the years immediately after 2002. The central point of the transmission programme in 2002 was a new Banking Act, which demanded the establishment of an independent BRSA, with the core task of implementing supervisory functions for all banks.

4.3. Literature review

4.3.1. Bank lending channel

Mishkin (1995) outlines how evaluating the impact of monetary policy on the economy began to be investigated in the late 1970s. Some of the main monetary transmission mechanism channels include interest rate, exchange rate, equity and real estate prices, bank lending, and balance sheet channels (Ireland, 2010). There are two main types of monetary policies. The first is conventional monetary policy. Inoue and Rossi (2019) explain that according to

conventional monetary policy any expansionary monetary policy shocks result in a currency depreciation in a country. In the case of conventional monetary policy shocks, we mainly consider changes in the interest rate. However, the second type of monetary policy we consider are unconventional monetary policy changes, which includes credit easing. Inoue and Rossi (2019) looked at US monetary policy decisions and their impact on the operation of financial entities from 1995 until 2016. According to their findings, monetary policy easing, belongs to an unconventional monetary policy type, depreciating the nominal exchange rate in both conventional and unconventional periods in the US. They also state that changes in expected real interest rates influence significantly the transmission of monetary policy shocks. Mishkin's (1995) research continues to discuss the issues around the impact of interest rate changes on asset expenditure and has generated a new perspective about the monetary transmission mechanism. This new view highlights how asymmetric information and costly contract enforcement contribute to agency issues in the financial market. Agency issues can generate two channels of monetary transmission; the BLC and the balance sheet channel. In the case of BLC the idea is that changes in monetary policy alter the loan supply of any depository institutions (Kishan and Opiela, 2000). On the other hand, while examining the balance sheet channel the focus is on loan demand (Disyatat, 2011).

Analysing the role of banks in the monetary transmission mechanism and particularly the BLC has received considerable attention globally, in both the economic literature and among practitioners. Mainly, these studies examine the existence of BLC in different European countries and in other countries around the world. For instance, Albertazzi *et al*. (2021) apply a monthly dataset to bank-level lending rates to study the transmission of conventional and unconventional monetary policy in the Eurozone. Their results show that the BLC is active for conventional and unconventional monetary policy tools. According to their results, bank characteristics in turn influence bank reactions to monetary policy changes. Matthys *et al*.

(2020) investigates banks' risk-taking behaviour in the context of the unconventional monetary policy in US banks between 2008 and 2015. They measure monetary policy by applying the identification-through-heteroskedasticity approach with a VAR model. Their results demonstrate that fixing the monetary conditions leads to lower loan spreads. They argue that this spread would be less for riskier banks. Albrizio *et al*. (2020) examine how domestic monetary changes can influence changes in the rest of the world. They evaluate the monetary policy shocks in the US and the impact of these shocks on other countries' bank lending. They use data from the first quarter of 1990 through to the last quarter of 2012. Their results suggest that the exogenous monetary policy tightening in more advanced economies results in a decline in bank lending. These results also highlight an increase in the international risk-taking behaviour of banks globally. Grandi (2019) studies the monetary transmission mechanism through BLC in the European banks from 2007 to 2016. He considers both conventional and unconventional monetary policy in his study while evaluating the monetary transmission through BLC. In particular, Grandi tests the impact of sovereign risk on bank reactions to sudden monetary policy changes. His results outline how, despite the initial perceived usefulness of the European Monetary Union with its single currency and centralised monetary authority, there is a heterogeneity in monetary transmission. This heterogeneity shows countries' difficulties in dealing with monetary policy shocks in the Euro area. Ippolito *et al*. (2018) demonstrate a link between a bank's loan rate and monetary policy rates. Hence, monetary policy can influence liquidity and balance sheet strength significantly. Their results show that tightening the monetary policy increases the debt-service responsibilities of borrowers. Their results also confirm that BLC plays a crucial role in the monetary transmission mechanism through a floating-rate channel, which contradicts the findings of some other studies relating to the US. Moreover, Vithessonthi *et al*. (2017) investigate the relationship between monetary policy changes, the loan supply changes of commercial banks, and banks'

investment behaviour. They looked at Germany, Switzerland and Thailand's monetary policies in the context of inflation targeting. There are four hypotheses in their study. They test whether a change in monetary policy positively changes the market interest rate in a short period of time. They consider the sensitivity of bank loans to the size of lending rates. Additionally, they explore the sensitivity of banks' investments to their investment opportunities in the context of a decrease in lending rates. Finally, they test the sensitivity of a bank's investment opportunities if there is an increase in loan supply. Their results only support the first hypothesis. They fail to confirm the remainder. Similar to Albrizio *et al*. (2020), Vithessonthi *et al*. (2017) also discuss the positive and direct impact of changes in US monetary policy on bank lending in Germany and Thailand. Salachas *et al*. (2017) examine the impact of monetary policy on BLC pre and post financial crisis in 2008. They consider 480 commercial banks from the US, the UK, Japan and the Eurozone (including Germany, France and Italy) from 2001 to 2013. First, they test bank liquidity. Then they examine how much a financial institution's funding depends on their balance sheet items or on financial market factors. They also examine the impact of monetary policy on the bank lending rate. Their results show that BLC effectively and actively responds to changes in a bank's interest rate before the financial crisis. However, they assert that after the financial crisis bank reactions to monetary policy changes were not so dependent on bank characteristics because their results for capitalisation and size are insignificant. Because they measure for both conventional and unconventional monetary policy tools, their results support the notion that unconventional monetary policy has a positive impact even after the financial crisis in 2008. Cantero-Saiz *et al*. (2014) examine how sovereign risk impacts bank loan supply decisions around monetary policy changes via the BLC. They argue that, due to the financial crisis, it is important to consider the sovereign risks in banks when examining the BLC of monetary transmission mechanism. Hence, along with bank size, liquidity and capitalisation, studying the impact of sovereign risk is necessary. They looked at European

banks between 1999 and 2012. Their results confirm the important role of sovereign risk in determining loan supply when there is tight monetary policy in Europe. In addition, Leroy (2014) provides an interesting study which examines bank reactions to monetary policy changes whilst considering their characteristics, especially their market power. The study considers the Eurozone countries between 1999 and 2011. The results suggest that banks with market power (calculated by Lerner index) are less sensitive to monetary policy shocks. These results are the same for the market structure as well. In other words, banks with more market power are less sensitive to the market structure. The influence of competition on the performance of these banks is less than that of banks with lower market power. According to their results between 2008 and 2011, BLC strengthened in the Eurozone countries due to implementation of unorthodox measures by the ECB during these years. Perera *et al.* (2014) look at the impact of off-balance sheet activities on the BLC in 114 South Asian commercial banks. They argue that having more off-balance sheet activities in a bank reduces the effectiveness of BLC in monetary transmission. According to this study the reason behind this is that banks with high off-balance sheet experiences are able to protect their loan supply and make better decisions in the wake of monetary policy shocks. Brei and Schklarek (2013) investigate the role of government-owned banks (equivalent to state-owned banks in our study) when a country experiences a financial crisis. They examine the loan supply changes in the government-owned banks and private banks during times of financial crisis. They collect data for 50 countries from 1994 until 2009 and impose a nested panel regression. Their results support of the notion that government-owned banks take risks by increasing the loan supply during times of financial crisis. This is an interesting finding which highlights the important role of government in the functioning of a country's banking sector. Olivero *et al.* (2011), similar to Leroy (2014), test how competition can potentially influence the transmission of monetary policy via BLC. They impose a two-step estimation using bank-level panel data for

the commercial banks across ten Asian and ten Latin American countries from 1996 to 2006. They measure the competition scores using Panzar-Rosse. Their results show that performing in a more competitive market reduces the impact of monetary transmission mechanism through BLC. They find stronger evidence for banks in Latin America and for smaller banks with a low degree of liquidity and capitalisation. Wu *et al*. (2011) study the impact of a greater degree of participation from foreign banks on the BLC of monetary policy transmission in emerging economies. They use a dynamic panel model of loan growth for 1273 banks in emerging Asian economies from 1996 to 2003. To verify the robustness of their results, they also apply OLS, GMM, and panel VAR models as well. Their results suggest that foreign banks are less sensitive to contractionary monetary policy shocks in host countries. This is because they reduce their loans and increase their loan interest rate to a lesser degree than other domestic banks. The lower sensitivity of foreign banks can also be attributed to their other characteristics, like liquidity, capitalisation, size, efficiency and riskiness. Their results emphasise the important role of foreign banks in stabilising the global financial market. In addition, Disyatat (2011) argues that the focus on policy-induced changes in the arena of bank deposits is misplaced. Hence, he reformulates the BLC evaluating monetary policy changes first on balance sheet strength and then on the financial entity's attitude to risk. His results give further weight to the argument that unconventional changes in monetary policy have an attendant impact on the lending channel. His results also confirm the role of bank characteristics in the way that a bank reacts to any changes or financial shocks. Matousek and Sarantis (2009) examine the BLC of monetary transmission in eight central East European countries (the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, the Slovak Republic, and Slovenia) from 1994 to 2003. In addition to considering bank characteristics, the authors also consider the impact of ownership by applying dynamic panel estimation techniques as well. Their results confirm the impact of bank size, liquidity, and capitalisation

on the BLC of monetary transmission. According to their results, bank size and liquidity play a more significant role in a bank's reaction to monetary policy changes. They also confirm the positive impact of having foreign banks present in the country and its positive impact on the overall performance of the banking sector. Jonas and King (2008) study the relationship between efficiency and monetary policy. They develop a hypothesis that for a given rate of interest the loan supply curve moves left when there is a monetary contraction. According to them, because more efficient banks have a flatter loan supply curve they react significantly by cutting their loan supply more than less efficient banks. To test this hypothesis the authors, use US banks and run SFA to estimate the cost efficiency. They also consider the banks on the basis of their asset sizes. Kishan and Opiela (2006) examine the impact of expansionary and contractionary monetary policy on loan decisions of both low and high capital banks between pre-Basel/FDICIA and post Basel-FDICIA periods. They outline that the BLC literature explains how contractionary monetary policy leads to decreases in the loan supply of capital-constrained banks and how expansionary monetary policy does not significantly increase the loan supply for the constrained banks. They evaluate this phenomenon and call it "policy-stance asymmetry". In addition to policy-stance asymmetry, they also consider cross-sectional asymmetry, which concentrates on the loan responses of capital-constrained and unconstrained banks. Their results confirm the impact of monetary policy changes on the low-capital and high-capital banks' reactions and support the argument that conventional expansionary monetary policy impacts on loan growth. Their results also highlight the fact that large high-capital banks do not react against contractionary monetary policy while the smaller high-capital banks increase loan growth in response to expansionary policy. Overall, bank characteristics play an important role in their responses to monetary policy changes following either conventional or unconventional monetary policy. Huang (2003) considers the BLC of monetary transmission in the US banks using balance sheet data information from 1975 until

1999. His findings indicate that a decline in loans decreases the bank-debt ratio. According to these findings, tighter monetary policy reduces loans. His results also confirm the existence of BLC of monetary transmission in the UK banks, which explains debt structure in UK banks and changes in this debt volume. Huang argues that the reduction of bank loans in the tight monetary policy period and the investment behaviour of a bank can be influenced by its characteristics, such as its size. Altunbas *et al*. (2002) looked at the BLC in Europe from 1991 to 1999. They particularly focus on balance sheet data and characteristics while evaluating the BLC in Europe. Their results confirm the positive impact of bank size and capitalisation on the loan supply reaction in the case of monetary policy shocks. Similarly, Kakes and Sturm (2002) focus on the impact of monetary shocks on BLC in Germany. In particular, they emphasise the banks' characteristics, such as size and balance sheet items. According to their findings, although larger banks do have fewer liquid assets, they can protect themselves against any unpleasant events in case of monetary policy shocks. Their results also reflect that private and co-operative banks experience more obstacles when monetary policy shocks happen.

Another similarity in the literature is evaluating the bank characteristics when considering BLC. The consolidation process and the impact of quantitative easing are among the other aspects that have been considered in the available literature while considering the existence of BLC.

Generally, BLC tries to state that any changes in the monetary policy might impact on loan supply policies. The BLC is to the result of a combination of a binding lending constraint and a deposit market constraint (Akinci *et al*. 2013). Generally, when the CBT reduces liquidity from the financial system, banks have no option than to shift from reservable funds to non-reservable[21] funds. The purpose of monitoring the bank lending is to highlight the issues in

[21] The funds that are earmarked by a bank from its earnings for future use, such as for the payment of unexpected bad debts. In the case of illiquidity, there would be more enough liquid sources to be reserved for any future use.

their balance sheets, which results in an increase of uninsured funds (Kishan and Opiela, 2006). Kashyap and Stein (2000) also argued that uninsured funds are also possibly dependent on opposing collection issues and credit rationing. Accordingly, these banks lose funds on their loans and are thus required to diminish lending to their customers in order to control their risk level. BLC signifies the opposing impact of higher interest rates on the supply of loans in a bank if both the bank and its customers fail to replace fully the missing loans with other possible credit sources. As a result, analysing non-interest income for a bank becomes enormously important. Indeed, different channels need to be assessed individually and differently. However, in the case of Turkey, due to its volatile interest rate and continuous changes in monetary policy, the lending channel should be evaluated separately from the standard interest rate channel.

The three main banking characteristics are examined in the existence of the lending channel. Kashyap and Stein (1995, 2000), Kishan and Opiela (2000), and Akinci *et al*. (2013) consider bank size as one of the characteristics that need to be considered. The idea is that smaller banks are more likely to fail due to issues related to information asymmetry in comparison to the larger banks. Moreover, these smaller banks have fewer possibilities to issue certain financial and market instruments, such as certificates of deposits. These findings suggest that the small banks are more sensitive to any sudden changes in monetary policy. The second characteristic that needs to be considered is the level of liquidity. Results and conclusions provided by Chatelain *et al*. (2003) and Kashyap and Stein (2000) indicate that banks with a high level of liquidity can more easily protect their loan portfolio by reducing their liquid assets. However, the scenario is inverse in the case of less liquid banks as they do not have enough liquidity to make these kinds of decisions. The last feature in the bank is related to bank capitalisation. Kishan and Opiela (2000, 2006) and Peek and Rosengren (1995) state that well-capitalised banks – due to their abilities and power to switch into uninsured funds when any monetary

policy shocks happen – reduce their loan supply to a lesser degree that less capitalised banks. As a result, it can be concluded that the capitalisation, the liquidity level, and the size of the bank are positively correlated with the bank's loan portfolio, especially in the event of any monetary policy shocks. In addition to these features, evaluating efficiency is particularly important. Hence, this study considers efficiency as an additional feature for the Turkish banks, according to which we can analyse the importance of the quality of the Turkish banks' financial statements. Moreover, efficiency provides a reliable indicator in predicting a bank's loan supply.

Accordingly, to test the BLC, two main approaches are applied in the current literature. First one separates the banks on the basis of their size, capitalisation and liquidity (for example, Kishan and Opiela, 2006; Altunbas *et al*., 2002; Kishan and Opiela, 2000; Kashyap and Stein, 2000, 1995). To implement and follow this approach, a considerable number of banks are needed, which in the case of studies on America or any other large countries is not an issue. Since the number of banks in Turkey is relatively small, applying this approach is not practicable. Under the second approach, we can apply a panel data model by which we can monitor the response of a bank to any monetary policy changes on the basis of the bank's characteristics. For example, one study that followed this second approach is that of Chatelain *et al*. (2003). The second approach is applicable even when the number of banks is small. Thus, it can be applied in our study. There are many adjustments and modifications on the market loans model, which was introduced by Bernanke and Blinder (1988). All these improvements resulted in a conclusion that can be linked to the response of loan portfolios to monetary policy shocks both directly, through the money channel, and indirectly by considering the bank characteristics, through BLC.

The transmission mechanism literature can be categorised into two main groups. The first group relies on aggregate data for its analysis (for example, Kashian and Opiela, 2006; Kashian

and Opiela, 2000; Kashyap and Stein, 1995; Bernanke and Blinder, 1988). These studies generally examine the banks' decisions around their loans and deposits when monetary policy is changing. The applied methodological framework that is used is VAR model. These studies, however, do not allow for the identification of supply and demand effects on credit growth. Consequently, the results obtained from these studies are mainly treated as suggestive results. The second group used bank-level data (for example, Akinci *et al*., 2013; Ashcraft, 2006). These studies attempt to investigate and understand shifts in loan supply from shifts in loan demand. The assumption is that a specific bank's features define the degree to which it responds to monetary policy changes. The studies from this second group usually apply the panel regression model, which typically distinguishes loan growth for each bank as a separate function of its aggregate variables. It also considers the bank's specific characteristics such as size, liquidity and capitalisation, which can determine the possibility of default for a bank during changes in monetary policy change. A key identifying statement is that all banks respond in similar ways to each other regarding the demand of loans. However, the issue with this empirical approach is that it usually ignores the fact that changes in monetary policy can be an exogenous event rather than an endogenous decision. Considering monetary policy changes as an exogenous shock makes any investigation on the true impact of high interest rates on supplied loans extremely difficult. This issue has not yet been addressed in an appropriate manner.

Due to the importance of evaluating and accounting for bank efficiency, in the next section we first review the bank efficiency studies in the transmission economies and then focus on Turkish banks' efficiency. This study introduces efficiency as an additional bank characteristic, which can provide a broad view of a bank's performance.

4.3.2. Lending channel in Turkish banks

On the basis of the CBT, the overall impact of interest rates on economic activity in Turkey is highly uncertain. The uncertainty arises mainly from the structural changes that Turkey has undergone since the 2001 crisis. These structural changes include the capitalisation of the Turkish banking system, relaxing and adopting a flexible exchange rate system, and continually improving the "inflation-targeting framework". Hence, applying econometric techniques to the pre-crisis period is not very informative with regards to the current performance of Turkey's monetary transmission. Simultaneously, many other local instabilities and financial aspects happened during the post-crisis period due to which interest rates fluctuated massively. Nevertheless, a better understanding of Turkey's monetary transmission is important for effective monetary policy management.

The existence of a lending channel in the Turkish banking sector is attracting the attentions of many scholars and researchers because the banking sector is the backbone of the financial market and performs more effectively as an intermediation in developing countries. Indeed, the opinion that the BLC plays a role in Turkey is clearly reflected in the CBT's expectation that the supply of bank credit would reduce due to the high short-range interest rates and liquidity withdrawal.

Establishing a lending channel can be difficult for two reasons. First, variations in interest rates are typically the result of changes in economic circumstances. Additionally, all channels of monetary transmission are willing to work together, which complicates their separate identification. For instance, by increasing the interest rate, bank credit may decrease because of either less loan demand, which can be related to the interest rate channel/balance sheet channel, or less loan supply, through BLC, or sometimes even both.

Generally, there are two circumstances under which banks can operate a lending channel. Initially, banks should not be able to buffer their loans portfolio completely against any changes

in monetary policy. This means that banks would not be able to fully balance their shortage in liquid funds, considering the restriction of the monetary policy situation, from any alternative fund sources without paying the added costs. Consequently, loan supply diminishes in banks. The other assumption is that a large number of borrowers in the market are not able to protect their spending from the bank credit discount. Consecutively, total real investment and consumption can be reduced (Drehmann and Gambacorta, 2012). Theoretically, depending on the banks' features, banks may respond to the monetary policy shocks differently. Hence, this paper evaluates four fundamental bank characteristics while examining the existence of BLC in Turkish banks.

The main aim of this study is to investigate whether the BLC has been influenced by the financial reforms in Turkey after 2001. The vital question is how changes in monetary policy can influence bank lending on the basis of bank characteristics. In other words, this paper aims to investigate and assess the extent to which Turkish banks, with various financial positions and characteristics, are being influenced by monetary policy changes. Hence, this study focuses on the main characteristics of banks, namely their size, liquidity and capitalisation. Additionally, NPLs, as a proxy according to which the strength of a bank's balance sheet may be determined, are going to be considered in measuring the efficiency of the Turkish banks. Hence, efficiency is an additional bank characteristic, on the basis of which their financial strength against any possible shocks can be tracked.

4.3.3. Bank efficiency in transmission economies

The following section discusses the related literature on bank efficiency in transition economies. The reason behind this is that a broader view of efficiency analysis and with a comparison between these studies and similar studies on Turkey can be seen as beneficial in obtaining a deeper understanding and better results. Moreover, available information on efficiency studies can be combined with a consideration of bank ownership, providing a

hypothesis to evaluate in this study. Among numerous studies about transition economies, those by Bonin *et al*. (2005a) and Fries and Taci (2005) examine the impact of bank ownership on bank efficiency. Their results suggest that foreign banks are more cost-efficient than national banks. The reason for this could be due to currency changes or the environment in which the foreign banks are operating. Sometimes, foreign entities are required to follow some specific principles, which in the end help them to perform much better in comparison to their mother branch. Kasman and Yildirim (2006) assessed both the profit and cost efficiencies of commercial banks in eight Central and Eastern European countries. These countries are interesting to investigate as they have improved their systems to match the international standard. Kasman and Yildirim (2006) report a significant level of cost and profit inefficiency. Without mentioning the main reasons for these inefficiencies, the authors state that no stable efficiency achievements can be reported in these new EU member states within the time horizon of their study. These findings are not in line with the other studies on transition countries, which report a better banking performance and higher efficiency levels in the banking sectors of these countries during the late 1990s. Perhaps the only constant in these studies relates to the performance of foreign banks, which have largely been evidentially proved to be better than the domestic banks. Recent similar studies are those by Assaf *et al*. (2013) and Koutsomanoli-Filippaki *et al*. (2009). Recently, scholars have been more interested in applying a directional technology distance function in order to assess the profitability and efficiency changes in almost developing countries. For instance, Shamshur and Weill (2019) examine the relationship between bank efficiency and the cost of credit for borrowing firms. According to the authors, bank efficiency can be defined by a bank's ability to minimise the total operating cost. They consider both firm-level data and bank-level data for 240,000 companies across nine European countries. Their main finding is that higher efficiency scores in a bank can result in a lower cost of credit. Peng *et al*. (2017) consider the impact of the

collaboration of insurance companies on a bank's efficiency and profitability in Taiwan. They run DEA to measure bank efficiency scores. Their results fail to provide sufficient evidence to support the impact of the collaboration between insurance companies and banks in Taiwan. Wang *et al*. (2014) compute the efficiency scores for Chinese commercial banks using the two-stage network DEA. They are especially interested in Chinese banks efficiency scores from 2003 to 2011. According to their findings, Chinese banks' efficiency has improved overall. In China, their results show higher efficiency scores for the state-owned banks compared to the joint-stock commercial banks. They also investigate the impact of NPLs. Their result shows that having fewer NPLs makes for better efficiency scores in Chinese banks.

Gaganis and Pasiouras (2013) examine whether a bank's profit efficiency can be influenced by the interactions and supervision of a country's central bank, and if yes, what kind of impact this interaction may have on bank performance. They use data from 3886 commercial banks across 78 countries from 2000 to 2006. Their results confirm a negative impact of central bank supervision on efficiency scores. Sun and Chang (2011) examine the role of risk on the cost efficiency of international banks in eight emerging Asian economies (India, Indonesia, Korea, Malaysia, Philippines, Taiwan, Thailand and China) applying both DEA and SFA. Their results emphasise the important role risk plays in bank efficiency. Their results are in line with Delis *et al*. (2017) on US banking efficiency and risk. Staub *et al*. (2010) measure the cost, technical, and allocative efficiency for Brazilian banks over the period 2000 to 2007 using the DEA method. Brazilian banks are overall less cost efficient than European banks. Between 2000 and 2002, the main source of their inefficiency was technical. Their results show that, in Brazil, state-owned banks are more cost efficient than foreign ones. Berger *et al*. (2009) investigate efficiency in the Chinese banking sector giving consideration to the impact of reforming its banking sector between 1994 and 2003. Their findings suggest that the big four state-owned banks are not performing as they should, demonstrating low efficiency scores compared to the

foreign banks in China. This is important because the majority of banks in China are state-owned, with foreign banks being in the minority. Lensink *et al*. (2008) is another study which investigates the impact of ownership on bank efficiency scores. They are especially interested to these whether the efficiency of foreign banks depends on the institutional quality of their host country. They run SFA for 2059 commercial banks in 105 countries from 1998 to 2003. They find that foreign banks are not more efficient compared to the other types of ownership. Their results also confirm the fact that when the economic environment of the home and host countries are similar, or when there is a higher institutional quality in the home country, the performance of foreign banks in the host countries is better and more efficient.

4.3.4. Turkish bank efficiency

As discussed earlier, one of the main contributions of this study is introducing technical and allocative efficiency as additional characteristics while evaluating the monetary transmission mechanism through BLC. Considering efficiency as a bank characteristic is especially important as it highlights how well a bank is able to convert its assets into desirable outputs. In the available literature on monetary transmission mechanisms through different channels the importance of strengthening balance sheet quality is always discussed. Hence, considering the importance of reducing the NPLs is crucial – they are an undesirable output, and have a significant impact on the quality of a bank's balance sheet. Hence, in this study we measure technical and allocative efficiency while our model maximises good outputs and minimises bad outputs simultaneously. We also evaluate the impact of NPLs independently. Before discussing in depth, the contribution and aims of this study, it is important to review the available studies around bank efficiency in Turkey. Some of the main studies such as Isik and Hassan (2002), assessed the efficiency in Turkish banks over the period 1988–1996 by applying many different methods including both non-parametric and parametric approaches. According to their findings, inefficiency in Turkish banks is due to technical inefficiency rather

than allocative inefficiency. Moreover, these studies state that the foreign banks perform more efficiently than domestic Turkish banks. Assaf *et al*. (2013) investigate the productivity and efficiency of Turkish banks between 2002 and 2010 applying a Bayesian stochastic frontier approach. They focus on the impact of NPLs and introduce them as a bad output in an input distance function. Their results confirm an improvement in the efficiency and productivity of Turkish banks between 2002 and 2010. Their results also demonstrate the negative impact of NPLs on the efficiency scores in Turkish banks. Interestingly, they discuss the shadow prices of NPLs as well. According to their results the shadow prices of NPLs had a downward slope until 2008 when the financial crisis happened. They also discuss that foreign banks, which only have branches in Turkey, are more efficient than domestic banks. Kasman (2012) used a three-input/three-output Fourier-flexible cost function to examine cost efficiency, economies of scale, and technological improvement in the Turkish banking sector over a decade, from 1988-1998. The empirical results of this study show that the Turkish banking system was suffering from a major inefficiency problem in this one decade, which is a reasonable assumption since Turkey was experiencing a financial crisis and an unstable economic situation during that period of time. In his study, the average yearly inefficiency levels reflected a decline over the sample period. Kasman (2012) claimed that Turkish commercial banks operated more inefficiently in comparison to their branches in other more developed countries, such as the US and European countries, which could be due to the economic environment in those countries. Kasman's study demonstrates the presence of scale economies across the sample. Additionally, there is no evidence reported in his study related to the diseconomies of scale for the large banks.

Fukuyama and Matousek (2011) apply a two-stage network model to evaluate technical, allocative and cost efficiencies in Turkish banks from 1991 to 2007. Considering this two-stage network model, in the first stage the bank using the given input produces an intermediate

output, which in this case is deposit. Then this intermediate output (deposit) then forms the input for the second stage to produce final output. The study's results show that Turkish banks positively react to the consolidation and restructuring programme. According to them, although Turkish banks experience a significant improvement in their efficiency scores after the 2000-2001 financial crisis, efficiency declines between 2004 and 2007. Their results do not confirm that foreign banks are more efficient than domestic banks in Turkey. Reviewing the Turkish literature shows a different finding about the efficiency of foreign banks compared to other types of ownership in Turkey. Denizer *et al*. (2007) studied bank efficiency pre- and post-liberalisation in Turkey by applying DEA. Unlike many other studies that support a positive impact of liberalisation on Turkish bank efficiency, they concluded that liberalisation programmes had a negative impact on Turkish bank efficiency, decreasing it. Another conclusion of their study stated that this decline in bank efficiency, more than the liberalisation programme, was due to macroeconomic instability. This finding is in contrast with the finding of Ertugrul and Zaim (1999) whose results seem to confirm the positive impact of liberalisation on the Turkish banking sector and its performance.

Another study around the efficiency of Turkish banks is that of Ozkan-Gunay and Tektas (2006), who examined the technical efficiency of private commercial banks from 1990 to 2001 by deploying the DEA model. A gradual decline in bank efficiency between 1990 and 2001 has been shown in their study, which was most probably due to two financial crises, in 1994 and 2001. Isik and Hassan (2003a) run both DEA and SFA to evaluate the efficiency of Turkish commercial banks considering the impact of ownership, market structure, and other efficiency determinants, like size, between 1988 and 1996. They find foreign and public banks to be more efficient than private banks in Turkey in terms of cost and technical efficiency. Moreover, their results do not demonstrate an impact of size on efficiency. Their results also suggest that the more efficient banks monitor and manage their loans better than the less efficient banks in

Turkey. They confirm the negative impact of NPLs on efficiency scores. Isik and Hassan (2003a) also examine the impact of the financial reforms introduced during the 1980s on the Turkish banks' productivity, efficiency, and technology during 1981 and 1990. They run DEA-type Malmquist Total Factor Productivity Change Index in their study. Their results show that the performance of all types of banks in Turkey improved after implementing financial reforms. However, according to this latter study there are not many changes to technological efficiency. Moreover, introducing some novel banking activities, like off-balance sheet activities, improved the technical progress in Turkish banks.

Reviewing the efficiency literature in the Turkish banking sector highlights the fact that there are still spaces to investigate about the additional banks 'characteristics and their impact on the banks' performance. Hence, this study evaluates the monetary transmission mechanisms through BLC to evaluate the impact of monetary policy changes on loan supply reactions, considering bank efficiency (as an additional characteristic) and NPLs as an undesirable output. The next section discusses our data and model.

4.4. Data and model specification

This study uses quarterly data for 44 Turkish commercial banks over the period 2002-2017[22]. These data are collected from the BAT. The current research investigates almost the entire number of Turkish commercial banks.

4.4.1. Background and motivation of applying Bayesian estimation

Bayesian analysis is a method that responds to questions with unknown parameters by applying probability statements. Bayesian estimation is in line with the probability principle, which is called Bayes' rule. This principle provides a function for combining prior information with available evidence from the collected data. Bayes' rule applies to shape the posterior distribution of model parameters. Bayesian estimation starts by defining the posterior model.

[22] Table 1.1 illustrates the list of these banks with their ownership type definitions.

The posterior describes the probability distribution of all applied parameters in the model on the basis of collected data and some prior information. The posterior has two components including likelihood, which represents some details the model itself has collected from available data, and a prior, which indicates prior information. Combination of prior and likelihood using Bayes' rule produces the posterior distribution.

$$Posterior \propto Likelihood\ X\ Prior$$

Due to the complexity of the above combination, posterior usually needs to be stimulated through simulation methods such as the Markov chain Monte Carlo (MSMC) method. This method for simulating Bayesian models usually requires an efficient sampling algorithm. Interval estimations are one of the outcomes from posterior distributions. Other estimations in the Bayesian estimation model including mean and standard deviation. In Bayesian estimation, the two Bayesian hypothesis tests available are interval-hypothesis testing and model-hypothesis testing. The interval-hypothesis testing analyses if a parameter or parameters belong to a specific interval or intervals, while the model-hypothesis tests how possible it is to compute the desired Bayesian model considering the given data. This study to examine the existence of lending channels in Turkish banks uses the prior testing.

As discussed in the introductory section, applying Bayesian estimation is superior to non-Bayesian methods. Bayesian analysis is a prevailing technique in the interpretation of results. It is consistent with Bayes' rule for all the parameters, which makes this method easy to apply. The information that is provided using both likelihood and prior to define the posterior of the model can add to its creditworthiness. In other words, the Bayesian method enables the user to use previous and historical real data of prior in shaping the posterior assumptions and distributions. Hence, applying the knowledge of posterior distribution of the method parameters makes the Bayesian analysis a more comprehensive and flexible measure in

comparison to other traditional models. Moreover, this information provides a straightforward and more intuitive analysis of the results in terms of probabilities. In addition, Bayesian analysis is not limited by the sample size and complexity as it can use other simulations with an arbitrary degree of precision. Despite all the advantages, this method is criticised by scholars. It has a degree of subjectivity in determining prior information. Moreover, there are some computational issues in implementing the Bayesian method. However, considering the advantages of Bayesian analysis, its applicability to this study's data distribution, and to address the further directions suggested by Akinci *et al*. (2013), this paper imposes Bayesian estimation to address the aim of the study.

4.4.2. Bayesian estimation

To run the Bayesian model, this paper follows Belviso and Milani (2006), who used the Bayesian estimation with a novel and different perspective. According to them, unlike the two-step method and non-Bayesian models, the Bayesian estimation approach considers both the observation and the transition equation together. Following the approach of Belviso and Milani (2006) enables this research to take the available knowledge and prior information into the estimation process. By doing so, more precise and accurate results can be reported. Similar to Belviso and Milani (2006), this paper deploys the Bayesian estimation to estimate the measurements for addressing the aim of the study, which is analysing the existence of BLC in the Turkish banking sector after 2001 with a consideration of bank characteristics. To run the Bayesian estimation the five stages outlined below will be followed in this study. The first step is to solve the linear rational expectation model. Generally, the model can be shown as:

$$\Gamma_0(\Theta)\, x_t = \Gamma_1(\Theta)\, x_{t-1} + \Gamma_\varepsilon(\Theta)\, \varepsilon_t + \Gamma_\eta(\Theta)\, \eta_t \qquad (4.1)$$

where x represents the vector for endogenous variables, ε shows the vector related to the exogenous process η, $E_t[\eta_{t+1}] = 0$ shows the predication errors for the rational expectation,

and Θ denotes the given parameter vector. The solution for the linear rational expectation model then is:

$$x_t = \Phi_1(\Theta)\, x_{t-1} + \Phi_2(\Theta)\, \varepsilon_t \quad (4.2)$$

In the second stage, the measurement equation relates the model variable *x* to a vector of observables, z:

$$z_t = A(\Theta) + B x_t \quad (4.3)$$

where A(Θ) represents the constant vector for the parameters, and *B* represents the matrix involving the selected factors for the model variable *x*. The third stage relates to the likelihood function, which should be taken to define the posterior distribution. It is represented by $L(\Theta|z)$, where $Z = \{z_t\}_{t=1}^{T}$ is estimated by the Kalman filter.[23] Assessing the vector for parameter Θ applying the maximum-likelihood function is not an easy step to take. That is because the maximum likelihood function is defined as a multi-dimensional parameter function, which might represent two or multiple peaks, or a flatter shape around the peak. Thus, to fix the complexity, for the fourth step, it is necessary to combine the likelihood function $L(\Theta|z)$ with the prior distribution $p(\Theta)$ in order to achieve the posterior density function as:

$$P(\Theta|z) \propto L(\Theta|Z)p(\Theta) \quad (4.4)$$

After combining prior distribution with maximum likelihood, a numerical optimisation routine should be used to maximise $\ln L(\Theta|z) + \ln P(\Theta)$ to achieve the posterior mode of $L(\Theta|z)\, P(\Theta)$, and the inverse or negative of the Hessian[24] of $L(\Theta|z)\, P(\Theta)$ should be evaluated at the posterior mode of $\Theta = \tilde{\Theta}$, which is indicated by $\tilde{\Sigma}$. $\tilde{\Sigma}$ is calculated as:

[23] Kalman filter is an algorithm that applies a series of measurements to observe the statistical noises and other estimations of unknown factors that are more accurate than using single measurements. It uses the joint probability distribution over the parameters.

[24] The negative Hessian represents the estimated standard errors. It tells us about the variance of parameters, or, if there are more parameters, the variance covariance matrix of parameters.

$$\tilde{\Sigma} = -\left[\frac{\partial^2 L(\Theta \mid z)\, P(\Theta)}{\partial \Theta\, \partial \Theta'} \mid_{\Theta = \tilde{\Theta}}\right]^{-1} \quad (4.5)$$

Finally, the posterior distribution for all the parameters can be obtained from the MCMC algorithm. In this algorithm, $\Theta^{(0)}$ as an initial value is selected from the normal distribution[25] of $N(\tilde{\Theta}, C_0^2 \tilde{\Sigma})$, while Θ represents the scale factor that regulates the variance, which is obtained from a proposal distribution of $N(\Theta^{(S-1)}, c^2 \tilde{\Sigma})$ for S=1… n, where c > 0. It is important to consider an assumption from which the jump from $\Theta^{(S-1)}$ is only recognised with the below probability:

$$\min\left(1, \frac{L(\Theta \mid z)\, P(\Theta)}{L(\Theta \mid z)\, P\, \Theta^{(S-1)}}\right) \quad (4.6)$$

Any other jumps are rejected otherwise ($\Theta^{(S)} = \Theta^{(S-1)}$). The arrangement of $\{\Theta^{(1)}, \Theta^{(2)}, \ldots, \Theta^{(n)}\}$ converges to the correct distribution, which can be represented as $L(\Theta \mid z)\, P(\Theta)$ as $n \to \infty$.

This paper assumes a condition in which the number of the exogenous shocks is equal to or greater than all of the observed variables in order to prohibit the stochastic singularity in the Bayesian estimation. To run the model, there are four endogenous variables, $x_t \equiv \{y_t, p_t, rs_{t,} z_t\}$ and three exogenous shocks, $\varepsilon_t \equiv \{\varepsilon_{y,t}, \varepsilon_{\pi,t}, \varepsilon_{r,t}\}$. Hence, we would be able to take a maximum of two observed variables. Two observed variables are represented by $z_t \equiv \{y_t, p_t\}$. Hence, the prior in this study can be shown as:

$$(\beta|\sigma^2) \sim MVN(0, g\sigma^2(X'X)^{-1}) \quad (4.7)$$

$$\sigma^2 \sim InvGamma\,(\nu_0/2, \nu_0\sigma_0^2/2) \quad (4.8)$$

The bank characteristics, which are the endogenous variables, in this study are capital ratio (calculated by dividing total equity to total asset), liquidity ratio (calculated by dividing the

[25] In running the model, this paper used normal regression to define the likelihood model with the variance of 0.5.

liquid asset to total assets (Kishan and Opiela, 2000), and bank size (a log of total assets). An additional bank characteristic in this study is efficiency.

To measure for technical and allocative efficiency following on from Fukuyama and Matousek (2017), this paper considers deposit and capital as two inputs. Accordingly, the desirable outputs are loans and receivables, net securities, total off-balance sheet activities, and non-interest income. An undesirable output considered in this study is NPLs. In order to compute the allocative efficiency, it is necessary to define the output prices. Hence, the price of capital, the price of deposit, the price of loan, the price of securities, and the price of NPLs are also taken, which will be explained in detail in the following parts of this section. It is particularly interesting to evaluate the impact of monetary policy on the reflected ratio of NPLs in a bank's financial statements. Also, the NPLs ratio, considering the total amount of loans and receivables, is something that is worth evaluating as it can reflect the ability of banks to generate money and be profitable. Some selected financial indicators, such as Net profit/total asset, which represents ROA, are reported in Table 4.10.1 to indicate overall Turkish banking performance and changing trends in the main indicators, imposing different restructuring programmes. Since considering the macroeconomic main indicators, namely real GDP growth and inflation, and the bank money market ratio are important, as the CBT or government decides who may be affected by them in changing the monetary policies in a county, the exogenous variables in this study are real GDP growth, inflation, and the bank money market ratio.

The standard errors are considered to be an inverse-gamma distribution with a mean of 0.5 and two degrees of freedom, which relates to a loose prior.

To define the bank characteristics, we follow Akinci *et al*. (2013), amongst others, as:

$$S_{it} = lnA_{it} - \frac{\sum_{i=1}^{N_i} \ln A_{it}}{N_i} \tag{4.9}$$

$$LIQ_{it} = \frac{LA_{it}}{A_{it}} - \frac{\sum_{i=1}^{N_i} (lA_{it}/A_{it})/N_i}{T} \quad (4.10)$$

$$CAP_{it} = \frac{C_{it}}{A_{it}} - \frac{\sum_{i=1}^{N_i} (C_{it}/A_{it})/N_i}{T} \quad (4.11)$$

$$Eff_{it} = \frac{Eff_{it}}{A_{it}} - \frac{\sum_{i=1}^{N_i} (Eff_{it}/A_{it})/N_i}{T} \quad (4.12)$$

Where A illustrates the total assets in a bank, LA shows a bank's liquid assets (for example, securities, cash and so forth), C shows a bank's total equity as its capital and reserves, Eff represents the efficiency level, and Ni is the number of panel observations that are accessible for the i^{th} bank. All of the bank characteristics and the other data are normalised. Doing this enables us to ensure that any monetary policy effects can be represented directly by the Γ_j coefficients in (4.1) (Gambacorta, 2005; Ehrmann *et al*., 2003). Following on from the above discussion, the interaction term of a bank's main features with the short-term interest rate pictures the distributional impact of the monetary policy position.

The literature has argued that larger, more liquid and better capitalised banks are less sensitive and so respond less strongly to monetary policy shocks compared with smaller, less liquid and less capitalised banks. In order to represent the discussed relations, in line with Akinci *et al*. (2013), this paper considers the below inequalities for illustrating the hypotheses of presence of a BLC. If:

$$\left(\frac{\partial^2 \Delta lnL_{it}}{\partial \Delta R_{it-j} \partial S_{it-1}}\right) > 0 \quad (4.13)$$

This indicates that the loan portfolio of a large bank is less sensitive against any monetary policy changes compared to smaller banks.

$$\left(\frac{\partial^2 \Delta lnL_{it}}{\partial \Delta R_{it-j} \partial LIQ_{it-1}}\right) > 0 \quad (4.14)$$

As shown above, the same hypothesis can be developed for liquidity. So, more liquid banks are more flexible in increasing their lending ratio through decreasing their stock of liquid assets.

$$\left(\frac{\partial^2 \Delta ln L_{it}}{\partial \Delta R_{it-j} \partial CAP_{it-1}}\right) > 0 \tag{4.15}$$

Moreover, as is illustrated below, banks with more capitalisation are less sensitive to monetary policy changes. Finally, more efficient banks are supposed to be less sensitive to any sudden monetary policy shocks, so:

$$\left(\frac{\partial^2 \Delta ln L_{it}}{\partial \Delta R_{it-j} \partial EFF_{it-1}}\right) > 0 \tag{4.16}$$

Therefore, to show the presence of a BLC, a positive coefficient should be seen in two-way interaction terms ($S_{it-1}Liq_{it-1}R_t$, $S_{it-1}Liq_{it-1}R_{t-1}$, $S_{it-1}Cap_{it-1}R_t$, $S_{it-1}Cap_{it-1}R_{t-1}$, $Liq_{it-1}Cap_{it-1}R_t$ *and* $Liq_{it-1}Cap_{it-1}R_{t-1}$) while running the Bayesian estimation, which proves that $\Theta_{kj} > 0$. Later, in the other model, this study indicates whether or not the defined three-way interaction terms ($S_{it-1}Liq_{it-11}Cap_{it-1}R_t$ *and* $S_{it-1}Liq_{it-11}Cap_{it-1}R_{t-1}$) are significant determinants of loan growth. For the same explained reason, the expectation is that we would see positive coefficients for the three-way interaction terms in the existence of a BLC. All the two- and three-way interactions have also been tested for both technical and allocative efficiency. The results are reported in Tables 4.4 and 4.5.

4.4.3. Technical and allocative efficiency measures

As discussed above, this study aims to examine the impact of bank efficiency as an additional characteristic on BLC. In other words, this study looks for other important factors in the banking sector that may influence a bank's reaction apart from size, liquidity and capitalisation. Hence, both technical and allocative efficiencies are measured using modified DEA with directional distance function, which was introduced and applied initially by Aparicio *et al*. (2015). Applying this method enables us to distinguish a separate vector for undesirable

outputs, which in this study is NPLs, to estimate the efficiency scores. Additionally, efficiency error can be separated from model error, which also helps to clarify the source of inefficiency in a bank. This model can be written as:

$$\overrightarrow{D_T}(X, Y^g, Y^b; d) = \sup [\, \delta : (Y^g + \delta d^g, Y^b - \delta d^b) \in \rho(X - \delta d^x)] \quad (4.17)$$

In the above formula, d = $(-d^x, d^g, -d^b)$ and the value δ shows the technical inefficiency. Furthermore, the directional technology function (4.17) is designed to obtain the optimal amount of desirable outputs in the direction d^g while producing the lowest amount of undesirable outputs in direction d^b.

Considering the right technology function, the expression can solve the below optimisation formula to compute the efficiency level.

$$\max_{\delta, \lambda} \delta$$

$$\text{s.t.} \sum_{j=1}^{n} \lambda_j Y_{rj}^g - \delta d_{ri_0}^g \geq Y_{ri_0}^g \,, \qquad r = 1, \dots, q \quad (4.18)$$

$$\sum_{j=1}^{n} \lambda_j Y_{kj}^b + \delta d_{kj_0}^b \leq Y_{kj_0}^b \,, \qquad k = 1, \dots, l \quad (4.19)$$

$$\sum_{j=1}^{n} \lambda_j X_{ij} + \delta d_{ij_0}^x \leq X_{ij_0} \qquad i = 1, \dots, m \quad (4.20)$$

$$\sum_{i=1}^{n} \lambda_i = 1 \quad (4.21)$$

$$\lambda_j \geq 0 \quad j = 1, .., n \quad (4.22)$$

Vector d = $(0, Y^g, -Y^b)$ allows us to increase the desirable outputs and decrease the undesirable outputs without changing the input level. Certainly, in this directional vector, the distance functions do not depend on the units and magnitude of the variable, so, the value of δ will fit to the interval [0, 1].

As Tables 4.1 and 4.2 indicate, in addition to selected characteristics for banks, we have selected some other financial indicators to measure efficiency. In line with the current literature (for example, Fukuyama and Matousek, 2017; Fujii *et al.*, 2014), the main two inputs in computing the technical and allocative efficiency are capital and deposit. Considering these

inputs, the desirable outputs are the total loans and receivables, total securities, total off-balance sheet activities, and total non-interest income.[26] NPLs are considered as an undesirable output. These loans reflect any default in their payment for three months or longer.

To compute the allocative efficiency, it is necessary to define two different vectors for input and output prices. Therefore, we calculate the price of capital by dividing total operating expenses by total fixed assets (Berger and DeYoung, 1997), and the price of deposits by dividing interest expenses on deposits by total deposits (Fukuyama *et al.,* 2020). Furthermore, similar to Fukuyama and Matousek (2017), the price of securities is calculated by dividing the other operating expenses by the total securities, and the price of total loans and receivables is calculated by dividing net interest income/expenses by the total loans and receivables.

In summary, the price of NPLs is calculated by dividing net interest income/expenses by the total amount of NPLs (Fukuyama and Matousek, 2017). Considering the fact that correlation between both desirable and undesirable outputs with inputs can create a misspecification in the distance function (4.17), there is a correlation coefficient matrix, which is presented in Table 4.9.1[27].

In order not to be influenced by the inflationary environment in Turkey, all of the variables and financial indicators are denominated in millions of US dollars. The descriptive statistics of quarterly variables for 44 Turkish commercial banks, from 2002-2017 are reported in Table 4.2.

4.5. Empirical results

The main aim of this study is to examine the role of the characteristics of Turkish banks in the monetary transmission mechanism through BLC. The study is enriched by considering

[26] Non-interest income represents how well a bank can generate money from its non-deposit activities.
[27] The correlation coefficient matrix presented in Table 4.9.1 indicates that correlations among the variables in this paper are mainly negligible, showing that the model applied in this paper is unlikely to suffer from the issue of considerable multicollinearity.

technical and allocative efficiency as additional characteristics. As discussed, due to the importance of bank efficiency and also because there is very little research in this area which takes efficiency into account, the current study introduces technical and allocative efficiency as an additional bank characteristic and examines their impact on the monetary policy imposed by the CTB. To address the main aim of the study, this study contributes to the current literature by applying a Bayesian estimation to test the role of bank characteristics in the monetary transmission mechanism through BLC. The main advantage of applying this approach rather than the non-Bayesian models is that the Bayesian estimation jointly considers both the observation and the transition equations. Moreover, prior information can be defined in the estimation process, which helps obtain more accurate results. Considering all of the advantages of Bayesian estimation, which is explained thoroughly in the introduction and section 4.4.1, the possible bias in the method is minimised considerably.

Table 4.3 reports the obtained estimations from posterior means, standard deviations and the 95 per cent credible intervals[28] of bank characteristics and efficiency. This paper represents the credible intervals as that suits the Bayesian inferences in order to describe the parameters' uncertainty levels.

The study reports the obtained results from the changes in interest rates, real GDP growth, and inflation rate. Moreover, following Akinci *et al*. (2013), this paper reports the result of two and three interactions terms between the bank characteristics and changes in interest rate. Initially, one bank's characteristics will join to a change in interest rate and lagged interest rate changes values. Later, two characteristics will be combined with changes in interest rates and lagged interest rate changes values. Lastly, all characteristics will be combined with the changes in the interest rate and lagged interest rate changes values. Both the current and first lagged value of real GDP growth, inflation, changes in interbank money market rates, and

[28] A range of values that indicate the probability of a parameter value being in this range.

banks' characteristics are taken into consideration in single and two/three interactions to ensure the autocorrelation impact. Thorough investigations and deep results can be achieved by taking the assumption of combining bank characteristics with changes in the interest rate. These combinations are: size and liquidity, size and capitalisation, and capitalisation and liquidity. All of these interactions are combined by the lagged interest rate changes values. Later, three-way interaction terms combined with the current and lagged value of ΔR_t with all combinations of size, liquidity, and capitalisation are considered. To address the aim of the study in evaluating the monetary transmission mechanism through BLC, initially, the main bank characteristics, including size, liquidity and capitalisation, are evaluated. Later, as represented in Tables 4.4 and 4.5, this study continues the examination by taking the technical and allocative efficiency into account and combines them with the current and lagged value of interest rates with other bank characteristics. The main purpose of doing so is to examine whether or not banks with different levels of efficiency are influenced differently against any monetary policy shocks.

In the estimations, the null hypothesis for the convergence of the posterior distributions is not excluded. It is expected that we will find a positive coefficient for both interacted and non-interacted bank characteristics, including size, liquidity, capitalisation, and efficiency. Furthermore, it is expected that we will see that bank loans relate to the monetary policy, changes in interest rates, directly through the money lending channel and indirectly, interaction terms with interest rates, through the BLC. There is some evidence to confirm both the direct and indirect effects of monetary policy changes on loan supply in this study. Hence, the presented results support the BLC hypothesis. The first lag of real GDP growth, the size and the first lagged value of the size with current and lagged change in the interest rate, and the interaction between the current and lagged liquidity with current and lagged change in the interest rate are found to be statistically significant in this study. These results can be confirmed

for the other characteristics and interactions terms as well. GDP growth, with the expected positive sign, is influenced positively with changes in the interest rates. As is expected, all the signs for the other factors are positive and statistically significant. However, interaction of lagged size with the lagged interest rate changes is found to be negative. To support for the negative signs in this interaction, this paper can refer to the 'dynamic lending activities' discussed about negative sign of the size. Moreover, this study suggests a negative relation between inflation and the bank's loan supply.

Tables 4.4 and 4.5 report the probability estimations for the addition of non-interacted, two- and three-way interacted technical and allocative efficiency variables. These tests show that both efficiency's variables can directly or indirectly be added to the models that are assessed by Bayesian analysis with statistical significance signs. The findings confirm the considerable efficiency impacts with the use of these estimators. Since this paper finds that both efficiencies significant, each one of them is evaluated separately (as illustrated in Tables 4.4 and 4.5). This study's findings about the impact of bank efficiency is superior to the only other available study, by Akinci *et al*. (2013), in Turkey. Unlike the study by Akinci *et al*. (2013), this study suggests that there is evidence to confirm the significant effect of efficiency on a bank's loan evolution. The motivation for applying the Bayesian approach is so that we are able to define the posterior using the likelihood and prior information, which can minimise bias in the investigation. The results of this study are in line with Jonas and King (2008), who stated that more efficient banks experience a greater loan response to policy changes than less efficient banks. The reasons for this are their sharper production functions and the more elastic loan supply curve. More flexibility in the production function enables efficient banks to have a more significant and faster response to any policy changes. More efficient banks are expected to have a flatter marginal cost of issuing a loan so, for an imposed interest rate in a monetary contraction time, the loan supply curve shifts left.

As a result, more efficient banks are expected to see greater declines in their loans in a monetary policy shocks period. In more efficient banks, the ratio of NPLs to total loans should decline as well. This study not only provides better results but it also assesses the monetary transmission mechanism in Turkey over a longer period, during which Turkey experienced several financial crises. Moreover, the sample of the study provides many spotlights on the Turkish financial market by considering almost all the financial events and crises after 2001. The analysis of long-run measures using Bayesian estimations are illustrated in Table 4.6. Based on results obtained from the Bayesian estimation, it can be confirmed that the loan portfolios in the Turkish banks are being influenced directly through the monetary lending channel since the ΔR_t variable is statistically significant and has a negative coefficient. This finding shows that an increase in the interest rate change by 1% leads to a decline in loans by around 0.59 percentage. This result confirms that the Turkish banks' loan portfolio is fairly responsive to changes in monetary policy. Also, in evaluating an indirect monetary policy impact over a longer period of time, only capitalisation is negatively influencing the loan changes in a bank. Other combinations among liquidity and capital with ΔR_t reflect expected positive coefficients. Given that, results show that monetary policy has an indirect impact on banks' loans through BLC over a long period of time. In contrast to what Akinci *et al*. (2013) reported on the impact of size, this paper finds that size positively influences bank loans and is a significant determinant of loan growth. Finding a negative sign for capitalisation over longer periods on the other hand, ignores the impact of capital in loan growth in the long term. Moreover, this study also indicates the positive sign of the real GDP growth rate on the banks' loans over a long period of time. While evaluating the long-term impact of both technical and allocative efficiency this study finds these characteristics have a positive impact on loan supply.

This study finds robust and clear proof that both the technical and allocative efficiencies improved for all of the 44 commercial banks in Turkey over the period 2002-2017. This is in

keeping with the findings that confirm a positive impact of the liberalisation in the early 1990s and 2000s on the Turkish banking system. As discussed in section 4.3.3, several studies have investigated the relationship between bank ownership and their efficiency scores. The reported results from these studies are not consistent with our results as we also find the foreign banks are more efficient compared to the other banks in Turkey.

Since efficiency is introduced as an additional important bank characteristic in this study, finding the efficiency scores for different ownerships was crucial for this study. In line with other studies by Chen *et al*. (2018) and Fukuyama and Matousek (2011), this study finds foreign banks to be more efficient in comparison to state-owned and private banks.

Table 4.7. represents the average technical and allocative efficiency measures by the type of ownership. Similar to the conclusions drawn by De Haas and Van Lelyveld (2006); Fries and Taci (2005); Isik and Hassan (2003a); Mercan and Yolalan (2000), and this study confirms that foreign banks operating within Turkey display better levels of efficiency than their peers. This result is in contrast with what Akinci *et al*. (2013) reported. Foreign banks in Turkey act as an intermediary for those who are willing to operate in the Turkish market. Their full integration started in 2000 with their first domestic customers and their competition with Turkey's domestic banks officially began at that point. This outcome is in line with the previous studies (for example, Akinci *et al*., 2013; De Haas and Van Lelyveld, 2006; Isik and Hassan, 2002,2003a, 2003b), in that foreign banks have been found to be more efficient than the other banks.

4.5.1. Robustness analysis

We run some further analysis to investigate the aim of the study in more depth. First, the results from the Bayesian estimation have been checked and compared with other non-Bayesian measures, such as the Fixed-effect and OLS methods. In running these tests, this paper follows the same pattern of having two- and three-way interactions among bank

characteristics with changes in interest rate. Moreover, the impact of efficiency on loan changes was tested separately to monitor the impact thoroughly. These tests ran for both short and long periods of time by considering the current and lagged value of parameters. Tables 4.8.1-4.8.8 indicate all the results of the robustness check. Robustness checks confirm the findings in Tables 4.3-4.6. There is evidence to prove that Turkish banks' loan portfolios responded to changes in monetary policy. The impact of bank characteristics also can be confirmed. In particular, the positive and significant impact of efficiency regarding how Turkish banks respond to policy changes can be affirmed considering the obtained results. Over a longer period of time, all bank characteristics positively influence loan supply, except for capitalisation. The positive and significant coefficient of the interaction between liquidity and capitalisation with the interest rate changes can be shown.

4.6. Conclusion

This paper considers how monetary policy changes influence Turkish banks through BLC over the period 2002-2017. This impact is evaluated considering bank characteristics (liquidity, capitalisation and size). Due to the importance of considering and measuring efficiency – in particular after the 2008 crisis – this paper also contributes to the current literature in Turkey by assessing how bank efficiency impacts on the BLC of monetary policy transmission in Turkey. Hence, the consideration of efficiency as an additional characteristic.

To allow for a more comprehensive evaluation, two types of efficiency – technical and allocative efficiency – as additional features are investigated. Due to an improvement in the Turkish banking system, evaluating new aspects and characteristics and their attendant impacts on BLC of monetary transmission is crucial. In particular this paper contributes to the existing literature by measuring bank efficiency by applying a modified DEA, introduced and used by Aparicio *et al*. (2015). This DEA method enables this study to define a separate vector for NPLs in order to not only investigate their impact on efficiency scores but also to detect the

main source of inefficiency in Turkish banks. The BLC operates more on the asset side of the balance sheet. Thus, any improvement in efficiency influences loan supply directly through BLC. Although the importance of considering efficiency has long been established in the literature for developed countries, in the case of developing countries like Turkey, there is room for more investigation into the impact of efficiency on money supply and bank performance. This study confirms that the more efficient banks respond quickly to monetary policy changes in their loan supply, as they have a flatter marginal cost curve and more flexible production functions (Jonas and King, 2008). Meanwhile, computing both technical and allocative efficiencies, this study specifically considered NPLs as undesirable outputs. The results obtained show that the impact of monetary policy shocks on banks differs not only as a result of their size, liquidity and capital but also according to their efficiency scores, which differs from bank to bank depending on ownership.

This study also contributes to the current literature by deploying a unique measure to investigate the existence of BLC in Turkey. To look at the monetary transmission mechanism through BLC, Bayesian estimation is applied in this study. Using Bayesian estimation enables us to take advantage of using more knowledge from likelihood and prior components in defining the posterior distribution. This is a significant advantage of Bayesian analysis, which makes this method superior to the non-Bayesian methods like GMM.

To extend the current Turkish literature, covering a longer time period, the impact of bank size, liquidity, and capitalisation while taking efficiency into account in terms of two and three interactions, changing interest rate and lagged value of interest rate are also evaluated. Both the current and lagged values of all parameters are considered to minimise the correlational impact. To evaluate bank performance thoroughly, efficiency per ownership is also discussed. Doing so provides information on the strongest and weakest banks in Turkey. Hence, regulators and policy makers can focus on the main sources of issues in the Turkish banks.

Results from running the Bayesian estimation illustrate that, with respect to bank lending rate, any sudden changes in the monetary policy directly and indirectly influence the loan portfolio of Turkish banks. Before combining the efficiency, considering the current and the first lagged value of the real GDP growth rate, inflation, and interbank money market rate, significant results have been found. These macroeconomic variables are taken as the exogenous variables in this study. The purpose of considering these variables is so we can examine their impact on the bank loan supply in the event of monetary policy shocks. The results confirm a negative impact of inflation. The real GDP growth rate represented the expected positive coefficients. Moreover, the negative impact of monetary policy shocks can be confirmed through BLC over short time periods. Empirical studies demonstrate that liquidity and bank size play a more noticeable role in the lending channel. Similarly, this study's results confirm the impact of size, liquidity, and capital for both their current and lagged values. A meaningful impact of a majority of the two and three interactions combinations is also observable. However, the results do not support the interaction of lagged value of size with changes in interest rate. Moreover, our results support the three interactions terms in lagged value of size, capitalisation and both current and lagged value of interest rate changes. The results suggest a positive and significant coefficient for the lagged value of the bank's size and interaction of lagged value of size with the current value of interest rate changes. Hence, unlike the findings in Akinci *et al*. (2013), it cannot be claimed that the problems due to informational asymmetry are especially related to the Turkish BLC over the study's time horizon. Moreover, as Kashyap and Stein (2000) discussed, bank liquidity indicates the bank's strength. Hence, the positive sign of the coefficients for liquidity and liquidity interaction with changes in the current and lagged value of changes in interest rate represents a meaningful impact of liquidity on loan supply.

Taking both technical and allocative efficiency into consideration and combining them with changes in interest rate and bank characteristics enriches the findings of this study. Finding the positive and significant coefficients for a combination of efficiency with changes in current and lagged interest rate reflect the positive impact of this characteristic on loan supply. Hence, the findings of this study are in line with Jonas and King (2008), who outlined the impact of efficiency on a bank's behaviour regarding loan supply when there is a change in monetary policy. Moreover, the positive coefficient of two- and three-way interactions between efficiency with other characteristics combined with changes in interest rate again emphasise the importance of this factor. Since there is only one study available on the lending channel in Turkey, the achieved results from this paper can only be compared with the one other available study. Our results generally illustrate better results compared to Akinci *et al*. (2013). Hence, this study is superior in proving the meaningful impact of efficiency. Unlike the Akinci study, this study finds the foreign banks to be more efficient than domestic banks, which is in line with Chen *et al*. (2018), Fukuyama and Matousek (2011), and Isik and Hassan (2003a). Finding these results should attract regulator and the CBT attention in Turkey, to improve and restructure the state-owned and private banks. Computed efficiency scores in this study confirm the poor performance of these banks. They reflect the highest ratio of NPLs in comparison with the other banks, which is not appropriate considering their total assets and sizes.

Moreover, running Bayesian estimation to evaluate the impact of these factors over a longer period of time suggests that the growth in bank loans is directly related to monetary policy through the money lending channel (via interest rates) and indirectly (when bank characteristics are related to interest rates) via BLC. Additionally, although size and liquidity are statistically significant and have expected long-term positive signs (confirming their positive impact on loan supply) the coefficient for capitalisation is negative. Moreover, real GDP growth rate shows expected positive signs over a longer period of time, which is not a guarantee of any

impact on the bank loan. The impact of both technical and allocative efficiency as a fourth characteristic is also investigated. Our results also confirm the long-term impact of efficiency.

To confirm the robustness of our initial results, we run both fixed effect and OLS to check the transmission monetary policy through BLC and the impact of banks' characteristics as well. The robustness check confirms changes in loan supply in the Turkish banks when there is a change in the conventional monetary policy in Turkey. Moreover, the impact of bank characteristics can be approved. These characteristics positively influence loan supply when we evaluate the impact of them alone or when we consider the impact of their combinations. Our robustness check also confirms the positive impact of efficiency on the loan supply in Turkish banks both in the short and long-term.

To conclude, this study suggests that Turkish banks play a vital role in the transmission of monetary policy because monetary policy affects loan supply and total cost. Moreover, this paper suggests that BLC is an effective channel in the monetary transmission mechanism in Turkey. Thus, this study suggests regulators pay more attention to some of the main characteristics of the Turkish banks, such as efficiency, liquidity and capitalisation. Hence, more consideration may be needed for monitoring banks in their implementation of the Basel regulations. Moreover, as banks need to operate in a more stable financial environment, Turkey should keep addressing both micro- and macroeconomic challenges to stabilise prices and keep interest rates steady. It is worth remarking that deeper and broader consideration is probably also needed to improve the balance sheet quality of banks, especially considering the impact of the existence of NPLs on technical and allocative efficiencies.

Generally, this study attempts to provide some useful information for regulators and policy makers. However, more investigations are required in further studies on different banks' characteristics, which may affect BLC of monetary policy transmission.

List of Tables:

Table.4.1. Variable Description

x_1	Capital	Capital
x_2	Deposit	Total Deposit
y_1	Loans and Receivables	Total Loans and Receivables
y_2	Total Securities	"Securities" name was changed as "Financial Assets" at the end of 2002.
y_3	Total Off-balance sheet activities	Off-Balance Sheet Activities
y_4	Non-interest income	The total of "Net Fees and Commissions Income/Expenses", "Dividend Income", "Net Trading Profit and Loss", "Other Operating Income" after 2002.
y_5	Non-performing loans	Non-performing Loans" name was changed to "Loans Under Follow-up".
Px_1	Price of Capital	Total operating expenses/Total fixed assets
Px_2	Price of Deposit	Interested expenses on deposit/ Total deposit
Py_1	Price of Loan and Receivables	Total net income/expenses/Total loan and receivables
Py_2	Price of Securities	Total other operating expenses/Total securities
Py_4	Price of NPLs	Total net income/expenses/Total NPLs
CR	Capital Ratio	Total equity to total asset
LR	Liquidity Ratio	Liquid asset to total assets
Size	Size	Log of total assets

Note1. The above table shows the variables definitions. x_n represents two main inputs including capital and deposit while y_n illustrate all of the desirable and undesirable outputs. P_x and P_y represents the price of inputs and output to compute for the allocative efficiency.

Table.4.2. Descriptive Statistics (Mil US.$)

Variable	Mean	Std. Dev.	Min	Max	Obs.
Capital	45.523	82.387	3.623	1169.25	2,575
Deposit	10550.7	16938.73	0.029	83107.24	1,843
Total Loans & Receivables	7461.004	14247.92	0.043	79073.68	2,468
Net Securities	3160.268	7029.979	0.672	50050.32	2,520
Off-Balance Sheet Activities	108527.3	593430.1	0.439	1.2000	2,571
NPLs	266.142	461.196	0.0637	2612.399	2,340
Non-Interest Income	136.861	298.916	-70.966	2514.196	2.682
Price of Capital	4.512	49.204	-947.955	826.095	2,416
Price of Deposit	0.054	0.202	0.056	5.697	1,805
Price of Total Loans & Receivables	3.046	57.252	-39.6	2378	2,248
Price of Securities	16.104	313.358	-0.0415	1225	2,356
Price of NPLs	583.883	9528	-174.466	2614	2,136

Note1. The above table represents all the main variables taken to compute the technical and allocative efficiency. The main two inputs are capital and deposit. The desirable output, focusing on the contribution of this paper in computing for efficiency, are loans and receivables, net securities, off-balance sheet activities and non-interest income. Accordingly, the undesirable output is NPLs. Data for this study covers the period of fifteen years from December 2002 to December 2017.

Table.4.3. Bayesian Estimation-Results without Efficiencies

Variables	Mean	Std.Dev.	MCSE	Median	[95% Cred.Interval]	
ΔR_t	-0.0855***	0.0003	0.0008	0.0855	-0.0949	0.0862
ΔR_{t-1}	-0.0082***	0.0007	0.0001	0.0082	-0.0001	0.0096
Real GDP_t Growth	0.0001***	0.0008	0.0001	0.0002	-0.0016	0.0015
Real GDP_{t-1} Growth	0.0003***	0.0001	0.0002	0.0002	-0.0014	0.0024
Inf_t	-0.0104***	0.0007	0.0001	-0.0103	-0.0118	-0.0091
Inf_{t-1}	-0.0059***	0.0001	0.0002	-0.0057	-0.0079	-0.0042
$Size_t$	0.0286**	0.0004	0.0001	1.1286	1.1279	1.1295
$Size_{t-1}$	0.0416**	0.0008	0.0002	-0.0417	0.0429	0.0435
$Size_{t-1}.\Delta R_t$	0.0027***	0.0005	0.0007	-0.0028	0.0039	0.0166
$Size_{t-1}.\Delta R_{t-1}$	-0.0027***	0.0003	0.0004	-0.0038	-0.0045	-0.0031
Liq_t	0.0038***	0.0008	0.0002	-0.0351	-0.0369	0.0341
Liq_{t-1}	0.0432**	0.0004	0.0001	-0.0038	0.0036	0.0021
$Liq_{t-1}.\Delta R_t$	0.0353**	0.0003	0.0005	-0.0012	0.0026	0.0005
$Liq_{t-1}.\Delta R_{t-1}$	0.0029***	0.0002	0.0003	-0.0014	0.0018	0.0009
Cap_t	0.0011***	0.0001	0.0009	-0.0011	0.0014	0.0007
Cap_{t-1}	0.0375**	0.0003	0.0006	-0.0375	0.0896	0.0902
$Cap_{t-1}.\Delta R_t$	0.0899*	0.0001	0.0004	0.0898	0.0024	0.0034
$Cap_{t-1}.\Delta R_{t-1}$	0.0029***	0.0002	0.0006	0.0029	0.0001	0.0001
$Size_{t-1}*Liq_{t-1}*\Delta R_t$	0.0001***	0.0006	0.0009	-0.0001	0.0001	0.0002
$Size_{t-1}*Liq_{t-1}*\Delta R_{t-1}$	0.0021***	0.0003	0.0004	0.0002	0.0411	0.0393
$Size_{t-1}*Cap_{t-1}*\Delta R_t$	0.0402**	0.0004	0.0008	-0.0402	0.0032	0.0045
$Size_{t-1}*Cap_{t-1}*\Delta R_{t-1}$	0.0038***	0.0003	0.0005	0.0038	0.0023	0.0029
$Liq_{t-1}*Cap_{t-1}*\Delta R_t$	0.0022***	0.0006	0.0006	-0.0022	0.0005	0.0002
$Liq_{t-1}*Cap_{t-1}*\Delta R_{t-1}$	0.0001***	0.0001	0.0001	-0.0001	0.0001	0.0005
$Size_{t-1}*Liq_{t-1}*Cap_{t-1}*\Delta R_t$	0.0011***	0.0001	0.0003	0.0011	0.0010	0.0021
$Size_{t-1}*Liq_{t-1}*Cap_{t-1}*\Delta R_{t-1}$	0.0013***	0.0005	0.0001	0.0001	0.0006	0.0021
Cons	0.1422	0.0014	0.0003	-.1423	0.1447	0.1391

Note1. The above table shows the results of applying Bayesian estimation to examine the monetary transmission mechanism through BLC in Turkish banks. The dependent variable is the difference of the natural logarithm of loan. Coefficients for the regressors are reported with t-ratios given in parentheses. Standard errors in parentheses, ***p<0.001, **p<0.005, *<0.1. There are 2140 observations.

Table 4.4. Bayesian Estimation-Result with Technical Efficiencies

Variables	Mean	Std.Dev.	MCSE	Median	[95% Cred.Interval]	
Eff_{t-1}	0.0279**	0.0012	0.0003	2.0284	2.0304	2.0257
$Eff_{t-1}\ \Delta R_t$	0.0011***	0.0013	0.0003	0.0014	0.0017	0.0032
$Eff_{t-1}\ \Delta R_{t-1}$	0.0292**	0.0011	0.0008	0.0292	0.0311	0.0471
$Eff_{t-1}\ \Delta R_t\ Size_{t-1}$	0.0314**	0.0016	0.0003	0.0315	0.0343	0.0483
$Eff_{t-1}\ \Delta R_{t-1}\ Size_{t-1}$	0.0134**	0.0012	0.0003	0.0131	0.0154	0.0115
$Eff_{t-1}\ \Delta R_t\ Liq_{t-1}$	0.0061***	0.0001	0.0002	0.0061	0.0058	0.0063
$Eff_{t-1}\ \Delta R_{t-1}\ Liq_{t-1}$	0.0017***	0.0007	0.0007	0.0017	0.0016	0.0019
$Eff_{t-1}\ \Delta R_t\ Cap_{t-1}$	0.0126**	0.0007	0.0008	0.0126	0.0124	0.0127
$Eff_{t-1}\ \Delta R_t\ Cap_{t-1}$	0.0074*	0.0004	0.0007	0.0075	0.0074	0.079
Cons	0.0779	0.0045	0.0006	7.0779	7.0694	7.0864

Note1. This table reports the probability values for individual t-tests for the addition bank' characteristic, which is Technical efficiency. Eff_{t-1} represents Technical efficiency. Both non-interacted and interacted of efficiency with change in interest rates and bank-specific characteristics are taken into account. Standard errors in parentheses, ***p<0.001, **p<0.005, *<0.1. There are 2140 observations.

Table.4.5. Bayesian Estimation-Results with Allocative Efficiencies

Variables	Mean	Std.Dev.	MCSE	Median	[95% Cred.Interval]	
Eff_{t-1}	0.0027***	0.0112	0.0235	0.0237	0.0266	0.0678
Eff_{t-1} ΔR_t	0.0082***	0.0113	0.0786	0.0076	0.0058	0.0092
Eff_{t-1} ΔR_{t-1}	0.0012***	0.0011	0.0011	0.0012	0.0041	0.0091
Eff_{t-1} ΔR_t $Size_{t-1}$	0.0079***	0.0049	0.0897	0.0068	0.0068	0.0098
Eff_{t-1} ΔR_{t-1} $Size_{t-1}$	0.0085***	0.0132	0.0016	0.0097	0.0057	0.0912
Eff_{t-1} ΔR_t Liq_{t-1}	0.0043***	0.0812	0.0324	0.0053	0.0034	0.0665
Eff_{t-1} ΔR_{t-1} Liq_{t-1}	0.0027***	0.0267	0.0011	0.0028	0.0031	0.0084
Eff_{t-1} ΔR_t Cap_{t-1}	0.0065***	0.0012	0.0022	0.0065	0.0062	0.0097
Eff_{t-1} ΔR_t Cap_{t-1}	0.0052***	0.0081	0.0044	0.0052	0..0051	0.0075
Cons	0.9624	0.0081	0.0073	5.9624	5.9622	5.9626

Note1. This table reports the probability values for individual t-tests for the addition bank' characteristic, which is Allocative efficiency. Eff_{t-1} represents Allocative efficiency. Both non-interacted and interacted of efficiency with change in interest rates and bank-specific characteristics are taken into account. Standard errors in parentheses, ***p<0.001, **p<0.005, *<0.1. There are 2140 observations.

Table.4.6. Long-Run Estimations-Bayesian Estimation.

Variables	Mean	Std.Dev.	MCSE	Median	[95% Cred.Interval]	
ΔR	-0.0059***	0.00007	0.0002	0.0059	-0.0067	0.0062
Real GDP Growth	0.0017***	0.0003	0.0001	0.0017	0.0017	0.0018
Size	0.0239**	0.0001	0.0005	1.2392	1.2389	1.2395
TEff	0.0065***	0.0001	0.0003	0.0065	0.0045	0.0367
AEff	0.0043***	0.0001	0.0002	0.0043	0.0023	0.0099
Cap	-0.0012***	0.0001	0.0004	-0.0012	-0.0014	-0.0010
Liq*ΔR	0.0003***	0.0001	0.0001	0.0003	0.0002	0.0004
Liq*Cap*ΔR	0.0002***	0.0001	0.0002	0.0002	0.0001	0.0003
Cons	0.3433	0.0009	0.0002	3.0433	3.0.432	3.0434

Note1. The above table shows long-run estimation of transmission monetary mechanism through BLC. All four main banks characteristics including size, capitalisation, liquidity, efficiency have been taken into consideration. Standard errors in parentheses, ***p<0.001, **p<0.005, *<0.1. There are 2140 observations.

Table.4.7. Average Efficiency by Bank Type

Bank Type	Technical Efficiency			Allocative of Efficiency		
	Average Efficiency	No.Banks	Obs.	Average Efficiency	No.Banks	Obs.
Investment& Development Banks	0.476	12	212	0.246	12	212
Foreign	0.258	19	855	0.174	19	855
Private	0.154	10	456	0.141	10	456
State-Owned	0.014	3	171	0.091	3	171

Note1. This table indicates the average efficiency per ownership considering both technical and allocative efficiency. The number of banks represented in the column headed "No. banks" and total number of observations (Obs.) taken to calculation the average efficiency scores are also given. There are four main types of banks namely, foreign-owned, privately-owned banks, state-owned, and investment and development banks.

Table.4.8.1. Fixed-Effects Estimates of Table 4.3, Excluding Efficiency Variables

Variables	Coef.	Std.Dev.	t	P>|t|	[95% Conf.	Interval]
ΔR_t	-0.0319***	0.0017	0.020	0.0017	-0.0832	0.1999
ΔR_{t-1}	-0.0073***	0.0066	0.002	0.0012	-0.0092	0.0412
Real GDP_t Growth	0.0057***	0.0012	0.086	0.0016	-0.0065	-0.0010
Real GDP_{t-1} Growth	0.0022**	0.0012	0.099	0.0049	-0.0055	0.0002
Inf_t	-0.0052***	0.0011	0.052	0.0011	-0.0239	0.0190
Inf_{t-1}	0.0071***	0.0014	0.047	0.0015	-0.0146	0.0195
$Size_t$	0.0138**	0.0001	0.089	0	0.0623	0.4214
$Size_{t-1}$	0.0286**	0.0009	0.081	0.0012	0.1019	0.4577
$Size_{t-1}.\Delta R_t$	0.0032***	0.0017	0.056	0.0016	0.0181	0.0112
$Size_{t-1}.\Delta R_{t-1}$	-0.0021***	0.0041	0.011	0.0018	-0.0057	0.0016
Liq_t	0.0331**	0.0002	0.026	0	0.0278	0.0373
Liq_{t-1}	0.0039***	0.0003	0.076	0.0014	0.0011	0.0023
$Liq_{t-1}.\Delta R_t$	0.0009***	0.0001	0.088	0.0015	0.0018	0.0035
$Liq_{t-1}.\Delta R_{t-1}$	0.0011***	0.0002	0.076	0.0008	0.0002	0.0003
Cap_t	0.0002***	0.0007	0.013	0.0006	0.0004	0.0005
Cap_{t-1}	0.0028***	0.0045	0.078	0.0047	0.0065	0.0143
$Cap_{t-1}.\Delta R_t$	0.0157**	0.0421	0.021	0.0015	0.0311	0.0625
$Cap_{t-1}.\Delta R_{t-1}$	0.0021***	0.0031	0.059	0.0012	0.0044	0.0088
$Size_{t-1}Liq_{t-1}\Delta R_t$	0.0002***	0.0002	0.043	0.0019	-0.0004	0.0003
$Size_{t-1}Liq_{t-1}\Delta R_{t-1}$	0.0002***	0.0009	0.067	0.0028	0.0002	0.0003
$Size_{t-1}Cap_{t-1}\Delta R_t$	0.0209**	0.0089	0.054	0.0020	0.0033	0.038
$Size_{t-1}Cap_{t-1}\Delta R_{t-1}$	0.0048***	0.0025	0.098	0.0018	0.0048	0.0055
$Liq_{t-1}Cap_{t-1}\Delta R_t$	0.0004***	0.0005	0.069	0.0037	0.0001	0.0005
$Liq_{t-1}Cap_{t-1}\Delta R_{t-1}$	0.0002***	0.0008	0.047	0.0024	0.0001	0.0004
$Size_{t-1}Liq_{t-1}Cap_{t-1}\Delta R_t$	0.0006***	0.0001	0.049	0.001	0.0002	0.0012
$Size_{t-1}Liq_{t-1}Cap_{t-1}\Delta R_{t-1}$	0.0008***	0.0002	0.051	0	0.0004	0.0013
Cons	0.0816	0.2209	0.087	0	2.6483	3.5151

Note1. The above table shows the results of running fixed-effect regression to examine the monetary transmission mechanism through BLC in Turkish banks. The dependent variable is the difference of the natural logarithm of loan. Coefficients for the regressors are reported with t-ratios given in parentheses. Standard errors in parentheses, ***p<0.001, **p<0.005, *<0.1. There are 2140 observations.

Table.4.8.2. Fixed-Effects Estimates of Table 4.3, Including Technical Efficiency

Variables	Coef.	Std.Dev.	T	P>|t|	[95% Conf.Interval]	
TE_{t-1}	0.0023***	0.0012	0.056	0	0.2089	0.4921
$TE_{t-1}\ \Delta R_t$	0.0018***	0.0011	0.029	0.0016	-0.0068	0.0054
$TE_{t-1}\ \Delta R_{t-1}$	0.0028**	0.0019	0.001	0.0021	0.0024	0.0075
$TE_{t-1}\ \Delta R_t\ Size_{t-1}$	0.0102**	0.0065	0.006	0.0015	0.0011	0.0272
$TE_{t-1}\ \Delta R_{t-1}\ Size_{t-1}$	0.0048***	0.0038	0.018	0.0023	0.0040	0.0123
$TE_{t-1}\ \Delta R_t\ Liq_{t-1}$	0.0008***	0.0003	0.038	0.0019	-0.0011	0.0007
$TE_{t-1}\ \Delta R_{t-1}\ Liq_{t-1}$	0.0003***	0.0001	0.047	0.0031	0.0001	0.0007
$TE_{t-1}\ \Delta R_t\ Cap_{t-1}$	0.0033***	0.0002	0.074	0	0.0014	0.0035
$TE_{t-1}\ \Delta R_t\ Cap_{t-1}$	0.0018***	0.0001	0.086	0	0.0007	0.0018
Cons	0.3214	0.0329	0.91	0	6.2446	6.4302

Note1. This table reports the probability values for individual t-test for an additional bank characteristic, which is Technical efficiency applying fixed-effect regression. Both non-interacted and interacted combination of this feature with changes in interest rate and other banks' characteristics (size, liquidity, and capitalisation) are considered. Standard errors in parentheses, ***p<0.001, **p<0.005, *<0.1. There are 2140 observations.

Table.4.8.3.Fixed-Effects Estimates of Table 4.3, Including Allocative Efficiency

Variables	Coef.	Std.Dev.	t	P>|t|	[95% Conf.Interval]	
AE_{t-1}	0.0021***	0.0001	0.018	0.0031	-0.0005	0.0004
$AE_{t-1}\ \Delta R_t$	0.0024***	0.0001	0.067	0	0.0014	0.0022
$AE_{t-1}\ \Delta R_{t-1}$	0.0029***	0.0012	0.088	0	0.0011	0.0017
$AE_{t-1}\ \Delta R_t\ Size_{t-1}$	0.0008***	0.0007	0.056	0	-0.0002	0.0001
$AE_{t-1}\ \Delta R_{t-1}\ Size_{t-1}$	0.0003***	0.0001	0.011	0	-0.0001	0.0001
$AE_{t-1}\ \Delta R_t\ Liq_{t-1}$	0.0015***	0.0011	0.049	0.0015	0.0004	0.0007
$AE_{t-1}\ \Delta R_{t-1}\ Liq_{t-1}$	0.0009***	0.0002	0.099	0	0.0002	0.0007
$AE_{t-1}\ \Delta R_t\ Cap_{t-1}$	0.0074***	0.0021	0.012	0	0.0044	0.0085
$AE_{t-1}\ \Delta R_t\ Cap_{t-1}$	0.0048***	0.0019	0.022	0.0001	-0.0048	0.0016
Cons	0.1766	0.0536	0.085	0	7.0564	7.2715

Note1. This table reports the probability values for individual t-test for an additional bank characteristic, which is Allocative efficiency applying fixed-effect regression. Both non-interacted and interacted combination of this feature with changes in interest rate and other banks' characteristics (size, liquidity, and capitalisation) are considered. Standard errors in parentheses, ***p<0.001, **p<0.005, *<0.1. There are 2140 observations.

Table.4.8.4. OLS Estimates of Table 4.3, Excluding Efficiency Variables

Variables	Coef.	Std.Dev.	t	P>|t|	[95% Conf.	Interval]
ΔR_t	-0.0834***	0.0066	0.001	0.0015	0.0971	0.2381
ΔR_{t-1}	-0.0081***	0.0089	0.082	0.0058	0.0096	0.0264
Real GDP_t Growth	0.0012***	0.0012	0.019	0.0076	0.0001	0.0034
Real GDP_{t-1} Growth	0.0005***	0.0041	0.033	0.0064	0.0003	0.0041
Inf_t	-0.0112***	0.0015	0.064	0.0057	-0.0401	-0.0198
Inf_{t-1}	-0.0058***	0.0001	0.061	0.0058	-0.0297	0.0177
$Size_t$	0.0113**	0.0132	0.020	0.0016	0.1145	0.1989
$Size_{t-1}$	0.0312**	0.0102	0.046	0.0071	0.0173	0.2824
$Size_{t-1}.\Delta R_t$	0.0044***	0.0014	0.029	0.0074	0.0023	0.0173
$Size_{t-1}.\Delta R_{t-1}$	-0.0042***	0.0034	0.051	0.0018	-0.0089	0.0013
Liq_t	0.0362**	0.0041	0.002	0	0.0291	0.0417
Liq_{t-1}	0.0029***	0.0039	0.082	0.0040	-0.0098	0.0036
$Liq_{t-1}.\Delta R_t$	0.0011***	0.0011	0.087	0.0042	-0.0055	0.0022
$Liq_{t-1}.\Delta R_{t-1}$	0.0019***	0.0005	0.009	0.0029	0.0008	0.0031
Cap_t	0.0015***	0.0001	0.028	0	0.0005	0.0016
Cap_{t-1}	0.0372**	0.0071	0.088	0	0.0246	0.0496
$Cap_{t-1}.\Delta R_t$	0.0882*	0.0452	0.075	0.0004	0.0259	0.1529
$Cap_{t-1}.\Delta R_{t-1}$	0.0035***	0.0044	0.063	0.0035	-0.0063	0.0123
$Size_{t-1}*Liq_{t-1}*\Delta R_t$	0.0001***	0.0001	0.042	0.0087	-0.0005	0.0005
$Size_{t-1}*Liq_{t-1}*\Delta R_{t-1}$	0.0004***	0.0001	0.032	0.0069	-0.0001	0.0004
$Size_{t-1}*Cap_{t-1}*\Delta R_t$	0.0451**	0.0101	0.017	0.0001	0.0162	0.0643
$Size_{t-1}*Cap_{t-1}*\Delta R_{t-1}$	0.0045***	0.0003	0.031	0.0013	-0.0018	0.0092
$Liq_{t-1}*Cap_{t-1}*\Delta R_t$	0.0028***	0.0005	0.019	0.0005	-0.0035	0.0841
$Liq_{t-1}*Cap_{t-1}*\Delta R_{t-1}$	0.0007***	0.0001	0.061	0.0053	-0.0006	0.0003
$Size_{t-1*}Liq_{t-1}*Cap_{t-1}*\Delta R_t$	0.0014***	0.0013	0.029	0	0.0006	0.0016
$Size_{t-1*}Liq_{t-1}*Cap_{t-1}*\Delta R_{t-1}$	0.0001***	0.0009	0.015	0.0002	0.0001	0.0004
Cons	0.1089	0.1589	0.078	0.0041	-0.5033	0.2194

Note1. The above table shows the results of running OLS to examine the monetary transmission mechanism through BLC in Turkish banks. The dependent variable is the difference of the natural logarithm of loan. Coefficients for the regressors are reported with t-ratios given in parentheses. Standard errors in parentheses, ***p<0.001, **p<0.005, *<0.1. There are 2140 observations.

Table.4.8.5. OLS Estimates of Table 4.3, Including Technical Efficiency Variables

Variable	Coef.	Std.Dev.	t	P>|t|	[95%	Conf.Intervl]
TE_{t-1}	0.0313**	0.0001	0.039	0	0.0178	0.0784
$TE_{t-1}\ \Delta R_t$	0.0014***	0.0023	0.022	0.0059	0.0113	0.0147
$TE_{t-1}\ \Delta R_{t-1}$	0.0341**	0.0041	0.049	0	0.0185	0.0396
$TE_{t-1}\ \Delta R_t\ Size_{t-1}$	0.0359**	0.0031	0.007	0.0032	0.0011	0.0623
$TE_{t-1}\ \Delta R_{t-1}\ Size_{t-1}$	0.0101**	0.0018	0.033	0.0024	0.0061	0.0294
$TE_{t-1}\ \Delta R_t\ Liq_{t-1}$	0.0069***	0.0011	0.078	0	0.0045	0.0082
$TE_{t-1}\ \Delta R_{t-1}\ Liq_{t-1}$	0.0013***	0.0002	0.029	0	0.0009	0.0024
$TE_{t-1}\ \Delta R_t\ Cap_{t-1}$	0.0214**	0.0005	0.076	0	0.0106	0.0145
$T[E_{t-1}\ \Delta R_t\ Cap_{t-1}$	0.0077***	0.0001	0.036	0	-0.0083	-0.0064
Cons	0.0678	0.0871	0.032	0	6.8923	7.2618

Note1. This table reports the probability values for individual t-test for an additional bank characteristic, which is Technical efficiency running OLS. Both non-interacted and interacted combination of this feature with changes in interest rate and other banks' characteristics (size, liquidity, and capitalisation) are considered. Standard errors in parentheses, ***p<0.001, **p<0.005, *<0.1. There are 2140 observations.

Table.4.8.6. OLS Estimates of Table 4.3, Including Allocative Efficiency Variables

Variables	Coef.	Std.Dev.	T	P>|t|	[95%	Conf.Interval]
AE_{t-1}	0.0071***	0.0005	0.059	0	0.0025	0.0029
$AE_{t-1}\ \Delta R_t$	0.0005***	0.0002	0.064	0.0012	-0.0001	0.0017
$AE_{t-1}\ \Delta R_{t-1}$	0.0022***	0.0001	0.059	0.0011	0.0002	0.0017
$AE_{t-1}\ \Delta R_t\ Size_{t-1}$	0.0013***	0.0014	0.039	0.0051	-0.0001	0.0009
$AE_{t-1}\ \Delta R_{t-1}\ Size_{t-1}$	0.0034***	0.0031	0.027	0.0002	-0.0001	0.0011
$AE_{t-1}\ \Delta R_t\ Liq_{t-1}$	0.0023***	0.0001	0.065	0.0001	-0.0008	0.0009
$AE_{t-1}\ \Delta R_{t-1}\ Liq_{t-1}$	0.0011***	0.0019	0.024	0.0021	-0.0039	0.0004
$AE_{t-1}\ \Delta R_t\ Cap_{t-1}$	0.0075***	0.0042	0.069	0.0003	0.0017	0.0112
$AE_{t-1}\ \Delta R_t\ Cap_{t-1}$	-0.0048***	0.0029	0.098	0.0039	0.0004	0.0105
Cons	0.8763	0.0542	0.020	0	5.8367	6.0881

Note1. This table reports the probability values for individual t-test for an additional bank characteristic, which is Allocative efficiency running OLS. Both non-interacted and interacted combination of this feature with changes in interest rate and other banks' characteristics (size, liquidity, and capitalisation) are considered. Standard errors in parentheses, ***p<0.001, **p<0.005, *<0.1. There are 2140 observations.

Table.4.8.7. Long-Run Estimations-Fixed-Effect Estimation

Variables	Coef.	Std.Dev.	t	P>|t|	[95%	Conf.Interval]
ΔR	-0.0044***	0.0051	0.061	0.0076	-0.0048	0.019
Real GDP Growth	0.0011***	0.0006	0.088	0.0013	-0.0031	0.0055
Size	0.0342**	0.0212	0.014	0.0011	0.4052	0.5294
TEff	0.0061***	0.0001	0.014	0.0001	0.0001	0.0099
AEff	0.0039***	0.0001	0.014	0.0002	0.0003	0.0089
Cap	-0.0014***	0.0012	0.031	0.0009	-0.0013	-0.0008
Liq*ΔR	0.0001***	0.0032	0.078	0.0079	-0.0004	0.0006
Liq*Cap*ΔR	0.0029***	0.0017	0.089	0	0.0003	0.0008
Cons	4.4692	0.1423	0.082	0.0032	4.06757	4.8701

Note1. The above table shows the estimation of monetary transmission mechanism through BLC using fixed-effect regression. In long run evaluation all four main banks characteristics including size, capitalisation, liquidity, and efficiency have been taken into consideration. Standard errors in parentheses, ***p<0.001, **p<0.005, *<0.1. There are 2140 observations.

Table.4.8.8. Long-Run Estimations-OLS Estimation

Variables	Coef.	Std.Dev.	t	P>|t|	[95% Conf.Interval]	
ΔR	-0.0066***	0.0113	0.069	0.034	-0.0095	0.02747
Real GDP Growth	0.0012***	0.0011	0.076	0.0001	-0.0004	0.0039
Size	0.0398**	0.0123	0.089	0	0.2153	0.2636
TEff	0.0111**	0.0017	0.061	0.0029	0.0019	0.1078
AEff	0.0285**	0.0022	0.021	0.0003	0.0033	0.9981
Cap	-0.0011***	0.0003	0.055	0.0012	-0.0023	-0.0638
Liq*ΔR	0.0021***	0.0002	0.074	0.0027	-0.0001	0.0008
Liq*Cap*ΔR	0.0001***	0.0002	0.033	0.0014	0.0001	0.0007
Cons	0.0414	0.0464	0.089	0.0045	2.7561	3.3304

Note1. The above table shows the estimation of monetary transmission mechanism through BLC using OLS. In long run evaluation all four main banks characteristics including size, capitalisation, liquidity, and efficiency have been taken into consideration. Standard errors in parentheses, ***p<0.001, **p<0.005, *<0.1. There are 2140 observations

Table.4.9.1. Correlation Coefficient Matrix

	Deposit	Capital	Total loans & receivables	Net securities	Off-balance sheet activities	Non-interest income	(NPLs)	Price of deposit	Price of capital	Price of loans &receivables	Price of securities	Price of NPLs
Deposit	1.0000											
Capital	-0.1959	1.0000										
Total loans & receivables	0.9370	-0.2302	1.0000									
Net securities	0.9197	-0.1114	0.7439	1.0000								
Off-balance sheet activities	0.7616	-0.2170	0.8496	0.5512	1.0000							
Non-interest income	0.7679	-0.1551	0.7550	0.6959	0.5933	1.0000						
Non-performing loans (NPLs)	0.8108	-0.1822	0.8408	0.6379	0.7553	0.7208	1.0000					
Price of deposit	-0.0339	0.2215	-0.0587	-0.0039	-0.0634	0.0399	-0.0142	1.0000				
Price of capital	0.0571	-0.0698	0.0559	0.0446	0.0607	0.0690	0.0626	0.0662	1.0000			
Price of loans &receivables	-0.0686	0.4600	-0.0678	-0.0548	-0.0621	-0.0532	-0.0679	0.6293	0.0333	1.0000		
Price of securities	-0.0717	0.0878	-0.0643	-0.0700	-0.0562	-0.0551	-0.0674	0.0248	0.0012	0.0373	1.0000	
Price of NPLs	-0.0392	0.0628	-0.0396	-0.0333	-0.0303	-0.0356	-0.0460	-0.0076	0.0537	0.0343	-0.0003	1.0000

Note1. The above table shows the correlation coefficient. It indicates that correlations among the variables in this paper are mainly negligible, which means that the model applied in this paper is unlikely to suffer from the issue of considerable multicollinearity

Table.4.10.1. Turkish Banking Sector-Selected Financial Indicators/Ratios

(US.$Mill)	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Total Asset	129700	179253	229328	295849	344947	484061	463839	536901	625570	614491	730278	767635	811513	766250	737482	820,552
Total Loan &Receivables	34377	50234	77259	114070	155139	241916	241097	256177	330946	351681	432572	476682	519870	499817	487788	549,160
Total Deposit	86835	115420	147717	188984	222561	307930	297992	341060	399766	370014	433177	442787	454526	428600	415675	98971
Net Profit	1437	4027	4831	4259	7813	12362	8394	13096	13892	10081	12717	11084	10514	8788	10350	12,483
Ratios to GDP%																
Asset	60.7	54.9	54.8	61.2	63.9	65.7	74.3	83.8	87.5	89.4	91.6	104.3	107.9	114.5	113.1	114.4
Loans	16.1	15.4	18.5	23.6	28.8	32.9	38.6	40	46.3	51.2	54.3	64.8	69.1	74.7	75.2	78
Deposits	40.6	35.4	35.3	39.1	41.2	41.8	47.7	53.3	55.9	53.9	54.3	60.2	60.4	64	64.5	55.8
Selected Ratios%																
Loan/Asset	26.5	28	33.7	38.6	45	50	52	47.7	52.9	57.2	59.2	62.1	64.1	65.2	66.1	66.9
Loans/Deposits	39.6	43.5	52.3	60.4	69.7	78.6	80.9	75.1	82.8	95	99.9	107.7	114.4	116.6	117.3	120.9
NPLs/Gross Loans	6.6	1.4	0.7	0.5	0.3	0.4	0.7	0.8	0.6	0.5	0.7	0.6	0.7	0.7	0.7	0.6
Net Profits/Assets	1.1	2.2	2.1	1.4	2.3	2.6	1.8	2.4	2.2	1.6	1.7	1.4	1.3	1.1	1.5	1.7
TC Deposits/Deposits	42.1	50.7	55.2	63.2	61.6	65.1	64.3	65.7	69.6	64.7	66.2	61.3	61.6	56	56.6	54.1
Total Deposit/Total Asset	67	64.4	64.4	63.9	64.5	63.6	64.2	63.5	63.9	60.2	59.3	57.7	56	55.9	56.4	55.4
Fund Borrowed/Total Assets	8.4	8.2	9	11	11.7	10.5	11.1	8.8	9.7	10.9	10	12.1	12.3	13.3	13.6	13.6
Capital Adequacy Ratio	24.2	30.9	28.8	24.2	22	19.1	18.1	20.9	19.2	16.7	18.1	15.4	16.4	15.6	15.5	16.8

Note1. The above table shows the key financial indicator in Turkish banks. On-balance sheet position including fix indexed assets and liabilities. Capital Adequacy Ratio as regulated by the BRSA (8 percent at minimum). All the figures are collected from BAT from 2002 to 2017.

Chapter 5

Competition in the Turkish Banking Sector: Boone Indicator

Abstract

How competition influences financial stability and efficiency has always been a controversial issue, particularly for emerging markets where (due to a limited number of studies) only a negligible amount of evidence is available for researchers. In the context of Turkey, this paper empirically investigates the relationship between competition, stability, and the technical efficiency of all Turkish commercial banks over the period 2002-2017. This paper also contributes to the Turkish literature by applying the modified version of the Boone indicator introduced by Boone (2008) to measure competition scores in the Turkish banking market. Additionally, our paper contributes to the current Turkish literature by accounting for the impact of bank efficiency on bank performance in a competitive environment. Our findings are in accord with the competition-stability theory. Our results indicate a positive and significant relationship between competition and stability. Moreover, we find a positive and significant relationship between competition and technical efficiency in Turkish banks over the time period of our study. We investigate the impact of ownership on the relationship between competition, stability, and efficiency from which we can confirm the impact of ownership on the links between these elements. Moreover, our results show that there is a clear trend towards an increasing concentration of all ownership types in the Turkish banking sector over the period analysed.

5.1. Introduction

The relationship between competition and financial stability has been one of the most debated in the banking literature. In part, this can be attributed to the contradictory empirical evidence that seems to support the two main theories: the competition-fragility theory (Keeley,

1990) and the competition-stability theory (Boyd and De Nicoló, 2005). The former argues that higher competition decreases the market power and profit margins of individual banks, which induces a higher degree of bank risk-taking (for example, Liu and Wilson, 2013; Yeyati and Micco, 2007; Matutes and Vives, 1996; Diamond and Dybvig, 1983). According to Boyd and De Nicoló, 2005) competition-stability, on the other hand, claims that competition enhances stability by cutting interest rates, reducing moral hazard issues, and reducing loan default rates for banks, which enhances banking stability (for example, Cummins *et al.*, 2017; Schaeck and Cihak, 2014; Berger *et al.*, 2009).

The main challenge Turkey faces is to accomplish the process of transition from a 'state-led economy'[29] to a 'market-driven' economy. This challenge is being addressed in part by eliminating monopolies in the Turkish financial market and regulatory falsifications[30]. Accordingly, deregulation and financial integration have increased competition in the banking sector either from peer financial institutions or from 'non-banks', such as insurance firms, venture capitalists, and currency exchanges, which have been increasingly active in offering financial products. Turkey is no exception to this pattern. Therefore, since the 1980s, several financial reforms have been introduced with the main aim of boosting the efficiency and productivity of banks in Turkey. Moreover, Turkey has designed its banking framework to be in harmony with European Union strategies and regulations.

Financial liberalisation and deregulation, along with restructuring programmes during the last three decades, have influenced the competitive environment in the Turkish banking sector. Due to the importance of the Turkish banking system after each financial crisis, particularly after the 1980s, significant action was taken was to reform and restructure the banking sector.

[29] State-led economy is a popular term among the international political economists when they want to weigh the role of the government in determining the macroeconomic policies and decisions.

[30] For instance, in June 2003, Imar Bank presented its total deposit amount as $98 trillion while after BRSA investigation it was discovered that the actual amount of the deposit for this bank was $ 2 trillion. It was also found that the banks sold some Treasury bills without having the licence to do so. All of these similar actions not only mislead the officers but also falsify regulators' evaluations.

Thus, the Turkish banking system during the last three decades has been through numerous restructuring programmes and experienced major consolidation plans[31]. The last and the most important currency and financial crisis in Turkey occurred in November 2000-2001 after which the government established a comprehensive Banking Sector Restructuring and Rehabilitation Program (Ahn and Breton, 2014). After introducing the liberalisation and deregulation programme and establishing the Banking Sector Restructuring and Rehabilitation Program, the main goal of both the Turkish government and the CBT was to increase competitiveness and efficiency in the Turkish banking system. Despite all these efforts, the operating environment for Turkish banks remains challenging due to a combination of factors including a slowing of economic growth, ineffective monetary policy, and deterioration of banks' asset quality, which caused a boost in problem loans in Turkish banks. Therefore, Turkey can be considered as a very interesting environment to study the relationship between competition, stability, and efficiency from the perspective of the competition-stability theory.

Focusing solely on the Turkish banking sector enables us to thoroughly investigate this segmented market. Following Liu and Wilson (2013), in this study we focus on a single market. Emphasising a single market helps to better target under-served segments, strengthening public and private sector coordination in Turkey, enhancing the monitoring and evaluation framework, and providing a detailed plan for payment mechanisms for banks, non-banks, and government payments. Furthermore, focusing on a single banking sector enables us to provide comparability that is more accurate across both dependent and independent variables in this study. Turkey as a developing country provides the circumstances to examine productively the

[31] There are many principals in consolidation planning. The most important ones involve the audit committee (for example, making sure about the internal audit performance of an institution subject to consolidated supervision is accomplished in a consolidated and co-ordinated way, if there is a parent undertaking covered by the Banking Law). The role of the credit committee is also important (for example, to monitor and control risk, banks must establish and operate effective internal controls, risk management team and internal audit systems, that are consistent with the scope and structure of their activities and suitable for changing conditions, and which cover all branches and subsidiaries subject to consolidated accounts). Finally, a detailed plan for consolidated supervision of the banking system is necessary.

competition-stability theory since this country has engaged continually in the process of financial liberalisation and technological changes. Our analysis of the Turkish banking sector also allows us to create a more detailed sample to measure competition scores, providing more insight into the relationships between competition, stability, and efficiency in the Turkish banking sector without any external impact from other markets and economies.

Although a vast body of global literature has assessed the impact of competition on bank stability and financial performance (for example, Schaeck and Cihak, 2014; Beck *et al*. 2013; Zarutskie, 2006; Petersen and Rajan, 1995), reviewing the current Turkish literature indicates that there are many gaps which require consideration. Accordingly, this study contributes to the current Turkish literature by investigating the following areas detailed in the next paragraphs.

Our study contributes to the current literature in three ways: Firstly, considering how the competitive environment has changed in Turkey, this study investigates the relationships between competition, stability, and efficiency amongst Turkish banks. The main target of this study is to provide new evidence about these relationships using data from Turkish commercial banks over the period 2002-2017. It is important to monitor and evaluate these relationships since Turkey is a developing country, which provides an appropriate foundation for examining the aforementioned relationships because the country has been participating in a process of financial liberalisation, privatisation, economic integration, and technological change since the 1980s[32]. Moreover, according to Bikker and Bos (2008), bank performance can be defined in terms of competition, stability and efficiency. Hence, we analyse the impact of bank efficiency

[32] The structural reform and liberalisation programme of the Turkish banking system in recent years has influenced the financial market structure and competitive environment in this country and its banking sector. For instance, there were seven banks with an asset size above 40 billion dollars, five banks with an asset size between 10 billion dollars and 40 billion dollars, and 20 banks with an asset size lower than 10 billion dollars in 2012. The number of banks with the above asset sizes in 2002 was 1,6, and 39, respectively. These figures, which are taken BTA, indicate that the number of large banks in the Turkish banking sector has increased considerably during this period of time.

on bank performance in the dynamic competitive environment of the Turkish banking sector. The difference between this study and previous studies in Turkish literature is the consideration of 'efficiency' as a key factor in measuring competition. Considering efficiency is crucial. Isik and Hassan (2003a) state that banks with higher efficiency scores are able to decline the costs and achieve a greater profit. Hence, evaluating the bilateral impact of competition on efficiency and the performance of more efficient banks in a competitive environment is important. Kasman and Kasman (2012) investigate the influence of competition and concentration on bank stability in the Turkish banking industry using efficiency as a proxy for measuring competition. This study differs from Kasman and Kasman (2012) as we consider efficiency as a separate factor according to which competition is measured and as an element on the basis of which banks may behave differently given competitive circumstances. Secondly, this paper follows the Boone indicator method (Boone, 2008) to compute competition scores by regressing profitability against technical efficiency in the Turkish banking system. The results of previous empirical studies confirm that the main source of inefficiency in Turkish banks is technical inefficiency therefore, in this study we focus on technical efficiency. The Boone indicator is an appropriate method of measuring the competition based on an assumption that competitive circumstances enhance bank efficiency, and eventually market share. It considers how competition may influence the performance of more efficient banks since they are the ones that represent a stronger balance sheet quality and better performance. This indicator is based on the efficiency hypothesis developed by Demsetz (1973) who argues that there is a strong and positive relationship between bank efficiency and competitive performance, which results in them increasing their market share. To provide more detailed explanations and more accurate evidence about the relationships between the selected factors, we separated the Turkish banks in our sample into four major ownership types; state-owned banks, private banks, foreign banks, and investment and development banks. Hence, not only can each type of bank be

evaluated separately but also the performance of each ownership type can be monitored and assessed within the Turkish banking sector. Thirdly, we collected quarterly data for forty-four commercial Turkish banks from December 2002 to December 2017 from BAT. This wide observation period covers all the important events for the last two decades, such as the restructuring period, the global financial crisis in 2008, as well as the recent changes in the Turkish banking system and its economy in 2010 and 2017 after the currency and financial crises in 2000-2001.

As a short summary of our findings, foreign banks indicate the highest Boone scores after development and investment ownership, which shows that these banks are more competitive in comparison with the private and state-owned banks in Turkey. In addition, we find more evidence which supports the positive impact of competition on stability. In other words, our findings are more in line with the competition-stability theory. Moreover, we find there is a positive and significant relationship between efficiency and competition while efficiency is negatively related to risk in the Turkish banking sector. Hence, our findings illustrate that a higher degree of market power belongs to banks that are more efficient. Furthermore, in our findings, private banks show the highest *Z*-scores in comparison to the other ownership types. The least volatile ownership type is the development and investment bank category. Our results are beneficial for policymakers and regulators considering further banking restructuring. Our results are also in favour of the main target of the Turkish government and the CBT to relax the financial market and improve banking performance by enhancing profitability and efficiency under the umbrella of competition. Hence, this study provides policy recommendations for Turkey where significant challenges in banking consolidation persist.

The rest of this paper is structured as follows: Section 5.2 provides information about general studies on competition in the banking sector worldwide and specifically in Turkey. Section 5.3 outlines the data, estimation methodology, and model used in this study to measure

technical efficiency in the Turkish banking industry. Section 5.4 reports the results and lastly, Section 5.5 provides a robustness test. Finally, Section 5.6 delivers some final suggestions for policymakers and managers.

5.2. Literature review

The empirical literature regarding the relationship between competition and bank performance is limited to developed countries. Hence, we attempt to initially express some key theories about competition and some common methods of measuring it through the available literature from around the world. Later, this study mainly focuses on the literature relating to competition in Turkey.

5.2.1. Theories on competition

The two main theories on the relationship between competition and financial stability are i) the competition-fragility theory and ii) the competition-stability theory. The former dates back to Keeley (1990) and argues that less concentrated banking systems are fragile as they take on more risks. This view has been supported in many other studies, such as Beck (2008) and Carletti and Hartmann, (2002). The idea behind this theory is that higher profits induce banks to decrease risky decision-making to avoid the possibility of failure and increase the possibility of higher returns instead. Moreover, this theory argues that since competition imposes stress on margins and reduces a bank's charter value, banks are encouraged to take riskier decisions. In addition, competition can impact on the channel through which financial innovation contributes to financial stability. Another negative consequence of competition is related to the risks that a bank may decide to take in order to be able to survive in a competitive market (Beck, 2008). In order to support Keeley (1990), Allen and Gale (2004) applied his method again and concluded that more financial crises happen in less concentrated more competitive banking systems. Other studies by Boyd *et al.* (2006), and Schaeck, Cihak, and Wolfe (2006),

Boyd and De Nicolo (2005), and Hellmann *et al*. (2000) confirmed the idea introduced by Keeley (1990) in their studies.

Conversely, competition stability theory documents the positive impact of competition on stability through a complex mechanism (Leroy and Lucotte, 2017). The key assumption is that a high degree of competition will reduce the market power of the bank, and consequently reduce its profitability. As profits would be similar across the sector, depositors would be less likely to shift deposits between banks in search of better returns. Moreover, recent papers argue that more competition in the loan market would lead to lower interest rates on loans. On the other side of this transaction, those lower interest rates would increase the return on investment for entrepreneurs who are borrowing money. The prospect of higher returns would encourage entrepreneurs to expend more effort to succeed, thus reducing the risk of default to the bank.

According to these studies, a more competitive or less concentrated banking system is more stable compared to a less competitive and more concentrated banking system. For instance, Goetz (2018) investigated whether an increase in competition can lead an increase in bank stability. To answer this question, he studied on American banks from 1976 to 2006. His results suggest that competition can positively influence bank stability and being more competitive can significantly increase bank stability. Fiordelisi and Mare (2014) evaluated the dynamic relationship between competition and cooperative European banks' soundness in the short and long-term from 1998 until 2009. Their study supports the competition-stability theory for the European banks. Beck *et al*. (2013) studied the relationship between competition and bank stability in a large cross-country variation. They reported that more competition leads to better deposit insurance and a more effective credit information system. They also stated that in countries with stricter restrictions competition has a larger impact on risk-taking behaviour. Boyd *et al*. (2006) studied over 2700 banks across 134 countries and their results support the existence of a positive relationship between bank market power, which increases with more

competition in a market, and risk of failure. Similarly, Beck *et al*. (2006) investigated data from 69 countries and found that countries with more competition and less market concentration experienced fewer financial crises. Yeyati and Micco (2007) confirmed this finding for eight Latin American countries. In particular, bank competition and financial market stability were studied by Schaeck and Cihak (2008) who considered 3600 banks across ten European countries and 8900 banks across the US over the period 1995-2005. They concluded that competition and a less concentrated banking system improved bank performance and financial stability in these countries. Schaeck *et al*. (2009) evaluated 31 systemic banking crises in 45 countries and concluded that competition reduces the possibility of a financial crisis. Similarly, Berger *et al*. (2009) applied a panel of 8235 banks from 23 developed countries. They found that banks in a more competitive environment perform better and are more stable. Fu *et al*. (2014) investigated the relationship between competition and stability in 14 Asian countries. They found that more banking concentration leads to more instability in the banking sector in these countries due to government mismanagement. Boyd and De Nicola (2005) claimed that having a less competitive environment would have caused higher interest rates for loans. Hence, more bank defaults would have been expected due to moral hazard. In addition, they discussed that in a focused financial market with higher competition, banks are motivated to take more risks. In the current literature, there are some studies like that of Allen and Gale (2004) who stated that the relationship between competition and stability is very complex and there are many studies with different findings. Interesting, they argue that social target is important as sometimes being more concentrated is socially more preferable than having perfect stability.

Among all studies, some scholars investigated the characteristics of banks to ascertain whether banking instability resulted from these characteristics rather than from competition itself. For instance, Boyd *et al*. (2006) provided some evidence according to which larger banks

in concentrated banking systems were able to increase profits. Hence, larger banks were more successful in reducing insubstantiality to provide better capital buffers, which can protect banks against unexpected external and internal shocks. Mishkin (2009) discuss the 'too big to fail' hypothesis. He argued that large banks would receive public guarantees or subsidiaries when financial markets in a country were struggling and facing difficulties. Accordingly, these banks tend to keep lower capital buffers. It is valuable to mention a fact in this case regarding the deregulation process, which makes monitoring banks difficult for regulators. The behaviour of large banks may lead to a moral hazard issue, influence risk-taking behaviour, and worsen financial instability (Rosenblum *et al*., 2014).

Many other aspects which may cause a bank to take more risks have also been investigated. For instance, Beck *et al*. (2006) investigated the relationship between bank size and complexity. This study can be used to highlight the idea that bank features, such as efficiency and profitability levels, can lead to instability in a banking sector not performing in a competitive environment. According to their study, monitoring larger banks is more challenging than monitoring smaller banks. Due to economies of scale and scope, there is less transparency in larger banks, which may increase the level of risk. Hence, despite competition, these factors may decrease bank efficiency, due to inappropriate management, and increase the operational risks of the banks (Fu *et al*., 2014).

Other literature focuses on some other specific bank characteristics to determine the risk paradigm of banks. For example, Ahamed and Mallick (2017a) studied how using regulatory forbearance on restructured loans can increase stability in Indian banks. Their results are robust for different ownership structures and use different estimators like bias-corrected covariate matching estimator. Liu *et al*. (2012) applied several bank risk indicators, such as the ratio of loan loss provision to total loans and receivables, loan loss reserve to total loans and receivables, net return on asset volatility, and *Z*-score, to evaluate the relationship between

competition and risk. They provided panel data from some countries in South East Asia, including Indonesia, Malaysia, the Philippines and Vietnam, over the period 1998-2008. They concluded that there is an inverse relationship between competition and the majority of risk indicators. This conclusion suggests that competition itself does not lead to financial instability in the financial market and banking sector.

Among all the studies relating to the relationship between competition and stability, some researchers focused on the relationship between bank characteristics, such as size and volatility in profitability. Boyd and Runkle (1993), for example, examined the relationship between bank size and profitability fluctuations over the period 1971-1990. They used a panel of 122 US banks. Their findings support an inverse relationship between bank size and volatility in bank profitability. On the other hand, Stiroh (2004) claim that their studies of 14000 US banks during the period 1987 to 2001 confirm that there is no meaningful relationship between size and return on equity, which was taken as a profitability indicator in their studies. De Nicolo (2000) followed Boyd and Runkle (1993) and examined 826 banks in 21 developed countries from 1988 to 1998 and reported that larger banks are willing to take more risks. Hence, according to his study, more return fluctuations should be expected from larger banks compared to the smaller banks. De Haan and Poghosyan (2012 b) investigated whether any fluctuations in bank returns and profitability were contingent on bank size. Using US bank data for the period 1995 to 2010 enabled them to draw a conclusion, which indicated that bank size reduces return volatility and has a negative influence on the volatility in profitability. They confirmed the direct relationship between size and volatility during the financial crisis of 2008. Ahamed and Mallick (2017b) also studied the impact of regulatory intervention imposed by the Indian central bank on the growth of non-performing assets in Indian banks between 2003 and 2012. Their results suggest that a higher level of restructured assets considerably diminishes the risk-taking behaviour of Indian banks as banks benefited from low provisioning.

There is some evidence regarding the relationship between efficiency and competition in the current literature. According to the literature on industrial organisation, competition activates a reallocation of profits and market share towards more efficient firms (for example, Olley and Pakes, 1996). Hence, more efficient financial institutions operate better than the less efficient industries both locally and internationally. For banks particularly, Stiroh (2000) indicates that dynamic asset reallocation can indicate how weak banks compared to strong banks can increase their profitability level in a competitive environment. Stiroh and Strahan (2003) also show that competition, which is enhanced by deregulation, reallocates profits from weak and less efficient banks to strong and more efficient banks. Presbitero and Zazzaro (2011) state that banks react to competition by adjusting their lending strategies and emphasising specific types of loans, which enables them to reduce their operation costs while generating loans. They also may become better at monitoring particular groups of borrowers. These considerations help to achieve two empirical predictions: Firstly, competition boosts efficiency. Secondly, more efficient banks perform better and are sounder. These predictions are supported in the empirical literature in two ways: Berger and Hannan (1998) indicates that banks operating in uncompetitive markets are more inefficient. Furthermore, Jayaratne and Strahan (1998) state that efficiency increases after the introduction of a deregulation programme, and DeYoung and Hassan (1998) illustrate that removing interstate restrictions encourage banks to perform better and more efficiently. Likewise, Evanoff and Ors (2008) show that banks with obligations respond to threats of competition by improving efficiency. The literature is also rich and consistent on the link between bank efficiency and soundness. Berger and DeYoung (1997) and Kwan and Eisenbeis (1997) prove that efficiency and soundness are positively associated with each other.

Moreover, to support the undeniable role of efficiency, the current literature discusses three hypotheses, which highlight the role of bank efficiency in competition studies. The first

hypothesis is the ‘bad management hypothesis’, as labelled by Berger and De Young (1997). According to this hypothesis, higher costs will be incurred by banks with lower levels of efficiency due to the fact that in these banks credit is inadequately monitored, and operating expenses are not managed efficiently. Due to credit, operational, market, and reputation issues a bank increases the risks it takes, and its efficiency score decreases even more. The second hypothesis is called the ‘bad luck hypothesis’, which was again discussed initially by Berger and De Young (1997). This hypothesis focuses more on exogenous events rather than managers’ skills or their risk-taking appetite to explain NPLs. Under this hypothesis, we expect to see an increase in risk results leading to a decrease in technical efficiency and productivity. Finally, the last hypothesis is the ‘moral hazard hypothesis’, which was discussed initially by Jeitschko and Jeung (2005). According to this hypothesis, bank managers (to stay competitive in a market) tend to take on more risk when they have lower levels of capital or are less efficient. The moral hazard problem occurs as a result of informational friction and the existence of the agency problem. Disliking the reaction of less efficient banks, banks with higher efficiency levels impose cost-reducing strategies to increase their capital level. These more efficient banks also are less likely to have moral hazard issues. Based on Basel regulations, and country-level regulations, banks are forced to hold higher levels of capital when risks increase; this is due to the fact that the cost of issuing fresh equity at short notice can be avoided by holding additional capital above the regulatory minimum (Peura and Keppo, 2006). However, banks can react to the requirement by the regulatory authority to hold more capital by aggregating portfolio risk.

All of these findings emphasise the importance of some of the main features of banks, such as efficiency, in evaluating the impact of competition on the banking instability.

5.2.2. Competition measures

The lack of any direct measure of competition has encouraged policymakers and researchers around the globe to explore different indicators, which could stand as a proxy for the underlying level of competition. The literature on the measurement of competition can be categorised into two main groups: structural and non-structural approaches. The structural approach, which links competition to concentration, to the measurement of competition uses the SCP and the efficiency hypothesis. This model assesses whether highly concentrated market origins collusive behaviour among the larger banks create a better market performance, or whether the efficiency levels of the larger banks improve their operations in the financial market. The traditional theory of industrial organisation concentrates on the market structure to examine competition. This theory has created several indicators related to market structure such as concentration ratio, HHI, and HTI. All these indicators place specific emphasis on the size of the examined financial institution, including banks, to recognise the market structure. Conversely, non-structural models were established with the purpose of improving the theoretical and empirical shortcomings of the structural models. Some famous examples of non-structural models are the Lerner index (Lerner, 1934), the Panzar-Rosse model (Panzar and Rosse, 1987), and the Boone indicator (Boone, 2008, and 2002).

5.2.2.1. Lerner index

Based on a non-structural approach, the Lerner index (Lerner, 1934) is used to measure the degree of bank competition. The Lerner index is a proxy for profits originating from the market pricing power and it is calculated by the mark-up of price over marginal cost. Thus, it is an inverse proxy for bank competition. This means a lower index shows a higher competition degree and a higher index represents less competition in the market. The Lerner index is a number between 0 and 1. Zero Lerner index shows the perfect competition market while Lerner index equal to one shows a perfect monopolistic market. There are two benefits to applying the

Lerner index compared to other measures such as the Boone indicator (Boone, 2008), the H-statistic (Panzar and Rosse, 1987), or the HHI. First, the Lerner index is the only time-varying measure of competition that can be computed at a disaggregated level. Second, the Lerner index seems to be a better proxy for evaluating the level of competition among banks than structural measures, such as concentration indexes. An extensive empirical banking literature has confirmed that concentration is not a trustworthy measure of competition (see for example, Lapteacru, 2014; Claessens and Laeven, 2004a, 2004b) which explains why several recent studies have used the Lerner index (Anginer *et al*., 2014; Beck *et al*., 2013; Beck *et al.*, 2011).

5.2.2.2. Panzar-Rosse

This method, developed by Panzar and Rosse (1987), indicates the competitive behaviour of banks on the basis of the comparative static properties of reduced-form revenue equations based on cross-sectional data. If this method is to yield reasonable results, then banks need to have operated in the long-term equilibrium while the performance of banks needs to be influenced by the actions of market participants. Molyneux *et al*. (1994) tested this model on a sample of French, German, Italian, Spanish and British banks over the period 1986-1989 to evaluate competitive conditions in European banking markets. They achieved values for H which were not significantly different from zero for Italy and from one for Germany, Spain, and Britain, showing the monopolistic competition market. Moreover, Vesala (1995) applied the same model to the Finnish banking industry between 1985 and 1992 to study competition and market power in the Finnish banking sector. He found a positive and significant H value which was different from zero and from unity only in 1989 and 1990. There are many other studies that applied Panzar-Rosse such as Mogro *et al*. (2018); Bikker *et al*. (2012); Schaeck *et al*. (2006); and Claessens and Laeven (2005).

5.2.2.3. Boone

Under the Boone indicator approach, the main idea is that more efficient entities with lower marginal costs gain a larger market share or are more profitable and that this impact would be bigger when there is a higher level of competition in the market. The Boone model makes it possible to observe why concentration indices may not be good indicators of competition. For instance, if banks have different efficiency scores any increase in competition in the market will shift the other institution's output towards the more efficient banks, increasing concentration. Thus, an increase in concentration is the result of greater competition. Recently, deploying the Boone indicator to test and measure competition has attracted the attention of many scholars as it provides the possibility of considering efficiency which is often used as an indirect measure of competition. Many studies have applied Boone in their investigations into market structure and competition, for example, Ventouri, 2018 and Tan, 2018.

This Boone assumption, regarding measuring of competition and required factors to be considered, makes it more advantageous when compared with other concentration measures and other competition proxies such as HHI. For instance, if bank's product/service substitution increases, more efficient banks (on the basis of the efficiency structure hypothesis) gain a larger market share, which consequently increases competition in the market. If these efficient banks are already those with a dominant position, the HHI would increase instead of decrease. In fact, when product substitution increases, customers prefer banks which offer cheaper services. Indeed, banks that are more efficient are more flexible in adjusting their prices to meet customer preferences than less efficient banks. Hence, they could gain more market share. That is why HHI would increase when the competition is higher. However, these measures, which indicate that there is an inverse relationship between competition and the magnitude of the price margin over marginal costs, do not capture the entire relationship. This is because the more efficient

banks may charge higher prices due to their efficient scores that result in reducing the marginal cost faster than reducing prices.

Moreover, the Boone indicator enables us to measure competition in several specific product markets and different categories of banks. For example, Leuvensteijin *et al*. (2011) applied the Boone indicator to commercial banks and concluded that commercial banks face more competition than cooperative and savings banks, particularly in the US and Germany.

There are however some disadvantages of using the Boone indicator. For instance, due to an improvement in efficiency scores banks may decide to either decrease the prices that they charge to gain market share or to boost their profits and retain the same share as before. Thus, we need to assume that all the banks will pass at least part of their efficiency gains onto customers. The other disadvantage is related to uncertainty, in common with the other measures.

To conclude, many previous studies have attempted to explain the consequences of competition by focusing on capital structure and market share of the banks, the quality of financial services and innovation, the stability of the financial system, and the costs and profits of banks using two main methods. Measurement of competition has been considerably influenced by NEIO literature. This literature is built on the models of Iwata (1974), Bresnahan (1982), and Panzar and Rosse (1987). The method used most often in studies is the Lerner Index (1934). Apart from being straightforward to interpret and not posing any stringent data requirements, the main reason for the popularity of this index is that it can serve as a good proxy for actual market power, without the need to estimate production costs and equilibrium prices.

The other popular method is the H-statistic of Panzar and Rosse (1987). However, the disadvantage of this model is that it cannot analyse the variables continuously. Boone (2008) presents another technique to measure competition, which is also a non-structural method as

with Panzar and Rosse (1987). Comparing Panza and Rosse (1987) and Boone (2008) can highlight that the Panzar and Rosse indicator requires restrictive assumptions such as the existence of a long-run equilibrium banking market (Panzar and Rosse, 1987). The Boone indicator is more appealing, given that no such assumption is needed and it is robust in accounting for different forces that can lead to an increase in competition (for example, lower entry costs, relaxation of entry barriers, more aggressive interactions between firms/banks).

5.2.3. Competition in the international banking sector

The impact of competition in the banking sector has been investigated thoroughly. Competition not only as an independent factor but also as an element to explain the market structure has been taken into consideration. Hence, when scholars evaluate bank performance, looking too at competition and market structure has always been attractive. Since the aim of this study is to investigate the relationship between competition, stability, and efficiency in the Turkish banks, before reviewing the impact of competition on Turkish banks' performance, it is worth reviewing the international studies that examine different aspects of the impact of competition on the banking sector. Hossain *et al*. (2020) look at the impact of competition on the performance of microfinance institutions from 2005 to 2014 over 59 countries. Their findings show that competition negatively influences the economic sustainability of these institutions. According to the authors, this information can help the regulators, especially because the microfinance institutions market is expanding to some developing countries as well. Hence it needs to be well supervised and controlled. Ahmed and Mallick (2017) study the effectiveness of corporate debt restructuring as a regulatory forbearance to eliminate bad assets, including NPLs, and improve bank stability. They look at Indian banks. Hence their results contribute significantly to the emerging economic literature. Their results confirm a positive impact of regulatory forbearance on stability. This result is robust when they use an alternative measure to estimate bank stability, market power measures, and different

ownership. Initially they consider the *Z*-score to examine the impact of regulatory forbearance and then they consider the NPLs as an alternative stability measure. To measure for market power, they use Lerner indices and (in) efficiency-adjusted Lerner indices from a SFA approach following Koetter *et al*. 2012. Their study also considers the impact of ownership. Ahamed and Mallick (2017b) also investigate the impact of a regulatory intervention by the Indian central bank over the past decade on the banks' lending to protect banks from bankruptcy. They consider how restructuring assets in the Indian banks from 2003 to 2012 help the banks to eliminate their risks. Their results show that more restructured assets coincide with less default risk. It is interesting to discuss that according to this result, banks with higher provisions benefit less from the restructured asset comparing to those banks with lower level of provisions on risky assets. Moreover, according to their findings, having more restructured assets also improves the stability of the banks. The authors report that private banks in India are less stable compared to the private and foreign banks in India. Kick and Prieto (2015) examine the bank competition-stability theory using a regulatory dataset from Deutsche Bundesbank from 1994 to 2010. They measure market power using inefficiency-adjusted Lerner Indexes. Their results show that an increase in the market power of a bank declines the possibility of bank default risk. They measure the competition via geographical reach and Boone indicator at the county and federal state level. Moreover, their results show that more competition also leads to lower levels of risk. According to them banks in less competitive environments react more strongly to any changes in interest rates. Whether their results confirm the competition-stability theory is uncertain because some banks reflect more stability when competition pressure is greater, and some do not. Cornaggia *et al*. (2015) examines the impact of deregulation and competition on bank innovation. They collected data from 1976 to 2006 from US listed corporations and private financial institutions. They suggest that having more competition reduces the innovation levels of state-owned banks for those that are performing

in deregulated markets. However, for private banks that are dependent on external financial sources, competition increases their innovation activities. Montes (2014) considers the Spanish banking sector. This aforementioned study examines the impact that the consolidation on the Spanish banking sector (following the 2008 crisis) had on competition. His competition analysis is based on structural demand and cost estimates. His results show that consolidation has had a small impact on competition in Spanish banks. Hence, he asserts that concerns around the anti-competitive effect of bank consolidation are not valid in the case of Spanish banks. Beck *et al*. (2013) consider the relationship between bank competition and bank stability using a large cross-country sample. They consider the impact of market, regulatory, and institutional features in their study. Their results suggest that increases in competition will have a larger impact on the risk-taking attitude of a banks in countries with stricter restrictions and lower systemic fragility. According to their findings, the competition-stability theory varies across different countries depending on other market and economic conditions. Fang *et al*. (2014) considered the impact of institutional reforms on risk in transmission economies. They apply difference-in-difference approach for 434 commercial banks across 15 Eastern European countries, including Albania, Bosnia-Herzegovina, Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Macedonia, Poland, Romania, Serbia, Slovakia, and Slovenia from 1997 to 2008. They argue that despite literature always emphasising the importance of institutional development for financial market development, this relationship rarely is discussed in literature. Their results show that there is a significant improvement in financial stability after liberalising interest rates, decentralising the role of central banks, and deregulation practices. According to their results, legal reforms in corporate governance and creditor rights also positively influence bank stability. They also demonstrate a strong link between legal institutional reforms and banking reforms. This chain also results in risk reduction. The authors also outline that the efficacy of creditor rights and corporate governance

reforms depend on the banking reform of a country. However, for all countries in their sample they confirm the positive impact of creditor rights and corporate governance reforms on banking stability. Moreover, Tabak *et al*. (2012) considered the impact of competition on the risk-taking attitude of the banks across 10 Latin American countries from 2003 to 2008. To measure the competition scores they run the Boone indicator. Then they regressed this measure and other results by running the stability stochastic frontier to compute bank stability inefficiency measures. Their results suggest that competition influences the risk-taking attitude of a bank non-linearly. Their results also confirm the positive impact of competition on increasing stability, which is in line with competition-stability theory. Evaluating banks' specific characteristics, they report that larger banks can benefit from competition more than smaller banks. This result would be true also for the banks with higher capitalisation levels. Olivero *et al*. (2011) investigate the impact of competition on the transmission of monetary policy through BLC applying two-step estimation. They look at 10 Asian and 10 Latin American countries between 1996 and 2006. Their competition scores, which are calculated running the Panzar-Rosse model, show a negative impact of the transmission of monetary policy through BLC. This result is especially valid for the Latin American banks. As with Tabak *et al.*'s study (2012), their results also confirm the positive impact of bank characteristics, like size and capitalisation, on a bank's reaction. Uhde and Heimeshoff (2009) consider 25 European countries between 1997 and 2005. They examine the impact of market concentration on bank performance and financial soundness. They measure stability using the *Z*-score technique. Their results are in line with the concentration-fragility theory. Schaeck *et al*. (2009) look at the relationship between bank competition and banking sector stability. They use cross-country data from 38 countries considering almost 28 systemic banking crises from 1980 to 2003. They measure competition using the Panzar-Rosse H-statistic model. Their results are in line with competition-stability theory. Their results also confirm there is less

possibility of banking crisis when banks perform under competition. They discuss what makes banks face more crises and assert that the issue is not one of competition, but with a more restrictive institutional environment. Goddard and Wilson (2009) evaluate the implications of Panzar-Rosse H-statistics. They outline how commonly-used techniques, like fixed effect and GMM, used to measure the competition in empirical literature require market equilibrium assumptions to achieve accurate results for H-statistic. While Panzar-Rosse model is based on static equilibrium framework. According to their discussion, considering a static equilibrium might be biased as the market may be out of equilibrium either occasionally or always. Hence, they criticise the use of the Panzar-Rosse model with a static revenue equation because it leads to biased and inefficient coefficients. Thus, they conclude that when applying Panzar-Rosse H-statistic one should impose dynamic revenue equation. Athanasoglou *et al.* (2008) consider the impact of the macroeconomic environment, banks and industry-specific characteristics on bank performance using the SCP hypothesis. They look at Greek banks between 1985 and 2001 running GMM technique. More than measuring the competition, they focus on the market structure and examine the impact of this on profitability. Their results do not support the SCP hypothesis and its impact on bank profitability. Their results give greater credence to characteristics like size and capital, on bank profitability. Beck and Demirguc-Kunt (2006) also investigate the importance of having a competitive environment and an open market by evaluating how important it is for small and medium-size enterprises to access finance. They discuss how a competitive business environment and a flexible market to enter and exit improve the development process and business environment. According to them, considering the absence of well-developed financial markets, improving competition and easy access to sources of finance can contribute to financial market development. Claessens and Laeven (2004a) use the Panzar-Rosse method to estimate the degree of competition in 50 countries. To evaluate the impact of competition on the bank performance they consider some characteristics,

such as a country's openness or its level of deregulation. Their results suggest that fewer restrictions and markets that are open to foreign input increase the competition overall, which positively influence bank performance. Additionally, the authors do not find any negative impact of concentration on competitiveness. This study also presents some (arguably weak) evidence regarding the negative relationship between competition and the number of banks in a country. This is something which needs further investigation. Bikker and Haaf (2002) also test the competitive conditions and market structure in the banking sector using 23 countries in Europe and beyond. They measure competition using the Panzar-Rosse model. Their results from H-statistic illustrate the existence of monopolistic competition for industrial countries. They consider the impact of geography and bank size while measuring the degree of competition. Hence, they define large banks as those that are actively operating in an international market, and small banks as those operating mainly in local markets. Moreover, medium-sized banks do have an intermediate position in their study. They find a positive relationship between banksize and competition. Additionally, their results show a stronger competition in Europe than in the US, Canada, and Japan. Boot and Thakor (2000) develop a banking model by which to evaluate the nature of the relationship between competition and bank performance. They also evaluate the nature of changes in competition as well. According to their model, it is the banks who decide their specialisation and activities in the borrower sector, providing lending services, and allocating their capacity across transaction lending and their networking with other banks and financial institutions. Their findings show more lending and lower interbank competition. Moreover, according to their results, more capital market competition reduces total bank lending.

5.2.4. Competition in the Turkish banking sector

Historically, the Turkish banking sector has been through numerous regulatory and system changes. Before the 1980s, the Turkish banking system was largely closed without any

meaningful interactions with other economies. The financial liberalisation begun in 1980 can be considered as a milestone in the development of the Turkish economy and its banking system. According to the main aims and objectives of this liberalisation, the efficiency and competitiveness of the Turkish banking system and the financial market should have increased. The majority of restrictions on market entry for foreign entities were eliminated in order to motivate foreign banks and organisations to enter the Turkish market. Consequently, due to the elimination of the heavily regulated environment, Turkey during 1980 experienced innovation and technological improvements in its banking sector and financial market (Kasman, 2012).

To fulfil the main aims of the liberalisation programme, the banking system has been changed and re-regulated continuously since the 1980s. As in other emerging countries, the liberalisation programme began to be implemented before sufficiently strong fundamentals were built. Hence, straight after implementing the deregulation programme, Turkey experienced several macroeconomic challenges. These challenges were reflected in the form of high inflation rates, volatile economic growth rates, and considerable instabilities in the financial system. To address these issues the Turkish government, CBT, and IMF signed many different agreements, particularly after the currency crisis in 2001. The results of these reform plans and agreements improved the Turkish financial environment significantly. One of the most significant regulatory changes happened during 2004 when the proposal to have full coverage deposit insurance was rejected. Furthermore, new banking principles in line with EU directives and international standards were introduced by BRSA in 2005. Despite these efforts, Turkey still needs to address some macroeconomic and banking challenges.

One of the main aims after liberalisation was to boost competition in Turkey. The relationship between competition and financial stability has attracted the attention of scholars during the last two decades, especially after the financial crisis of 2008. There is a general belief that competition can influence innovation in a positive manner and can increase product

quality and efficiency. Hence, competition can be considered as a positive factor in the banking sector. Although there are several studies on the Turkish banking system which have evaluated it from different perspectives and with various purposes, there are very few studies in which the relationship between competition and concentration in the Turkish banking sector have been examined.

Among the available literature, Gunalp and Celik (2006) applied the Panzar-Rosse H-statistic in order to evaluate the competitiveness of Turkish banks over the period 1990-2000. Their results indicate that bank revenue patterns are similar to earning patterns under monopolistic conditions. Moreover, Abbasoglu *et al*. (2007) stated that despite the implementation of merger and acquisition activities and the reform of Turkish banks, they behave in similar ways to non-concentrated banks over the period 2001-2005. In all of these studies, H statistics are always between zero and one, which can be taken as evidence of the existence of monopolistic market conditions in the Turkish banking sector. Also, the relationship between competition and concentration cannot be clarified from their findings. According to Yayla (2007), concentration in the Turkish market decreased during 1995-1999 while a boost can be found during the period 2000-2005. It is interesting to see that the net interest margin, which can be considered as a relevant price indicator for the banking sector, decreased in both time horizons. Masood and Aktan (2010) investigated 17 Turkish banks from 1998 to 2008. They evaluated some factors which can provide more a more detailed account of the differences in the competitiveness level of the banks. On the basis of their results, the Turkish banking sector is in an equilibrium state, especially over longer periods. They concluded that Turkish banks are performing in an environment of monopolistic competition. According to Masood and Aktan (2010) the fact that the market power of the banks derives from a strong concentration level in the banking sector cannot necessarily lead to the rejection of the idea that banks are competitive.

Generally, the financial liberalisation and restructuring programme in Turkey brought many changes for the competitive environment in the Turkish banking sector. Overall, competition can be taken as an engine which can motivate and accelerate the consolidation process in the banking sector although bank concentration is still a concern. Although the investigation into the relationship between competition, concentration, and financial stability remains important, there is insufficient consideration given to this topic in the literature about the Turkish banking sector. Therefore, the main target of this paper is to provide unique evidence of the relationship between competition and financial stability, focusing on bank profitability and efficiency levels. To capture a more coherent picture, we are using data from Turkish commercial banks over the period 2002 to 2017. Because Turkey is participating in financial liberalisation, privatisation, economic integration, and technological innovation, examining the relationship between competition and stability is interesting. To the best of our knowledge, this study represents results from almost all commercial banks that are operating in Turkey.

Providing more evidence and revising the current literature relevant to Turkey is especially crucial for regulators and supervisors in order to impose appropriate discipline in the banking system. New evidence should help both policymakers and researchers to address the current issues. It also should guide regulators to decide whether competitiveness should be considered as a threat to financial stability or as an opportunity to enhance stability.

5.3. Data and methodology

5.3.1. Data

In this study, we use quarterly data for 44 commercial banks[33] that were operating in Turkey over the period 2002-2017. The data are collected from BAT. Using BAT enables this study to collect all the required data for evaluating the aim of this study for all the available commercial

[33] Our sample only represents those Turkish commercial banks whose data we could access through BAT, which are almost all of the banks operating in Turkey.

banks in Turkey. Moreover, it prpvides the most up-to-dated data. The data includes all the state-owned banks in Turkey as they contain the greatest proportion of total assets (around 66%) in the Turkish banking sector. Our sample includes all Turkish commercial banks operating in Turkey from 2002-2017, which corresponds to approximately 1000 quarterly observations. Our sample reflects the ongoing restructuring of the banking industry in Turkey and, given that it takes quarterly data into account, is likely to better reflect the changes in the macro-economy and in the regulatory treatment of banks over time.

The high inflation environment in Turkey could misrepresent the comparability of our results over the analysed period. In particular, hyperinflation during the period 2002-2004. During this period inflation targeting plans were implemented and could create problems in providing a fair assessment of the results. Table 5.1 illustrates the definition for each variable used in this study. Given the fact that any correlation between an undesirable output and the inputs, or a desirable output, can lead to a misspecification in the distance function (3.13), there is a correlation coefficient matrix, which is presented in table. 5.6[34]. To minimise the potential bias in our results, inputs and outputs are denominated in US dollars. Making the denomination of variables US dollars instead of TL allows us to control for the adverse impact of inflation. As Isik and Hassan (2003a) also correctly discussed, the expression of bank variables in US dollars indicates a straight adjustment of the selected parameters for inflation. Moreover, Assaf *et al*. (2013), Ozkan-Gunay and Tektas (2006), and Isik and Hassan (2002, 2003a,2003b) state that the denomination of variables in US dollars benefits the literature by managing the possible impact of inflation on real magnitudes.

In this paper we consider the relationship between competition, stability, and technical efficiency so we need to compute the efficiency scores and the competition for each type of

[34] The correlation coefficient matrix presented in Table 5.6 indicates that correlations among the variables in this paper are mainly negligible, showing that the model applied in this paper is unlikely to suffer from the issue of considerable multicollinearity.

Turkish bank between 2002 and 2017. Hence, the first seven variables (deposit, capital, total loans and receivables, total securities, non-interest income, off-balance sheet activities, and NPLs) are going to be applied to compute for technical efficiency using DEA model, which will be explained in detail in section 5.3.4. Following the current literature (Fukuyama and Matousek, 2017; Fujii *et al*., 2014), we use capital and deposits as our two inputs to calculate technical efficiency. In this study, due to lack of available data and categories for deposit, we consider the total amount of deposit per Turkish bank.

The main reason for us to compute technical efficiency using DEA model is to define a separate vector for an undesirable variable (in our study NPLs) in order to consider the impact of these bad loans on efficiency. Later, we compute the Boone indicators for each type of bank using data related to total expenses, capital ratio, and return on asset, MS_i, and MC_i using Boone indicator formula and translog cost function, which is explained in detail in section 5.3.2. The other variables like size, OBSA, LTA, and LIQ are going to be applied to investigate the relationship between competition, stability, and efficiency in section 5.3.5 to consider how these variables behave when looked at with the other key variables.

Before computing for the efficiency and competition scores, we evaluate the key statistics for taken variables in order to better picture the data. The main statistics for the considered variables in this study are represented in Table 5.2. This table describes the mean, standard deviation, minimum and maximum amount for each variable along with number of observations for the whole sample in this study. Non-interest income in this study is calculated by adding the total of net fees and commission income/expenses, dividend income, net trading profit/loss, and other operating income. Non-interest income represents how well a bank can generate money from its non-deposit activities. NPLs are a bad output, which indicates due loans in arrears for three to six months, and loan debts of longer than six months in length. Our undesirable output is NPLs. Capital represents all the book values of the fixed assets in the selected banks.

Respectively, the desired outputs are total loans and receivables, net securities, and net non-interest income. This study considers return on assets (ROA) as a proxy for profitability while computing for competition using Boone (2008). The *Z*-score is a proxy for credit risk, which is calculated as the sum of the capital asset ratio and the return on assets over the standard deviation of the return on assets (Fiordelisi and More, 2014). To examine the relationship between competition, stability, and efficiency this paper considers the other key variables, including size, OBSA, and LTA, following Tabak *et al.* (2012), into consideration. All the financial data, apart from ratios such as return on asset, are denominated in millions of US dollars.

5.3.2. The Boone indicator

According to Boone (2008), we are assuming that each bank i selects a vector of strategic variables, which is $a_i \in R^K$. This decision proceeds a bank towards the output vector $(q(a_i, Q, \theta) \in R_+^L$ for the bank i where Q aggregates actions decided by the banks in the banking system, which influences the bank i's output and θ is an element that impacts on the aggressiveness with which the bank interacts in the market. For example,θ can represent the substitution elasticity between offered services and products among different banks or it may simply indicate whether a bank plays Cournot and Bertrand competition[35]. We define the simplest function to identify the Boone indicator for bank i as follows:

$$\ln(MS_{ki}) = \alpha + \beta Ln\ (MC_{ki}) \qquad (5.1)$$

Where MS_{ki} represents the market share of bank i in the output k, and MC_{ki} is the marginal cost. β denotes the Boone indicator, which represents the degree of competition. The Boone indicator declines the profit elasticity to the marginal cost. That is why in this paper we assume

[35] Cournot and Bertrand competition illustrates an oligopoly competition in which a financial entity decides to produce a specific number of products. The total supplied amount from all suppliers determines the market price of that product.

a return on assets as a proxy for profitability in a bank. Hence, this measure also represents the market share for each bank. In this paper we focus on competition in the loan market, so k= total loans and receivables. Following the Boone (2008) assumption, competition means a bank's products are close substitutes and the market entry costs are low for any entities that decide to participate in the market.

Since observing marginal cost directly is not possible, Schaeck and Cihak (2010) proposed using the ratio of average variable costs to total income instead of using marginal costs. However, Tabak *et al.* (2012) calculate the marginal cost from a translog cost function for each country in their sample. This paper follows the latest view to find the marginal cost for each Turkish commercial bank. Using the translog cost function also enables us to measure the marginal cost of any one of the outputs while their costs are not directly available (Tabak *et al*., 2012). Following Tabak *et al*. (2012) we are going to consider the cost function for any bank i in the quarter t for all the banks in our dataset. We then derive the marginal costs from the translog estimation and use these measures as an independent regressor of the market share in equation (5.1). Thus, the translog cost function is as follows:

$$Ln(\frac{C}{W_2})_{it} = \alpha_0 + \sum_i \alpha_i lnY_{it} + \frac{1}{2}\sum_i \sum_k \alpha_{ik} ln\, Y_{it}\, lnY_{kt} + \beta_1 \ln\left(\frac{W_1}{W_2}\right)_{it} + 1/2\beta_{11} \ln\left(\frac{W_1}{W_2}\right)_{it} \ln\left(\frac{W_1}{W_2}\right)_{it} + \sum_i \theta_i\, lnY_{it} \ln\left(\frac{W_1}{W_2}\right)_{it} + \varepsilon_{it} \quad (5.2)$$

Where C_{it} represents a bank's total cost including interest expenses, personal and other administrative/operating costs and Y_{it} represents five outputs: total loans and receivables, total securities, total non-interest income, and NPLs for bank i at time t. Non-interest income represents that bank's non-traditional income. As for bank inputs, represented by W in the above formula, we consider two main inputs: W_1 which represents the capital and W_2 ,which indicates the deposits. It is calculated as interest on deposits to total deposits (Fukuyama *et al.*, 2020). Following the equation (5.2), cost function is measured independently for each Turkish

bank in the sample over the time horizon of this study to reflect any potential changes in costs per bank. Homogeneity of input prices is achieved by consideration $\sum_{i=1}^{2}\beta_i = 1, \sum_{i=1}^{2}\theta_i = 0$ and $\forall\, k \in \{1,2,3\}: \sum_{i=1}^{2}\beta_{ik} = 0$. Accordingly, we can find the marginal costs of loans if we take the first derivate of the dependent variable in equation (5.2) in relation to output y_{jit}, which represents the total loans. It can be better represented as:

$$MC_{it} = \left(\frac{\frac{C_{it}}{W_2}}{Y_{it}}\right)\left(\alpha_{i=1} + 2\alpha_{11} lnY_{it} + \sum_{k=1,\dots K;K\neq 1}\alpha_{11} lnY_{kt} + \theta_1 ln\left(\frac{W_1}{W_2}\right)\right) \quad (5.3)$$

After calculating the marginal cost of loans, we estimate the Boone indicator using equation (5.1). In using the Boone indicator, we make the following assumptions. First, we consider that the competitive condition is available for each Turkish bank over the entire period of study. Second, we assess the competition in each quarter per bank. This estimation of the following equation for each bank separately yields the competitive conditions in the loan market for the entire sample of this study.

$$Ln(MS_{it}) = \alpha + \beta Ln(MC_{it}) + \varepsilon_{it} \quad (5.4)$$

Where MC_{it} shows market costs and MS_{it} shows market shares in the loan market of bank i at quarter t. We expect that banks with low marginal costs gain market share; i.e. when $\beta < 0$. Competition tends to boost this impact for more efficient banks as they outperform in comparison to less efficient banks. Therefore, a more negative β value represents a higher competition level in the banking sector. Furthermore, there is the possibility of a positive sign for β. Leuvensteijin *et al*. (2011) state that this positive sign for β means that the higher marginal costs for banks lead to the higher market shares they will earn. According to Tabak *et al*. (2012), the other two possible explanations for this phenomenon are (I) an extreme level of market collusion and (II) banks competing on quality, which supports the collusion idea. Dick (2007) outlines how banks may increase their costs to gain further demand via the quality

channel when the market is growing, which explains the entry of competitors into the same market.

Following Leuvensteijin *et al*. (2011) and Schaeck and Cihak (2010), we are also aware of a possible endogeneity that may occur in equation (5.1). Both these and other studies such as Tabak *et al*. (2012) highlight the chance of joint determination of performance and cost. Considering the fact that correlation between both desirable and undesirable outputs with inputs can create a misspecification in the distance function (5.6), there is a correlation coefficient matrix, which is presented in Table 5.6.

5.3.3. Efficiency measures

As discussed earlier, there are not many studies investigating the relationship between bank efficiency and competition in the Turkish financial market and its banking sector. However, some industrial organisation studies suggest that competition increases efficiency (Hay and Liu, 1997). In addition, there is some evidence from banking research which reports that efficient banks maintain better screening and monitoring procedures under competition. These studies confirm the competition-stability theory and point to the positive impact of competition on bank performance. The lack of enough evidence to illustrate the relationship between competition and bank efficiency provides motivation for this study to consider efficiency as an element according to which a bank may react differently in competitive circumstances.

To meet the aim of this section, first, we need to calculate technical efficiency. As discussed in section 3.3.2, efficiency is generally estimated in the available Turkish literature by deploying either parametric or non-parametric approaches. Different bank features also have been assessed in previous studies. For instance, Fukuyama et al, 2020; Assaf *et al*., 2013; Fukuyama and Matousek, 2011; Isik and Hassan, 2002, 2003a, 2003b.

In this study, we explore the link between efficiency and competition by estimating efficiency using DEA with a directional distance function, which was introduced and applied

by Aparicio *et al*. (2015). As discussed in section 3.4.1, our focus is on the loan market while also considering competition. In the loan market, what we are particularly interested in investigating is the number of NPLs in different competitive conditions. Although recent studies have been more focussed on cost and profit efficiency (for example, Peng *et al*., 2017; Sun and Chang, 2011), in this paper we account for technical efficiency, which refers to a bank's productivity in producing the maximum amount of desirable outputs from any given amount of inputs. Other types of efficiency are also interesting; however, their focus and definition differ from the aim of this paper. Hence, not only do we focus on the impact of NPLs while accounting for technical efficiency we also consider NPLs indirectly when we measure the total and marginal cost of the banks through the translog cost function by taking efficiency into account. Moreover, based on industrial organisation theory[36], we expect more competitive environments to result in more efficient lending decisions, which ultimately increases soundness.

Applying the DEA method enables us to study the impact of NPLs separately by defining a different vector for undesirable output, which is NPLs in our study, to estimate efficiency scores. Additionally, efficiency error can be separated from the model error which also helps to clarify the source of inefficiency in a bank. This model can be written as:

$$\overrightarrow{D_T}(X, Y^g, Y^b; d) = \sup [\, \delta : (Y^g + \delta d^g, Y^b - \delta d^b) \in \rho(X - \delta d^x)] \quad (5.5)$$

In the above formula, d = $(-d^x, d^g, -d^b)$ and the value δ denotes technical inefficiency. Furthermore, the directional technology function (5.5) is designed to obtain the optimal amount of desirable outputs in the direction d^g while producing the lowest amount of undesirable outputs in direction d^b. Considering the technology function, the expression can solve this optimisation formula to compute the efficiency level.

[36] It refers to the strategic behaviour of firms, regulatory policy, antitrust policy and market competition.

$$\max_{\delta,\lambda} \delta$$

$$\text{s.t.} \sum_{j=1}^{n} \lambda_j Y_{rj}^{g} - \delta d_{ri_0}^{g} \geq Y_{ri_0}^{g} \quad , \qquad r = 1, \dots, q \tag{5.6}$$

$$\sum_{j=1}^{n} \lambda_j Y_{kj}^{b} + \delta d_{kj_0}^{b} \leq Y_{kj_0}^{b} \quad , \qquad k = 1, \dots, l \tag{5.7}$$

$$\sum_{j=1}^{n} \lambda_j X_{ij} + \delta d_{ij_0}^{x} \leq X_{ij_0} \qquad i = 1, \dots, m \tag{5.8}$$

$$\sum_{i=1}^{n} \lambda_i = 1 \tag{5.9}$$

$$\lambda_j \geq 0 \quad j = 1, .., n \tag{5.10}$$

Vector d = $(0, Y^g, -Y^b)$ allows desirable outputs to be increased and undesirable outputs to be decreased without changing the input level. In this directional vector the distance functions do not depend on the units and magnitude of the variable, so, the value of δ will fit to the interval [0,1].

5.3.4. Risk and stability

In this section, we show the relationship between competition on the one hand and risk and stability on the other. To meet the aim of this section we use a measure that indicates bank risk-taking behaviour, namely the *Z*-score. The *Z*-score measures how far a specific bank is from insolvency. This is a straightforward way to show that the *Z*-score is inversely proportional to a bank's probability of default (for example, Leroy and Lucotte, 2017; Fiordelisi and More, 2014; Demirguc-Kunt and Huizinga, 2010; Houston *et al*., 2010; Iannotta *et al*., 2007; Boyd *et al.*, 2006). In this paper, we are following Fiordelisi and Mare (2014) to calculate *Z*-score. This measure is calculated as the sum of CAR and ROA divided by the standard deviation of the return on assets $\sigma(ROA_t)$. Taking the standard deviation of the ROA is to capture the number of standard deviations by which returns have to diminish in order to diminish the equity of a bank. Thus, the *Z*-score is computed as follows:

$$Z\text{-score}_{i,t} = ROA_{i,t} + CAR_{i,t} / \sigma(ROA_{i,t}) \tag{5.11}$$

Where $ROA_{i,t}$denotes the return on assets for bank i in current period t. CAR_{it} represents the capital asset ratio for bank i in time t, and $\sigma(ROA_{i,t})$ is computed as the standard deviation of the return on assets for each bank i at time t. A higher value for *Z*-score, as a proxy for bank stability, shows a higher degree of solvency and therefore it provides a direct measure of bank stability.

5.3.5. The relationship between competition, stability, and efficiency

Apart from formal and common models of banking competition, competition can be influenced by other external factors such as stability and efficiency. These factors can enhance bank responsiveness, especially in times of financial crisis. Considering the theoretical debate, mixed empirical evidence, and the direction taken by banking reforms, it is crucial to examine the links between competition, stability, and efficiency in the Turkish banking system. Assessing this relationship can also help in providing a broader framework of competition, financial stability, and bank efficiency. To elaborate more on this relationship, it is important to explain some of the main relevant hypotheses that explain the relationship between bank efficiency, stability (*Z*-score) and competition before discussing the empirical model. Hence, by taking into consideration the three hypotheses below and emphasising the importance of considering NPLs, this paper contributes to the current literature.

To illustrate the relationship between competition, stability, and efficiency, we can use the following equations:

$$Boone_{it}= \alpha_0 + \alpha_1 Risk_{it} + \alpha_2 TEFF_{it} + \alpha_3 Loans_{it} + \alpha_4 ROA_{it} + \alpha_5 Size_{it} + \alpha_6 LIQ_{it} + \alpha_8 OBSA_{it} + \alpha_9 LTA_{it} + \varepsilon_{it} \quad (5.12)$$

$$Risk_{it}= \alpha_0 + \alpha_1 TEFF_{it} + \alpha_2 Loans_{it} + \alpha_3 ROA_{it} + \alpha_4 Boone_{it} + \alpha_5 Size_{it} + \alpha_6 LIQ_{it} + \alpha_8 OBSA_{it} + \alpha_9 LTA_{it} + \varepsilon_{it} \quad (5.13)$$

$$TEFF_{it}= \alpha_0 + \alpha_1 RISK_{it} + \alpha_2 Loans_{it} + \alpha_3 ROA_{it} + \alpha_4 Boone_{it} + \alpha_5 Size_{it} + \alpha_6 LIQ_{it} + \alpha_8 OBSA_{it} + \alpha_9 LTA_{it} + \varepsilon_{it} \quad (5.14)$$

Where LTA represents loans to total assets, size shows the logarithmic value of assets, credit risk is represented by the *Z*-score, TEFF denotes technical efficiency, and OBSA represents off-balance sheet activities to total assets.

In these equations, the i subscript denotes the banks, and t denotes the time dimension. Risk is the variable accounting for bank risk, which is calculated by the *Z*-score in section 5.3.3 in this paper. TEFF is technical efficiency, which is computed through DEA, which is explained in section 5.3.4.

Eq. (5.12) tests whether efficiency and stability influence variations in bank performance in competitive environments. Eq. (5.13) assesses if efficiency and competition have an impact on changes in bank risk-taking behaviour, which represents the level of its stability, while Eq. (5.14) examines whether or not a bank's appetite for risk-taking, together with the competition score reflect changes in bank efficiency. We measure individual bank risk by using the *Z*-score for each bank. A higher level of this ratio indicates higher bank risk. A limitation of measuring risk calculated from accounting data, as suggested by Rime (2001) and Shrieves and Dahl (1992), is that providing the portfolio quality can be accurately reflected by these measures, and therefore managers are more likely to have some time discretion, which is exercised in a way to minimise cost. However, they argue that this measurement is quite problematic for banks which do not have publicly traded securities (in our case, the majority of Turkish banks do not have publicly traded securities).

5.4. Empirical analysis

5.4.1. Boone coefficient scores

In this section, we present the results from the Boone indicator estimation. As discussed above, the Boone indicator in this study represents a measure of competition. Thus, we initially investigate the Boone indicator to compute the competition scores. Later, the relationships between competition, stability, and efficiency is evaluated by running 2SLS in section 5.4.2.

To obtain the marginal costs, we estimate a translog cost function for each Turkish bank in our sample and for four different ownership types in the Turkish banking sector. We then regress these marginal costs on the market share (profitability) in the loans market. In Eq. (5.1), the coefficient β represents the Boone indicator; a more negative indicator means the bank is more competitive. We used quarterly data to compute the Boone indicator as well as to assess the relationships between competition, stability, and efficiency. Since we have 61 quarters worth of data for all 44 banks in our sample, the estimates of quarterly β for full sample, per bank, is represented in Table 5.5 over the period from 2002 to 2017.

The Boone indicators are all statistically significant at the conventional level. There are two banks with a positive and significant Boone indicator sign, Diler Yatırım Bankası A.Ş. and İstanbul Takas ve Saklama Bankası A.Ş. These two banks are both development and investment banks. This positive sign for these two banks reflects their competition on equity and it illustrates their higher marginal costs, which lead to the higher market shares these banks will earn (Leuvensteijin *et al*., 2011). As figure.5.1 shows, the lowest Boone factor is -2.33 for Pasha Yatrim Bankasi A.S. and the highest score is 0.33 for Istanbul Takas ve Sajkaa Bankasu A.S. As the graph shows there is a significant variation during this period. This suggests that there was a considerable variation in the degree of competition in the Turkish banking sector.

The peak values of the Boone indicator can be detected after 2008. This is not surprising since 2008 overlaps with the outbreak of the global financial crisis in both Europe and the US. The main impact of the global financial crisis started to be reflected in Turkey's growth rate in 2009 when its economy shrank by about 5%. All the operating banks in Turkey faced an increase in their balance sheet risks, tightened external funding resources, and increased demand for liquidity. However, due to successful risk management by banks and regulatory institutions, the Turkish banking system remained stable from 2009 onward. That is why considering the effectiveness of Turkish banks and studying the relationship between

competition and efficiency is crucial. Regarding the high volatility in β after 2008, the Turkish banking sector witnessed a less competitive environment in the loans market after 2008, which could be due to the appropriate reaction of the CBT and regulatory organisations. Furthermore, in contrast to most developed and developing countries, Turkey did not change the deposit guarantee limit during the global crisis period which emerged from 2008. These developments may have changed the competitive structure of the loans market in Turkey.

Figure 5.2 presents the average Boone indicator per ownership type where the market share of a bank is presented by considering the return on assets as a proxy for bank profitability and marginal cost is calculated using the translog cost function, which is explained in section 5.3.2. The overall results suggest that development banks are operating in a more competitive environment than the other ownership types in the Turkish loan market as the more negative Boone indicator suggests a more competitive, less monopolistic market in the ownership. We acknowledge that this type of comparison should be made carefully as the estimation of the Boone indicator depends on how we model it. For example, Schaeck and Cihak (2010) consider the return on assets as their market share and as the dependent variable in the Boone estimation and average costs instead of marginal costs as the independent variable. Accordingly, these authors found that the Boone indicator for the US and Europe lay mainly between 0 and 0.15.

However, Leuvensteijin *et al*.'s (2011) findings are closer to the present paper despite some apparent differences. In fact, the Boone indicators for almost all the ownership types do not fully represent monopolistic market conditions as they are not particularly close to 0 at a 5% significance level. These results indicate developments in the banking framework in Turkey during the last years. We also estimate the Boone indicator by quarters in order to be able to deliberate the time evolution of competition. Based on analysis of these data, one can conclude that competition progresses differently for different Turkish banks and different ownership types. For some, competition has increased over the quarters (for example, for foreign banks);

for others, competition has decreased (for example, for development banks); and for others still, such as state-owned and private banks, competition has remained almost the same.

5.4.2. Competition-stability-technical efficiency analysis

To gain a full picture of the relationship between competition, stability, and technical efficiency, in this section we evaluate these relationships using the formulas 5.13-5.15 in section 3.5. As Table 5.3 illustrates, the results show a positive and significant relationship between the *Z*-score and the Boone indicator. This relationship shows the level of risk that an individual Turkish bank may take; i.e. it shows the lower the competition, the lower the risk that a bank may take. Our results are in line with previous studies (see, Kick and Prieto, 2015; Anginer *et al*., 2014; Fu *et al*., 2014; Berger *et al*., 2009). According to the traditional 'competition fragility' view, our findings do not indicate that more competition results in a reduction in market power, or in a bank's profit margins which lead to a decrease in franchise value for a bank. This fact discourages banks from taking more risks in their operating framework. Our results demonstrate that riskier bank has greater fragility.

Moreover, the empirical results show that there is a negative and significant relationship between risk (*Z*-score) and capitalisation. In the context of the Turkish banking sector, this finding explains the fact that banks with higher levels of capital are more capable of absorbing the losses accrued from NPLs, which reduces risk. In contrast, banks with higher levels of risk need larger amounts of capital to compensate for losses, which leads to lower levels of capital. In other words, more loans made by Turkish banks, with lower liquidity, decreases the level of capitalisation. This relationship can also be confirmed by evaluating the relationship between liquidity and risk. In line with our expectations, our results show a negative relationship between bank size and its risk-taking measures. This means smaller banks, due to their amount of total assets, are willing to take more risks compared to larger banks.

Furthermore, the efficiency hypothesis assumes that the most efficient banks gain market share at lower prices compared to the less efficient banks (Demsetz, 1974). According to efficiency hypothesis, bank efficiency can be reflected as an inspiring factor behind market concentration, which results in lower prices. Empirical results derived from the simultaneous estimations using technical efficiency as the dependent variable are reported in Table.5.3. Our findings indicate that the relationship between risk (*Z*-score) and technical efficiency is significant and negative while this relationship is significant and positive for technical efficiency and competition.

The figure 5.3 illustrates the risk fluctuation per ownership type over the time horizon of this study. As can be seen, development banks experienced the most volatile risk scores. These banks are the most efficient banks in Turkey, and this seems to indicate that the greater the levels of competition and efficiency, the greater the level of risk taken.

In the case of credit risk, to minimise the inputs invested in producing certain amounts of output, i.e. to achieve higher technical efficiency, it seems that Turkish banks reduced their attempts to check credit and monitor loans which led to higher risk in the Turkish banking sector. Alternatively, higher levels of risk because of a lack of sufficient monitoring increased the volumes of unsecured loans (NPLs) generated by Turkish banks, which negatively influenced technical efficiency. On the other hand, our results suggest that more competition in the market helps Turkish banks to optimise their resources and produce an appropriate level of output, which boosts both their profitability and technical efficiency scores. We believe that performing under competitive circumstances encourages more efficient banks to improve their performance considering the other main features in banking such as their capitalisation or their size. Less efficient banks, on the other hand, in order to survive in the competitive market, might decide to take more irrational risks, which negatively influences their performance. This matter is important as a considerable part of the Turkish financial market is dominated by its

banks. A significant ratio of financial transactions and CBT policies occur through banking channels. Hence, the sound performance of Turkish banks in competitive circumstances affects the financial market overall.

To assess the aim of the study, which is to evaluate the relationship between competition, stability, and efficiency, it is important to investigate the relationship between efficiency and competition thoroughly. Hence, Table 5.4 shows the average efficiency per ownership for Turkish banks. The total number of banks in each category and their size enables us to capture wider evaluations regarding the impact of their performance on the Turkish banking sector and the whole economy. As the table shows, the most efficient banks are investment and development banks and the least efficient are the state-owned ones. Comparing the efficiency scores for development banks and Boone indicators for this ownership shows that more efficient banks in Turkey reflect a greater degree of competitive behaviour in the financial market. In contrast, our results suggest that state-owned banks are the least efficient ones, which shows they are struggling to manage their risks in competitive market conditions. Hence, they are operating in more monopolistic environment. Addressing the issues in state-owned banks is important because they share the highest amount of deposits and assets in the Turkish banking sector. The fact that these banks own 66% of total assets and 65% of deposits should make the CBT more attentive to the risks posed by these banks. However, it is interesting to try and understand why customers still trust them more. There are many areas to consider which are beyond the scope of this study and we will leave this particular question for future studies.

As discussed above, we illustrate the relationship between bank efficiency levels and competition by using Boone indicator figures. One of the targets of this paper is to emphasise the fact that having sound competition in the banking market is a crucial economic factor because it helps to reduce prices and improves the quality of commodities by developing and improving technologies and innovative behaviour. Our results also suggest that competitive

markets encourage banks to improve their efficiency levels and to perform in a more stable and profitable manner. This line of thought tallies with competition-stability theory which is discussed thoroughly in the Introduction and section 5.2.1 of this paper. Finding a positive relationship between technical efficiency and competition, as represented by the Boone indicator, supports the idea that banks can improve their efficiency levels in competitive environments.

5.5. Robustness check

We apply two main robustness checks in this study. Initially, following Kick and Prieto (2015), we measure the competition scores using the (in) efficiency-adjusted Lerner Index. Subsequently, we apply quantile regression to evaluate the relationship between competition, stability, and technical efficiency. While running the quantile regression we divided the banks into two groups using a median efficiency split. Hence, investment and development banks and foreign banks are in the more efficient group and private state-owned banks are in the less efficient group.

5.5.1. Efficiency-adjusted Lerner Index

Following Kick and Prieto (2015), we also apply the Lerner Index to measure competition for each type of bank operating in Turkey. Lerner Index is a direct indicator of the market power degree and can be represented as:

$$L_{it} = \frac{ar_{it} - mc_{it}}{ar_{it}} \tag{5.15}$$

Where ar_{it} and mc_{it} indicate the average revenues and marginal cost of bank i at time t. As explained in section 5.3.2 when we compute competition using the Boone indicator, marginal costs are measured from the equations (5.2) and (5.3), which show a translog cost function. To measure the marginal cost following equation (5.2), C_{it} represents the bank's total cost including ineterst expenses, personnel, and other administrative/operating costs. Moreover,

following section 5.3.2, y_{it} and w_{it} shows the outputs and inputs for bank i at time t. In the cost function, as it is represented in equations (5.2) and (5.3), ε_{it} rrepresents the model error term, u_{it} shows the bank-specific inefficiency term, and ςt indicates the technology change.

To measure the average revenue, following Kick and Prieto (2015), we measure the average revenue by adding the total cost to the total profit of bank i and dividing it to the total amount of assets. Hence, it can be represented as:

$$ar_{it} = \frac{\overline{C} - \overline{\pi}}{Total\ Asset} \tag{5.16}$$

As discussed in Kick and Prieto (2015), ignoring possible inefficiencies in the production process may result in biased estimations for the Lerner Index. Hence, this study also considers the sum of the predicted values of total cost $\overline{C}$ from euqtion (5.2) and the predicted profits $\overline{\pi}$ obtained from the estimation of a profit function dual to the cost function depicted in equation (5.2).

The Lerner Index estimations are represented in Table 5.7. The (in) efficiency-adjusted Lerner Index results, similar to the Boone indicator results, confirm a low degree of competition in the Turkish banking sector. According to our results, the Royal Bank of Scotland Plc, which operates as a foreign bank in Turkey, represents the lowest degree of competition. Moreover, the maximum competition score is for the Turkish Banks A.S with a Lerner Index equal to 0.8993. Unlike the findings in Kick and Prieto (2015) study, our findings do not strongly support the fact that the Boone indicator overestimates the competition scores for Turkish banks. Figure 5.4 illustrates an average Lerner Index for each Turkish bank from 2002 to 2017.

Furthermore, to check our initial findings about the relationship between the competition, stability, and technical efficiency, we apply the quantile regression. In order to include as wide a range of quantiles as possible, we run regressions for quantiles 0.1, 0.25, 0.5, 0.75, and 0.90.

To evaluate the relationship between competition, stability, and technical efficiency running quantile regression, this study considers both competition scores from running the Boone indicator (Boone, 2008) and the (in) efficiency-adjusted Lerner Index (Kick and Prieto, 2015). In addition to competition, stability, and technical efficiency, following Tabak *et al*. (2012) and Kick and Prieto (2015), this study considers some bank-specific control variables as explained in section 5.3.5.

As it is represented in Tables 5.8 and 5.9, we find a positive relationship between technical efficiency with both competition measures from the Boone indicator and the (in) efficiency-adjusted Lerner Index. Our results show that the more efficient banks indicate a stronger relationship between competition and technical efficiency when we use the competition scores from the (in) efficiency-adjusted Lerner Index. However, in the case of less efficient banks, our results do not show any significant differences between the competition scores from the Boone indicator and the Lerner Index.

Moreover, our findings confirm the negative relationship between technical efficiency and *Z*-score, which supports our initial results from running 2SLS. Considering the negative relationship between stability and *Z*-score confirms a positive relationship between stability and technical efficiency. Hence, evaluating the relationship between both competition scores, including the Boone indicator and an alternative measure, which is the (in) efficiency-adjusted Lerner Index following Kick and Prieto (2015), stability, and technical efficiency by running the quantile regression also supports the competition-stability theory. Moreover, to provide more information, we also apply OLS regression, which supports the previous findings.

Furthermore, our results indicate the positive relationship between technical efficiency and bank capitalisation, size, and liquidity. These findings are in line with Tabak *et al*. (2012) who posit that a bank's amount of capital and size can significantly influence the relationship between competition and stability. Our results from the investigation into the relationship

between the ratio of off-balance sheet activities to total assets shows a negative relationship of this variable with technical efficiency. This finding confirms that Turkish banks should improve their off-balance sheet activities. Finally, our results confirm the positive relationship between the ratio of total loans and receivables to the total assets, with technical efficiency. This finding emphasises the importance of the lending process in Turkish commercial banks.

Additionally, we find that ownership types and technical efficiency are positively correlated in the Turkish banking system. It is interesting to see how ownership, bank size, and the NPLs ratio also can be connected to each other. For instance, state-owned commercial banks are the largest (log of total assets = 10.69) in terms of total assets. They have comprehensive branch networks, with a total of 3702 branches around the country, and the amount and variety of business they engage in is substantially more varied than the other types of bank in Turkey. Having more support from the Turkish government and owning the greatest amount of assets enables state-owned banks to reduce costs through economies of scale and scope. However, they show the lowest degree of technical efficiency in comparison to the other banks.

Our results have suggestions for policymaking in the banking sector. First, encouraging competition appears to benefit efficiency and financial soundness. This is because the banking sector in Turkey accounts for the majority of its financial market.

To check the robustness of our results following Kick and Prieto (2015), we estimate the competition measure running the (in) efficiency-adjusted Lerner Index. Moreover, to analyse the relationship between competition, stability, and technical efficiency, we apply the quantile regression to do a further analysis. This enables us to evaluate the relationship between competition, stability, and technical efficiency in more accurate manner, considering the heterogeneous nature of our sample. Before running quantile regression and considering the efficiency scores of different ownerships, we divide our sample into two main categories including more efficient banks (development and investment and foreign-owned) and less

efficient banks (private and state-owned). The competition results from running the (in) efficiency-adjusted Lerner Index confirm a low degree of competition in the Turkish banking sector. While analysing the relationship between competition and technical efficiency, we consider both the Boone indicator and the Lerner Index scores. Our results indicate a positive relationship between competition and technical efficiency. For more efficient banks, the Lerner Index represents a stronger relationship between competition and technical efficiency while in less efficient banks, the Lerner Index and the Boone indicator results are quite similar. Overall, our findings are significant and positive. Hence, we can confirm that a higher degree of market power is associated with a high level of efficiency in Turkey. Additionally, our results confirm a positive relationship between efficiency and stability in Turkey. The obtained results on the relationship between competition, stability, and technical efficiency in this study support the competition-stability theory in Turkey. Moreover, we find a positive relationship between technical efficiency and ROA, which confirms that the more efficient banks have higher profitability scores. The relationship between capital ratio and technical efficiency using quantile regression also is positive and statistically significant for both more and less efficient banks. Similar to Tabak *et al.* (2012), our results also confirm the positive impact of bank-specific characteristics on bank performance in a competitive environment.

5.6. Conclusion

Although it is crucial for the economy to determine the reasons for the fragility of the banking system and the role of competition in promoting financial soundness, there is no consensus about this. Reviewing current Turkish literature shows a huge gap in the investigation of competition and the potential relationship between competition, stability, and efficiency in Turkish banking sector. In particular, bank efficiency is important as more efficient banks are able to lower costs and gain more market share and more profit (Isik and Hassan, 2003a). An assessment of the relationship between competition and efficiency is

greatly missed in the Turkish literature. Hence, this paper contributes to the current literature by investigating the relationships between competition, stability and efficiency for the Turkish banking sector on a quarterly basis over the period 2002 to 2017. To the best of our knowledge, this is the first study in the literature pertaining to Turkey which considers this relationship with a focus on technical efficiency. Furthermore, we have used a different competition measure by applying the Boone indicator, which was introduced by Boone in 2008. The modified version introduced by Boone (2008), which we have used in this study, measures competition from an efficiency perspective.

We measured the Boone indicator for each commercial Turkish bank, as represented in Table 5.5. For a more coherent evaluation, we then divided all banks into four main ownership types – development and investment, foreign, state-owned, and private, as represented in figure 5.2. Out of 44 commercial banks, we find a negative and statistically significant Boone indicator for 42 of them from 2002 to 2017. There are only two banks, Diler Yatırım Bankası A.Ş. and İstanbul Takas ve Saklama Bankası A.Ş, with positive Boone indicators. Both of these are development and investment banks. According to Leuvensteijin *et al*. (2011), positive Boone indicators show that these banks compete on quality. In addition, it also shows their high marginal costs which result in more market share for these two banks. The Boone indicator in our sample varies between 0.33 and -2.33 over the period 2002-2017, which implies a considerable variation in performance and competition among local and foreign banks across the time-span of this study.

In addition to investigating Turkish bank competition trends by applying a Boone indicator method, we assessed the relationship between competition, stability, and efficiency by running 2SLS regression. To run 2SLS regression we defined three different equations. Competition, stability, and technical efficiency are each considered as a dependent variable in each one of these three equations. While competition is a dependent variable, stability and technical

efficiency are independent variables as we are investigating the relationship between them. To achieve a thorough analysis, we also consider some other bank-specific variables. Following Tabak *et al*. (2012) we define three equations to evaluate the relationship between competition, stability, and efficiency with considering other banks-specific characteristics. For instance, we consider capital ratio, which is calculated from dividing the equity capital to total assets. Moreover, we consider liquidity, logarithmic of total assets, as a proxy for size, the ratio of off-balance sheet activities to total assets, and the ratio of total loans and receivables to total assets. All these bank-specific variables are independent variables that we analyse for their impact on competition, stability, and technical efficiency in pursuit of our investigation.

Our results from the Boone indicator, which represents the competition, show that there exists competition in the Turkish banking sector. Some ownerships, like development and investment banks, are found to have more competition as they have more negative Boone indicators, equal to -0.293. Foreign banks are the most competitive ones compared to private and state-owned banks in Turkey. Moreover, both state-owned and private banks reflect a close rate of competition in them.

When we analyse the relationship between competition, stability, and technical efficiency running 2SLS regression, our results confirm a positive relationship between competition and stability. This relationship shows that higher levels of competition are found to increase bank-level stability, consistent with the competition-stability hypothesis discussed by Boyd and De Nicoló (2005). Although we find a statistically significant positive relation between competition and stability, the economic significance of the impact of competition appears relatively strong. We argue that if a lack of competition encourages risky investment behaviour in Turkish banks, this will lead to a greater supply of credit. Moreover, our results illustrate that a higher degree of market power is related to high levels of stability. The banks with more market power are able to track their prices more closely, and hence improve their profit, as can

be confirmed by the relationship between ROA and stability. Moreover, our results suggest that market power has benefits for both stability and risk. These findings are in line with Hossain *et al.* (2020) who report a positive relationship between competition and stability. Hence, gains in the market will increase stability and reduce the risks for the Turkish banking system. So, both market concentration and a competitive environment are essential to promote stability in the Turkish banking sector.

In a later part of this study, we focus on technical efficiency in the Turkish banking sector with an emphasis on the impact of NPLs as undesirable outputs while we measure the technical efficiency scores. After financial innovation, liberalisation, and in particular after the last financial crisis in 2008, bank concentration, the attention of policymakers and researchers has shifted to the efficiency of banks. The level of efficiency for each bank or for a whole banking sector of a country indicates the ability of managers and the CBT to generate money and use the limited resources available. In this paper efficiency is measured using a modified DEA model, which is also used by Aparicio *et al*. (2015). To measure technical efficiency using the DEA model, we consider capital and deposit as our inputs, total loans and receivables, net securities, total off-balance sheet activities, and non-interest income as our desirable outputs, and NPLs as our undesirable output. Applying this method enables us to expand the desirable output simultaneously with reducing the undesirable outputs and inputs. Similar to competition measures, to have a better evaluation about the technical efficiency scores we divide the banks into ownership type. The results show that the average technical efficiency is 0.57 for development and investment ownership, which is the highest score. After development and investment ownership, foreign ownership appears to be the most efficient compared to private and state-owned banks. The lowest technical efficiency score belongs to state-owned banks with a score equal to 0.14. Moreover, investigating the relationship between competition and efficiency confirms a positive relationship between the two. This means more competition

encourages Turkish banks to improve their efficiency scores. The relationship also is positive for technical efficiency and stability. This means that banks with higher technical efficiency are more stable. By combining these findings, we can confirm that performing in a competitive market boosts both efficiency and stability in the Turkish banking sector. It also contributes to a more risk-averse attitude amongst banks.

To check the robustness of our results following Kick and Prieto (2015), we estimate competition by running the (in) efficiency-adjusted Lerner Index. Moreover, to analyse the relationship between competition, stability, and technical efficiency, we apply quantile regression to conduct a further analysis. This enables us to evaluate the relationship between competition, stability, and technical efficiency in a more accurate manner, considering the heterogeneous nature of our sample. Before running the quantile regression and considering the efficiency scores of different ownerships, we divide our sample into two main categories: more efficient banks, and less efficient banks. The relevant ownerships for these two categories have already been outlined above. The competition results from running the (in) efficiency-adjusted Lerner Index confirm a low degree of competition in the Turkish banking sector. While analysing the relationship between competition technical efficiency, we consider both the Boone indicator and the Lerner Index scores. Our results indicate a positive relationship between competition and technical efficiency. For more efficient banks the Lerner Index represents a stronger relationship between competition and technical efficiency while in less efficient banks the Lerner Index and the Boone indicator results are quite similar. Overall, our findings are significant and positive. Hence, we can confirm that a higher degree of market power is associated with a higher level of efficiency in Turkey. Additionally, our results confirm a positive relationship between efficiency and stability in Turkey. The obtained results on the relationship between competition, stability, and technical efficiency in this study support the competition-stability theory in Turkey. Moreover, we find a positive relationship between

technical efficiency and ROA, which confirms that more efficient banks have higher profitability scores. The relationship between capital ratio and technical efficiency using quantile regression also is positive and statistically significant for both more and less efficient banks. Similar to Tabak *et al.* (2012), our results also confirm the positive impact of bank-specific characteristics on the bank performance in a competitive environment.

Furthermore, our results confirm that the bad management hypothesis, discussed by Berger and De Young (1997) applies to state-owned Turkish banks as these have the lowest technical efficiency scores due to their high NPLs ratio. Also, our results suggest that Turkey suffers from a moral hazard issue, as defined by Jeitschko and Jeung (2005) since Turkish banks attempted to take more irrational risks to stay competitive in the market. This appetite for risk has led to a high ratio of NPLs in their statements. Since we find a negative relationship between efficiency and stability and risk in Turkish banks, we can argue that less efficient banks do have less risk averse. Hence, not only can a higher number of NPLs be seen in their balance sheet, they are also less stable than more efficient banks. Our results are in line with many other studies, for example, Fukuyama and Matousek (2017), and confirm that the main source of technical inefficiency in Turkey was due to a high ratio of NPLs.

Our findings suggest several important policy implications. Firstly, we need to implement policies that promote concentration and competition in the Turkish banking sector. Banks in Turkey need a competitive market environment to earn higher profits and operate efficiently. Secondly, intensifying the level of competition does not mean increasing the number of banks and branches; it means increasing the level of competition in the sector by considering assets and the other key financial factors like ROA. To boost competition there is a need for larger banks in all categories of ownership – at present, only state-owned banks are large. These findings may help policymakers in Turkey where the banking sector faces lots of challenges.

List of Tables and Graphs:

Table.5.1. Definitions of main variables

Variable	Description
w_1	Capital
w_2	Deposit
Y_1	Total loans and receivables
Y_2	Total securities
Y_3	Non-interest income
Y_4	Off-balance sheet activities
Y_5	Non-performing loans
C	Total expenses (Cost)
Capital ratio	Equity capital to total assets ratio
ROA	Return On Asset
LIQ	Liquidity
Size	Logarithmic value of total assets
OBSA	Off-balance sheet activities to total assets
LTA	Total loan and receivables to total asset
Z-score	Sum of the mains of ROA and of Capital Ratio to the standard deviation of ROA ratio
MS_i	Market share in the loans market, which following Boone (2008) is shown by banks profit in this paper
MC_i	Marginal cost in the loan market

Note1. This table presents the description of the main variables we employ throughout the paper to measure for technical efficiency, competition, and size.

Table.5.2. Descriptive Statistics (Mil US.$)

Variable	Mean	Std.	Min	Max	Obs.
Capital	45.5232	82.3876	3.62327	1169.12	2575
Deposit	10550.7	16938.7	0.02942	83107.2	1843
Total loans and receivables	7461.04	14247.9	0.00047	79073.6	2468
Net securities	3160.26	7029.97	0.00067	50050.3	2520
Non-interest income	136.861	298.916	-70.9661	2514.19	2682
Off-balance sheet activities	198527	593430	0.00043	120000	2571
Non-performing loans	266.142	461.196	0.00063	2612.39	2340
Total cost	155.179	316.073	0.00645	2218.68	2416
ROA	4.39169	12.5582	-49.4833	95.9834	2529
LIQ	39.9073	23.7626	0.445532	98.1285	2576
Size	7.42985	2.38235	0.601334	11.6538	2580
OBSA	68.7652	80.1033	0.00012	8359.37	2572
LTA	0.47957	0.24451	0.00013	0.97122	2468
Z-Score	1.54697	1.99306	-4.25664	23.7413	2670

Notes1. The above table shows the key statistics for the key variables in this study. LIQ represents the amount of liquidity, size is logarithmic value of total assets, OBSA shows the total off-balance sheet activities to total assets, LTA represents the total loan to total asset, and the *Z*-score is the sum of the average values of ROA to the standard deviation of ROA ratio. The variables are used to compute technical efficiency, *Z*-score, and competition scores in this study.

Table.5.3. Effect of Competition on Stability and Technical Efficiency-2SLS Estimation

	Eq.(13) Y=*Boone*	Eq.(14) Y=*Risk*	Eq. (15) Y=*TEFF*
Risk	-0.0263***		-0.0763***
	(0.0251)		(0.0248)
TEFF	0.0134*	-0.0123***	
	(0.0133)	(0.0197)	
Capital ratio	0.0142*	-0.0041***	0.0033**
	(0.0012)	(0.0001)	(0.0041)
Loans and Receivables	0.0012**	0.0036**	0.0012**
	(0.0089)	(0.0012)	(0.0008)
ROA	0.0035**	0.0121*	0.0026**
	(0.0053)	(0.0538)	(0.0051)
Boone		-0.0755***	0.0119**
		(0.0672)	(0.0296)
LIQ	0.0088**	-0.0117*	0.0016**
	(0.0031)	(0.0371)	(0.0029)
Size	0.0164*	-0.0695*	0.0016**
	(0.0516)	(0.0037)	(0.0588)
OBSA	-0.0141***	-0.0266***	-0.0169***
	(0.1219)	(0.0563)	(0.0011)
LTA	0.0589*	0.0133*	0.0187*
	(0.0049)	(0.0051)	(0.0049)
Cons.	0.2378	0.6333	0.1909
	(0.0541)	(0.0511)	(0.0353)
Obs.	1404	1404	1404
R^2	0.4493	0.4887	0.6943

Note1. This table reports the 2SLS regression results on our panel data to assess the relationship of competition, stability, and technical efficiency. We estimate a system of equations for each of the relation by switching the dependent variables. The explanatory variables are size, which represents logarithmic of total assets, OBSA, which shows the total off-balance sheet activities, LIQ, which shows the liquidity, and LTA, which goes for total amount of loan to total assets in Turkish banks. Standard errors in parentheses, ***p<0.001, **p<0.005, *<0.1.

Table.5.4. Average Technical Efficiency by Bank Ownership

Bank Type	Average Technical Efficiency	No.Banks	Obs.
Investmentt& Development Banks	0.57	12	212
Foreign	0.56	18	855
Private	0.27	10	456
State-Owned	0.14	3	171

Note1. This table displays the average technical efficiency by type of bank's ownership. The number of banks (column headed "No. banks") and total number of observations (Obs.) used in the calculation of average efficiency are also given. There are four main types of bank being foreign (Foreign), investment and development banks, and local banks which is further broken down in to two sub-categories: privately owned banks (Private) and state-owned (State-owned) banks.

Table.5.5. Boone Indicator for the Loans Market per Bank

Bank	Boone	t	Method	Endogeneity test
Adabank A.Ş	-0.4409***	-1.5	OLS	0.18
Akbank T.A.Ş	-0.2871***	-1.37	OLS	0.18
Aktif Yatırım Bankası A.Ş	-0.1726***	-2.12	OLS	0.043
Alternatifbank A.Ş	-0.0615***	-1.75	OLS	0.086
Anadolubank A.Ş.	-0.2133***	-0.38	OLS	0.709
Arap Türk Bankası A.Ş.	-0.1033***	-3.15	OLS	0.003
Bank Mellat	-0.1384***	-3.29	OLS	0.0002
Bank of Tokyo-Mitsubishi UFJ Turkey A.Ş	-0.0593***	-1.14	OLS	0.213
BankPozitif Kredi ve Kalkınma Bankası A.Ş.	-0.0389***	-0.67	OLS	0.507
Birleşik Fon Bankası A.Ş.	-0.2258***	-2.22	OLS	0..32
Burgan Bank A.Ş	-1.0979***	-1.17	OLS	0.247
Citibank A.Ş.	-0.0652***	-1.08	OLS	0.283
Denizbank A.Ş.	-0.3072***	-1.61	OLS	0.118
Deutsche Bank A.Ş.	-0.0755***	-0.75	OLS	0.455
Diler Yatırım Bankası A.Ş.	0.3134***	-4.04	OLS	0
Fibabanka A.Ş	-0.0201***	-1.81	OLS	0.082
Finans Bank A.Ş	-0.0213***	-0.07	OLS	0.944
Habib Bank Limited	-1.6759***	-0.99	OLS	0.379
HSBC Bank A.Ş.	-0.5601***	-0.25	OLS	0.631
ICBC Turkey Bank A.Ş.	-0.2879***	-0.85	OLS	0.4
İller Bankası A.Ş.	-0.1292***	-1.28	OLS	0.207
ING Bank A.Ş.	-0.0161***	-0.13	OLS	0.9
İstanbul Takas ve Saklama Bankası A.Ş	0.3358***	-0.61	OLS	0.558
Merrill Lynch Yatırım Bank A.Ş	-0.0145***	-0.53	OLS	0.597
Nurol Yatırım Bankası A.Ş	-0.2441***	-1.69	OLS	0.097
Odea Bank A.Ş	-2.3337***	-2.06	OLS	0.132
Pasha Yatırım Bankası A.Ş	-0.0081***	-0.27	OLS	0.789
Şekerbank T.A.Ş.	-0.4753***	-5.77	OLS	0
Société Générale (SA)	-0.1967***	-3.38	OLS	0.001
Standard Chartered Yatırım Bankası Türk A.Ş	-0.2641***	-1.44	OLS	0.158
Tekstil Bankası A.Ş.	-0.7677***	-3.71	OLS	0.001
The Royal Bank of Scotland Plc	-0.0404***	-0.09	OLS	0.369
Türk Ekonomi Bankası A.Ş.	-0.2574***	-1.62	OLS	0.111
Türk Eximbank	-0.6316***	-3.57	OLS	0.001
Turkish Bank A.Ş	-0.7889***	-6.08	OLS	0
Türkiye Cumhuriyeti Ziraat Bankası A.Ş.	-0.1219***	-0.23	OLS	0.821
Türkiye Garanti Bankası A.Ş	-0.1062***	-2.71	OLS	0.009
Türkiye Halk Bankası A.Ş.	-0.0324***	-0.39	OLS	0.698
Türkiye İş Bankası A.Ş	-0.1052***	-3.11	OLS	0.003
Türkiye Kalkınma Bankası A.Ş.	-0.3699***	-2.68	OLS	0.01
Türkiye Sınai Kalkınma Bankası A.Ş.	-0.7481***	-5.45	OLS	0
Türkiye Vakıflar Bankası T.A.O.	-0.1866***	-1.21	OLS	0
Turkland Bank A.Ş	-0.2498***	-0.97	OLS	0.338
Yapı ve Kredi Bankası A.Ş.	-0.2342***	-0.89	OLS	0.389

Note1. This table shows Boone indicator per each Turkish bank during 2002 to 2017. All the scores as expected are negative. Only Diler Yatırım Bankası A.Ş. and İstanbul Takas ve Saklama Bankası A.Ş are showing a positive sign for beta in Boone function. This positive sign means that the higher marginal costs for banks leads for higher market shares they will earn. These banks have extreme level of market collusions and are competing on quality, which supports the collusion again. Standard errors in parentheses, ***p<0.001, **p<0.005, *<0.1.

Table.5.6. Correlation Coefficient Matrix

	Deposit	Capital	Total loans & receivables	Net securities	Off-balance sheet activities	Non-interest income	(NPLs)	Price of deposit	Price of capital	Price of loans &receivables	Price of securities	Price of NPLs
Deposit	1.0000											
Capital	-0.1959	1.0000										
Total loans & receivables	0.9370	-0.2302	1.0000									
Net securities	0.9197	-0.1114	0.7439	1.0000								
Off-balance sheet activities	0.7616	-0.2170	0.8496	0.5512	1.0000							
Non-interest income	0.7679	-0.1551	0.7550	0.6959	0.5933	1.0000						
Non-performing loans (NPLs)	0.8108	-0.1822	0.8408	0.6379	0.7553	0.7208	1.0000					
Price of deposit	-0.0339	0.2215	-0.0587	-0.0039	-0.0634	0.0399	-0.0142	1.0000				
Price of capital	0.0571	-0.0698	0.0559	0.0446	0.0607	0.0690	0.0626	0.0662	1.0000			
Price of loans &receivables	-0.0686	0.4600	-0.0678	-0.0548	-0.0621	-0.0532	-0.0679	0.6293	0.0333	1.0000		
Price of securities	-0.0717	0.0878	-0.0643	-0.0700	-0.0562	-0.0551	-0.0674	0.0248	0.0012	0.0373	1.0000	
Price of NPLs	-0.0392	0.0628	-0.0396	-0.0333	-0.0303	-0.0356	-0.0460	-0.0076	0.0537	0.0343	-0.0003	1.0000

Note1. The above table shows the correlation coefficient matrix. It indicates that correlations among the variables in this paper are mainly negligible, which means that the model applied in this paper is unlikely to suffer from the issue of considerable multicollinearity.

Table.5.7. (in) Efficiency-adjusted Lerner Index for Loan Market per Turkish Bank

Bank	Lerner Index	t	Method	Endogeneity test
Adabank A.Ş	0.5301*	-1.42	OLS	0.11
Akbank T.A.Ş	0.1275*	-1.46	OLS	0.21
Aktif Yatırım Bankası A.Ş	0.0941*	-0.33	OLS	0.13
Alternatifbank A.Ş	0.0413**	-0.57	OLS	0.61
Anadolubank A.Ş.	0.3112*	-0.13	OLS	0.69
Arap Türk Bankası A.Ş.	0.2134*	-1.48	OLS	0.02
Bank Mellat	0.1216*	-1.38	OLS	0.08
Bank of Tokyo-Mitsubishi UFJ Turkey A.Ş	0.0136**	-0.85	OLS	0.14
BankPozitif Kredi ve Kalkınma Bankası A.Ş.	0.0917*	-0.78	OLS	0.07
Birleşik Fon Bankası A.Ş.	0.1934*	-1.54	OLS	0.19
Burgan Bank A.Ş	0.2087*	-0.79	OLS	0.17
Citibank A.Ş.	0.0742*	-1.13	OLS	0.08
Denizbank A.Ş.	0.3623*	-1.48	OLS	0.03
Deutsche Bank A.Ş.	0.0532*	-0.63	OLS	0.07
Diler Yatırım Bankası A.Ş.	0.3154*	-1.23	OLS	0.02
Fibabanka A.Ş	0.0363**	-1.44	OLS	0.01
Finans Bank A.Ş	0.0461**	-0.36	OLS	0.04
Habib Bank Limited	0.8134*	-0.17	OLS	0.05
HSBC Bank A.Ş.	0.6847*	-0.65	OLS	0.07
ICBC Turkey Bank A.Ş.	0.2066*	-1.32	OLS	0.02
İller Bankası A.Ş.	0.2104*	-1.67	OLS	0.09
ING Bank A.Ş.	0.0194**	-0.42	OLS	0.06
İstanbul Takas ve Saklama Bankası A.Ş	0.4604*	-0.78	OLS	0.01
Merrill Lynch Yatırım Bank A.Ş	0.0308**	-0.37	OLS	0.06
Nurol Yatırım Bankası A.Ş	0.3408*	-1.89	OLS	0.04
Odea Bank A.Ş	0.2578*	-1.99	OLS	0.03
Pasha Yatırım Bankası A.Ş	0.6909*	-0.33	OLS	0.01
Şekerbank T.A.Ş.	0.5109*	-2.46	OLS	0.04
Société Générale (SA)	0.3582*	-1.23	OLS	0.02
Standard Chartered Yatırım Bankası Türk A.Ş	0.5209*	-1.67	OLS	0.08
Tekstil Bankası A.Ş.	0.7321*	-2.12	OLS	0.03
The Royal Bank of Scotland Plc	0.0101**	-0.88	OLS	0.06
Türk Ekonomi Bankası A.Ş.	0.2447*	-0.97	OLS	0.01
Türk Eximbank	0.7414*	-2.31	OLS	0.05
Turkish Bank A.Ş	0.8993*	-1.79	OLS	0.02
Türkiye Cumhuriyeti Ziraat Bankası A.Ş.	0.3967*	-0.66	OLS	0.04
Türkiye Garanti Bankası A.Ş	0.1284*	-1.86	OLS	0.01
Türkiye Halk Bankası A.Ş.	0.0748*	-0.47	OLS	0.08
Türkiye İş Bankası A.Ş	0.1048*	-1.54	OLS	0.03
Türkiye Kalkınma Bankası A.Ş.	0.3581*	-1.77	OLS	0.01
Türkiye Sınai Kalkınma Bankası A.Ş.	0.6647*	-2.11	OLS	0.05
Türkiye Vakıflar Bankası T.A.O.	0.1836*	-0.96	OLS	0.02
Turkland Bank A.Ş	0.1994*	-0.91	OLS	0.01
Yapı ve Kredi Bankası A.Ş.	0.3066*	-0.48	OLS	0.02

Note1. This table shows (in) Efficiency-adjusted Lerner Index per each Turkish bank during 2002 to 2017. Turkish Bank A.S, which is a private bank, has a maximum Lerner Index. Habib Bank Limited, which is a foreign bank, represented the second highest Lerner Index score. Bank of Tokyo, which is also a foreign bank, has the lowerst Lerner Index score in our sample.

Table.5.8. Quantile Regression-More Efficient Banks

TE	OLS	10	25	50	75	90
Risk	-0.0511***	-0.0072***	-0.029***	-0.0336***	-0.0482***	-0.0481***
	(0.0205)	(0.0064)	(0.0074)	(0.0072)	(0.0105)	(0.0165)
Capital ratio	0.0403*	0.0001***	0.0022**	0.0432*	0.0506*	0.0312*
	(0.0012)	(0.0001)	(0.0003)	(0.024)	(0.0031)	(0.0012)
Total Loans and Receivables	0.0004***	0.0019**	0.0032**	0.0043**	0.0005**	0.0002***
	(0.0002)	(0.0007)	(0.0009)	(0.0008)	(0.0001)	(0.0002)
ROA	0.0159*	0.0006***	0.0109*	0.0104*	0.0135*	0.0171*
	(0.0036)	(0.0018)	(0.0013)	(0.0013)	(0.0018)	(0.0029)
Boone Indicator	0.04383*	0.0614***	0.0509*	0.0085**	0.0193*	0.0541*
	(0.0177)	(0.0354)	(0.0437)	(0.0427)	(0.0616)	(0.0969)
Lerner Index	0.0641*	0.0358*	0.0674*	0.0912*	0.0439*	0.0819*
	(0.0136)	(0.0411)	(0.0507)	(0.0495)	(0.0715)	(0.0112)
Size	0.0121*	0.0314*	0.0845*	0.09874*	0.0436*	0.0657*
	(0.0393)	(0.0118)	(0.0146)	(0.0142)	(0.0206)	(0.0032)
LIQ	0.0012**	0.0009***	0.0022**	0.0017**	0.0016**	0.0043**
	(0.0035)	(0.0016)	(0.0013)	(0.0056)	(0.0018)	(0.0029)
OBSA	-0.0026***	-0.0088***	-0.0111***	-0.0067***	-0.0034***	-0.0034***
	(0.0156)	(0.0047)	(0.0058)	(0.0056)	(0.0082)	(0.0109)
LTA	0.0043**	0.0018**	0.0034**	0.0015**	0.0036**	0.0042**
	(0.0039)	(0.0011)	(0.0014)	(0.0014)	(0.0026)	(0.0032)
Cons.	0.3761	0.3955	0.4938	0.4296	0.3169	0.4287
	(0.0313)	(0.0945)	(0.0165)	(0.0139)	(0.0643)	(0.2585)
Obs.	866	866	866	866	866	866

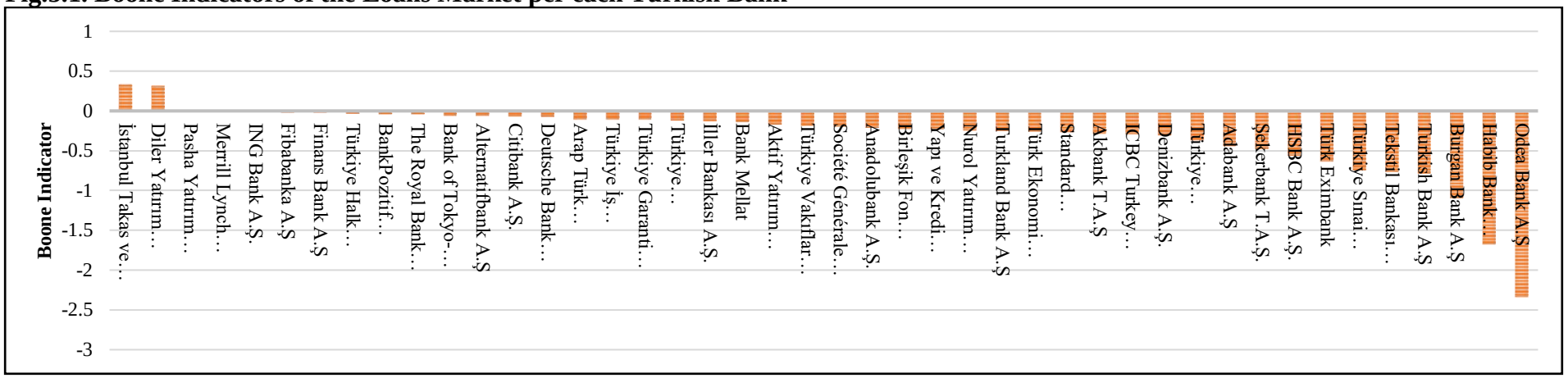
Note1. This table reports the results of quantile model examining the relationship between competition scores (which are measure running Boone indicator and (in) Efficiency-adjusted Lerner Index), Stability (which is measured using *Z*-score), and technical efficiency scores of more efficient banks. The results confirm the impact of bank-specific characteristics, like LTA, on this relation. Standard errors in parentheses, ***p<0.001, **p<0.05, *p<0.1.

Table.5.9. Quantile Regression-Less Efficient Banks

TE	OLS	10	25	50	75	90
Risk	-0.0614***	-0.0091***	-0.0112***	-0.0123***	-0.0115***	-0.0584***
	(0.0308)	(0.0139)	(0.0292)	(0.0422)	(0.0194)	(0.0103)
Capital ratio	0.0003***	0.0041**	0.0059**	0.0087**	0.0902*	0.0078**
	(0.0001)	(0.0002)	(0.0021)	(0.0033)	(0.0041)	(0.0037)
Total Loans and Receivables	0.0001***	0.0006***	0.0007***	0.0001***	0.0009***	0.0009***
	(0.0001)	(0.0004)	(0.0008)	(0.0001)	(0.0001)	(0.0002)
ROA	0.0077**	0.0016**	0.0009***	0.0008***	0.0109*	0.0072**
	(0.0052)	(0.0019)	(0.0043)	(0.0058)	(0.0057)	(0.0142)
Boone Indicator	0.0626*	0.0217*	0.0456**	0.0639*	0.0984*	0.0884*
	(0.0197)	(0.0072)	(0.0151)	(0.0219)	(0.0217)	(0.0535)
Lerner Index	0.0364*	0.0357*	0.0411**	0.0187*	0.08462*	0.0173*
	(0.0114)	(0.0421)	(0.0261)	(0.0127)	(0.0126)	(0.0113)
Size	0.0864*	0.0037**	0.0382*	0.0173*	0.0922*	0.0109*
	(0.0231)	(0.0084)	(0.0177)	(0.0256)	(0.0253)	(0.0062)
LIQ	0.0024**	0.0018**	0.0013**	0.0005***	0.0001***	0.0882*
	(0.0002)	(0.0007)	(0.0015)	(0.0022)	(0.0022)	(0.0055)
OBSA	-0.0232***	-0.0033***	-0.01525***	-0.0262***	-0.0732***	-0.0326***
	(0.0397)	(0.0146)	(0.0305)	(0.0044)	(0.0438)	(0.0107)
LTA	0.0154*	0.0009***	0.0028**	0.0067**	0.0063**	0.0194*
	(0.0025)	(0.0009)	(0.0019)	(0.0027)	(0.0027)	(0.0067)
Cons.	0.4212	0.1566	0.2547	0.3374	0.5893	0.5048
	(0.0228)	(0.0841)	(0.0175)	(0.0254)	(0.0254)	(0.0620)
Obs.	538	538	538	538	538	538

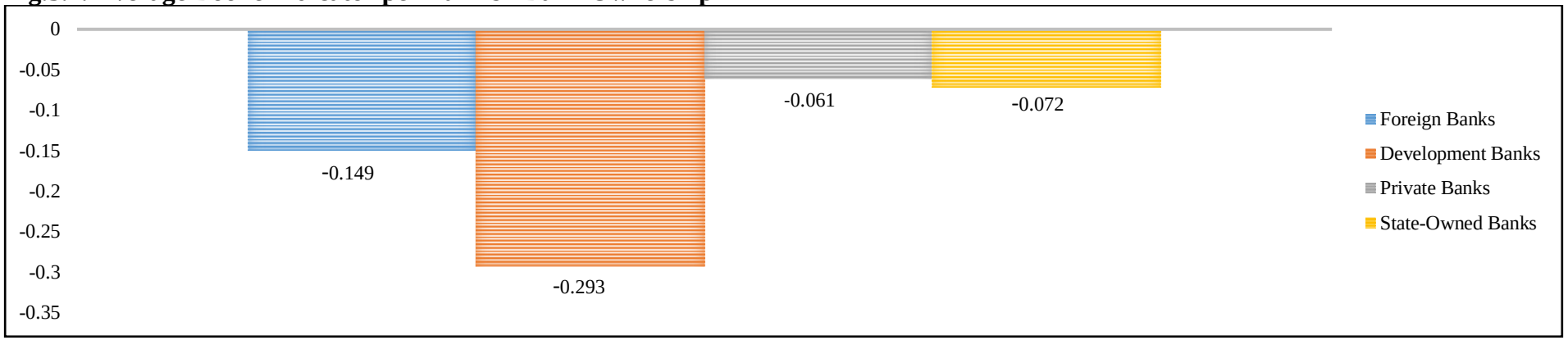
Note1. This table reports the results of quantile model examining the relationship between competition scores (which are measure running Boone indicator and (in) Efficiency-adjusted Lerner Index), Stability (which is measured using *Z*-score), and technical efficiency of less efficient banks. The results confirm the impact of bank-specific characteristics, like LTA, on this relation. Standard errors in parentheses, ***p<0.001, **p<0.05, *p<0.1.

Fig.5.1. Boone Indicators of the Loans Market per each Turkish Bank



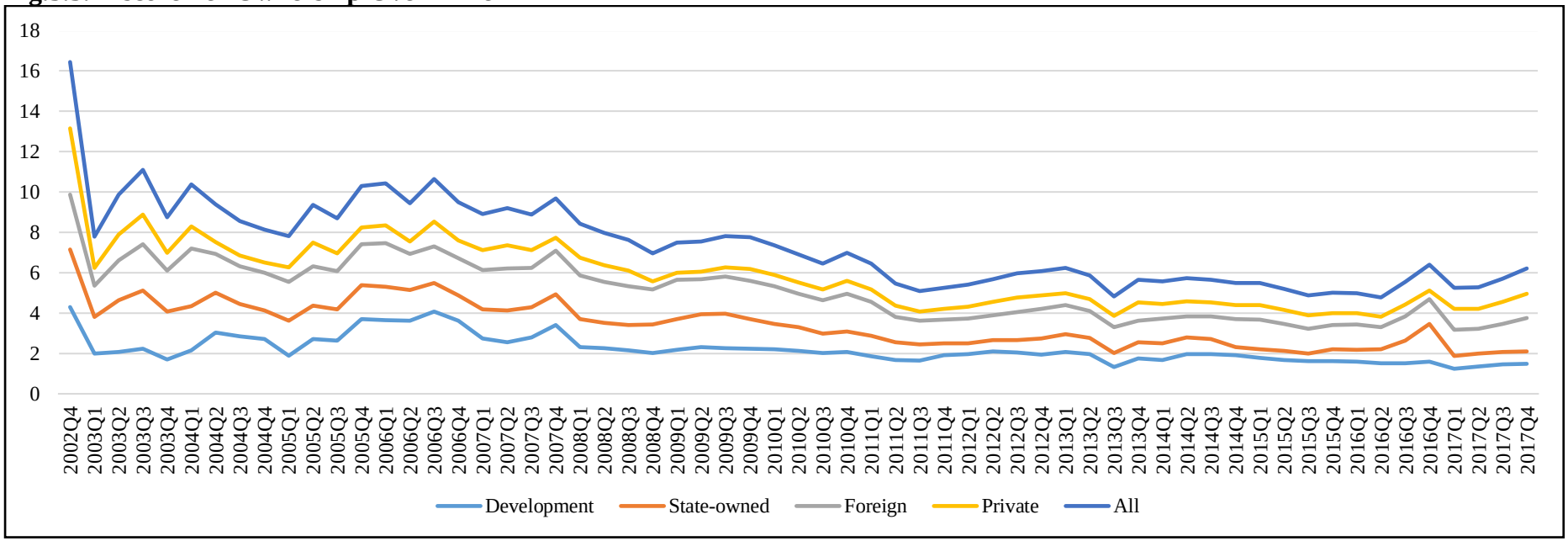
Note1. The above graph illustrates the average Boone indicator per each Turkish bank during 2001 to 2017. Odea Bank, which is a foreign bank is the most competitive one. The two development banks Diler Yatırım Bankası A.Ş. and İstanbul Takas ve Saklama Bankası A.Ş. have positive Boone indicator due to their competition on quality, for others Turkish banks Boone indicator is negative.

Fig.5.2. Average Boone Indicator per Turkish Bank Ownership



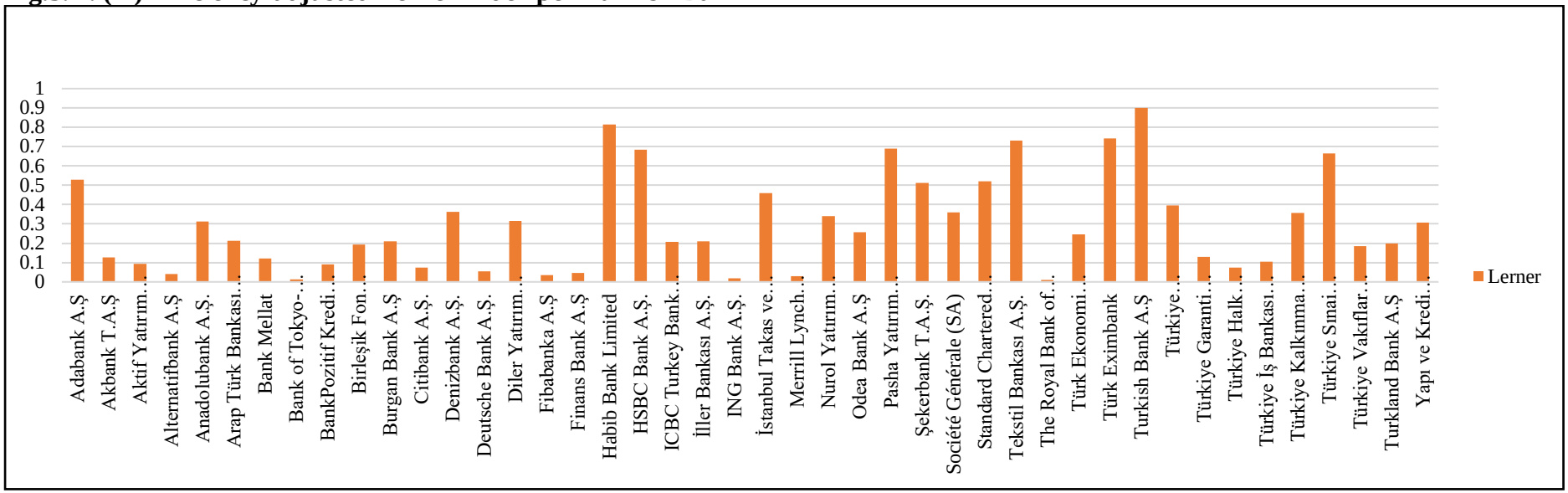
Note1. The above figure shows the average Boone indicator per Turkish bank ownership. The investment and development banks are the most competitive one as they have the most negative Boone indicator. The least Boone indicator is for private banks with -0.061.

Fig.5.3. *Z*-score Per Ownership Over Time



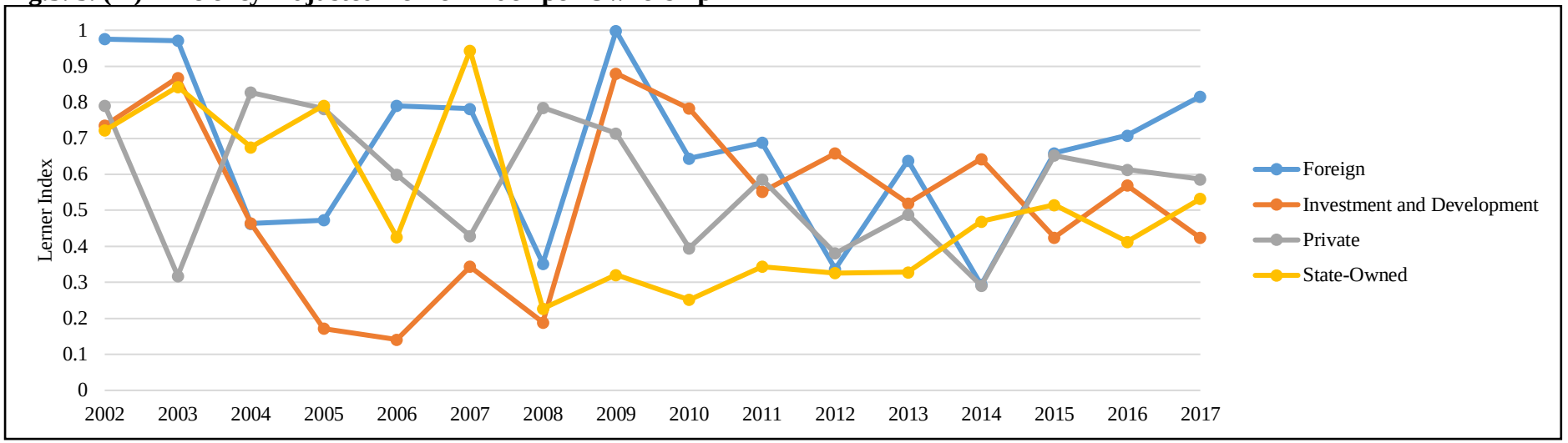
Note1. The above figure shows how *Z*-score is changing during each quarter from last quarter in 2002 till last quarter in 2017 per each ownership in Turkey. This figure also shows an average of *Z*-score changes for all Turkish banks, which can be compared with each ownership. Private Banks shows the highest *Z*-score comparing to the other ownership during 2002-2017 and the least scores of *Z*-scores are for investment and development banks. Investment and development banks also reflect the highest degree of efficiency as well which is shown in Table.5.4.

Fig.5. 4. (in) Efficiency-adjusted Lerner Index per Turkish Bank



Note1. The above graph illustrates the average (in) Efficiency-adjusted Lerner Index per each Turkish bank during 2002 to 2017. Turkish Bank A.S, which is a Private bank, shows the highest competition score. In contrast, Bank of Tokyo and the Rpyal Bank of Scotland, which are foreign banks, show the lowest competition scores.

Fig.5. 5. (in) Efficiency-Adjusted Lerner Index per Ownership



Note1. The above figure shows how (in) Efficiency-adjusted Lerner Index is changing in each ownership over 2002 to 2017 in Turkey. A significant change can be detected in investment and development and state-owned ownerships. All ownerships are experiencing the least competition score in 2008 exept Private banks.

Chapter 6

Conclusion

6.1. Research summary

The history of the Turkish economy and its banking sector can be divided into four main periods. The period from 1945 to 1980 is the development stage of privatisation, the liberalisation period is from 1980 to 2003. Turkey moved to its growth stage from 2003 to 2013. Finally, it reached maturity from 2014 onward. A high inflation rate can be detected in all of these periods. Although Turkey was successful in reducing the inflation rate for a short period of time, for example from 2002 to 2004 after implementing the restructuring programme, this challenge never has never been fully addressed. Considering this challenge is important as it influences balance sheet quality, monetary policy shocks, market structure, and stability in Turkey. After the political and currency crises in 2000-2001 in Turkey, the CBT with the help of the IMF imposed several restructuring programmes to strengthen the Turkish banking sector and improve its stability. As a result of implementing these restructuring programmes, Turkey was expected to strengthen the private banks and restructure the state-owned banks. These two types of ownership are particularly important as they are among the largest and oldest banks in Turkey. Hence, they hold a large proportion of the sector's total assets. One of the main results after the currency and financial crises in 2000-2001 was the provision of comfortable circumstances for foreign investments and a strengthening of the banking sector to enable it to compete internationally. From 2002 to 2007, Turkey experienced annual economic growth of 7.2%. Turkish banks represent appropriate performance and stable profitability. Following the 2008 financial crisis, Turkey saw a decline in its GDP but recovered quickly. Turkey's GDP growth rate increased to 8.48% in 2001 and 11.11% in 2011. This ratio has been in flux since then. It reached 7.5% in 2017 which is significantly lower than GDP

growth in 2011. Considering the other key indicators, like NPLs, Turkey also demonstrates volatile trends. Although the ratio of NPLs declined from 2002 to 2007, it fluctuated after 2008. NPLs reached 2.74% in 2014, 3.11% in 2016, and 2.84% in 2017. Observing the unstable economic conditions and an unstable banking sector in Turkey has motivated this thesis to investigate more into the Turkish banking literature.

Reviewing the literature around the Turkish banking sector highlights several gaps. Hence, with a particular focus on the Turkish banking sector, this thesis examines Turkish banks' technical, allocative, and cost efficiency, the monetary transmission mechanism through BLC, and relationship between competition, stability, and efficiency. While measuring all three types of efficiency scores, this thesis pays particular attention to the impact of NPLs by considering them as an undesirable output. Turkey is a distinctive case due to its high NPLs ratio, which has created liquidity and credit risks in its banking sector from 2000-2001 onwards. Additionally, CBT responses to eliminate this ratio and improve the quality of the Turkish banks' balance sheet, the adverse effect of NPLs threatens overall financial stability in Turkey.

Accordingly, the current thesis contributes to the current literature by evaluating these areas: the efficiency of Turkish banks, the monetary transmission mechanisms through BLC, the relationship between competition, stability, and efficiency in the Turkish banking sector from 2002 to 2017. All three empirical studies are explained in the following sections.

6.1.1. Bank efficiency and non-performing loans: Evidence from Turkey

Chapter Three investigates the impact of NPLs as undesirable outputs, on the technical, allocative, and cost efficiency of Turkish banks. This Chapter contributes to the existing literature in Turkish bank efficiency by applying a modified DEA method, which was initially introduced by Aparicio *et al*. (2015). This model enables us to study the impact of NPLs separately. It also enables us to maximise the good outputs, namely total loans and receivables, net securities, off-balance sheet activities, and non-interest income, while minimising bad

outputs, (NPLs) and inputs (capital and deposit). Running this model also helps us to distinguish the inefficiency errors from the random errors to find the main source of inefficiency in Turkish banks. To measure all three types of efficiency we collect quarterly data from BAT from 2002 to 2017. Moreover, the dataset of NPLs has not been used in previous studies. This study also contributes to the current literature by introducing a novel efficiency determinant (employee gender) while evaluating the other efficiency determinants, including NIM, NNIM, ROA, age, and employee education. In order to investigate the efficiency determinants, we run the quantile regression. To the best of our knowledge, quantile regression has not been used previously in the literature for evaluating the efficiency determinants.

Our results show that Turkey experienced an improvement in its efficiency scores after the financial crisis in 2000-2001. However, this positive trend of improvement stopped in 2008 due to the financial crisis. After that, efficiency scores have been fluctuating in the Turkish banking sector. Overall, Turkish banks' efficiency scores are rather low, standing at 0.3018 for technical efficiency. These scores are 0.8796 and 0.6453 for allocative and cost efficiency, respectively, which show a better performance for Turkish banks. We also investigate three types of efficiency in four ownerships, including development and investment, foreign, private, and state-owned banks. Our results show that the most efficient ownership is investment and development. Foreign ownership is also more efficient in comparison with private and state-owned banks. These results emphasise the importance of strengthening state-owned and private banks, especially since these banks are among the largest ones in Turkey. This means that they hold the majority of the sector's assets. Hence, the quality of their balance-sheet and their performance is crucial to the Turkish banking sector.

Examining the relationship of bank-specific characteristics and three types of efficiency, we can confirm the negative impact of NPLs on all types of efficiency. We also find a negative relationship between off-balance sheet activities and all kinds of efficiency in Turkish banks.

The negative impact of NPLs shows the importance of managing and controlling this variable to improve the quality of Turkish banks' balance sheets. Moreover, emphasising the impact of off-balance sheet activities and improving banks' good outputs is beneficial for Turkish banks considering the volatile financial market in which they operate as these changes could help them to manage their risks more appropriately.

Furthermore, our results from running quantile regression and investigating the efficiency determinants confirm that there is no misuse of deposit sources in Turkish banks since we find a positive coefficient for NIM and three types of efficiency from 2002 to 2017. Unlike NIM, the coefficient for NNIM is negative. This negative sign represents that the non-interest income courses can be managed and utilised more appropriately. Moreover, our results show that the more efficient banks are more profitable as the relationship between ROA and efficiency is positive and significant. We also note that older banks in Turkey are the least efficient.

One of the contributions of this paper is to expand the investigation on the impact of employee education. In our study we have four groups of employees with four different types of certificate. The first group have primary school degrees. The second group have high-school diplomas. Employees in third group have undergraduate degrees. Finally, the fourth group have postgraduate degrees. We divide these four groups into two main categories: those with postgraduate degrees and the rest of the employees with any lower degrees or school leaving certificates. We find a positive relationship between the employee education and all three types of efficiency in our study. This is in line with the only other available study from Isik and Hassan (2002), which investigates the impact of education on cost and profit efficiency in Turkish banks. Our results also show that more educated employees can improve the efficiency scores of Turkish banks. This finding is important as the majority of employees in Turkish banks do not have postgraduate degree. According to our collected data, Turkey has been hiring more employees with high-school diplomas recently.

We also introduce the employee gender as a novel efficiency determinant. Following the available theories about gender diversification, including resource dependency, human capital, social psychological, and agency theories, considering gender diversity is crucial in utilising all the available sources in order to improve the efficiency and productivity of the Turkish banks. According to our collected data, the ratio of female employees to males in Turkey, during the study's time horizon, is always on a downward trajectory. This means that, regardless of ownership type, there are always fewer females than males employed in banks in Turkey. Our results show a positive relationship between gender diversity and all three types of efficiency in Turkish banks. This indicates the importance of more equality and diversification. It also emphasises that having more women can add to the capital sources, networking, and can reshape the management style of the Turkish banks.

To investigate more into efficiency determinants, we divide our sample to pre- and post-financial crisis in 2008. We also consider the impact of *Z*-score, as a proxy of risk. Moreover, we evaluate the efficiency determinants on three different sizes of bank. Running quantile regression and OLS, our results are in line with our initial findings. Our findings emphasise the negative impact of NPLs on efficiency scores.

To check the robustness of our results, following Cuesta *et al*. (2009), we apply the translog hyperbolic enhanced distance function. This is a parametric method, which enables us to expand our desirable outputs while shrinking our undesirable output and inputs. We measure all three types of technical, allocative, and cost efficiency using this parametric model. The efficiency scores from running this parametric model confirms our initial findings. Average technical efficiency in foreign banks is higher compared to private and state-owned banks. Examining the relationship between bank-specific variables and efficiency scores is also in line with our initial findings. They confirm a negative impact of NPLs on three efficiency measures. There is also a sign for improving the off-balance sheet activities in Turkish banks.

This chapter provides a reference point for the potential expansion of desirable outputs and inputs and the shrinkage of undesirable ones. Alongside reducing NPLs in order to improve technical, allocative, and cost efficiency, Turkish banks could also diversify their loan and investment portfolios to achieve the optimal desirable output matrix. Investing in technological innovation could possibly number among banks' strategic policies since this could enable them to expand their market share and, accordingly, raise their desirable outputs. It is worth noting that caution is needed as there is a potential for high-risk decisions and activities which will be associated with the best performing banks.

Our study provides useful information for regulators and supervisors in Turkey. Our findings emphasise the negative impact of NPLs on Turkish banks' performance. This issue should be addressed immediately as it is long standing issue in the Turkish banking sector. There is also an emphasis on the improvement of gender equality and diversity in Turkish banks.

6.1.2. How monetary policy affects the lending channel in Turkey: Bayesian estimation

The monetary transmission mechanism, well represented in the literature focussing on developed countries, is perhaps more important in developing countries such as Turkey which is home to a volatile economic situation where policies change fast and often. Turkey has experienced high volatility in its interest rates, which has affected both the supply and demand sides of bank credit in the economy. These monetary policy changes are likely to have contributed to a change in the strategies which form the basis for banks to design their loan portfolios and grant loans. Despite the extensive structural and legal reforms initiated by the Turkish government and CBT, commercial banks' balance sheets show a large volume of NPLs (Assaf *et al.*, 2013; Fukuyama and Matousek, 2011). Given that the banking sector is the backbone of Turkey's economy, achieving a robust, well-regulated and effective banking system is crucial to the country. Therefore, considering the destructive impact of volatile

interest rates on NPLs is important because these undesirable loans influence banks' balance sheet quality. The Turkish government realised that an efficient and profitable banking sector requires both adequate micro- and macroeconomic stability and a well-regulated market in order to operate and expand commercial activities.

Reviewing the Turkish literature demonstrates that there is a lack of investigation in this area. Hence, in chapter four, we examine the monetary transmission mechanism through BLC in Turkish banks. Following Kishan and Opiela (2000), the reason for choosing the BLC from other channels is the focus of this channel on the loan portfolio in Turkish banks. Since, according to Mishkin (1995), issues around the impact of interest rate changes on asset expenditure led to the development of the monetary transmission mechanism. As this development highlights how asymmetric information and costly contract enforcement contributes to agency issues, focusing on the BLC and balance-sheet channel becomes significantly important.

Accordingly, this chapter contributes to the current Turkish literature as follows. Initially, in chapter four we evaluate the monetary transmission mechanism through BLC applying new estimator, which is the Bayesian estimation following (Belviso and Milani, 2006). The main differences between Bayesian and non-Bayesian estimations, such as GMM methods, which motivate this study, are the attributes of the deviations between the sample distributions and prior/posterior distributions. Using Bayesian estimation enables us to define the prior and posterior on the basis of all available information. Hence, more accurate results can be achieved. Moreover, applying Bayesian is superior to the previous methods since it is more flexible and more up to date in comparison with the other methods.

Moreover, we contribute to the current Turkish literature by considering an additional bank characteristic while examining the monetary transmission mechanism through BLC. We consider technical and allocative efficiency as an additional bank characteristic. Considering

the efficiency as a characteristic is important. As Jonas and King (2008) outline more efficient banks have a flatter loan supply curve. This means in the case of any conventional or unconventional monetary policy shocks they reduce their loan supply faster in comparison to less efficient banks. We measure the technical and allocative efficiency in our study applying a modified DEA whilst considering NPLs as an undesirable output. Moreover, in measuring for both technical and allocative efficiency we consider the impact of NPLs, by defining a separate vector. This is particularly important as the impact of these bad loans on efficiency scores can be detected separately.

Additionally, we evaluate the impact of other bank characteristics, including size, liquidity, and capitalisation, on the Turkish banks' responses to any short- or long-term monetary policy shocks. To examine the impact of these four characteristics we not only consider them individually but also in the form of two and three-ways interactions. Moreover, we consider both the current and lagged values of these characteristics and interest rate changes. In addition to the bank-specific characteristics, we consider some macroeconomic factors, like inflation and real GDP growth while examining the monetary transmission mechanism through BLC.

Lastly, the current study covers a longer period during which not only the boom cycle in the Turkish economy is considered but also the changes during 2013-2017 when Turkey was again faced with financial and economic issues. This study focuses on the following areas, considering three main classes of variables to find the impact of monetary policy on bank loans. From the balance sheet this study took total deposits, total loans, return on assets and NPLs because it is interesting to know how loans are influenced by unexpected shocks. This study assessed the size, liquidity and capital ratio but also introduced efficiency as a fourth bank characteristic. And finally, from a macroeconomics perspective, real GDP growth, inflation, and the interbank money market rate.

There is only one study, that of Akinci *et al*. (2013), available on Turkey with a similar context for comparison. Unlike Akinci *et al*. (2013) who consider the cost and profit efficiency as an additional characteristic, our study takes technical and allocative efficiency into account to provide more information about the impact of this additional feature on the banks' responses to any monetary policy changes. Moreover, most importantly, in contrast to the Akinci *et al*'s (2013) paper, our findings show a positive and significant impact of the role of bank efficiency in the way they react to any monetary policy shocks by changing their loan supply. These findings emphasise the importance of considering efficiency as a key characteristic in banking as it is directly and indirectly related to bank performance. Our results also confirm the positive impact of the other bank characteristics on banks' reaction to monetary policy changes. Our findings show a positive influence of the size, liquidity, and capitalisation on loan supply when there are monetary policy shocks. Hence, we can confirm that smaller, less liquid, and less capitalised banks are not able to reduce their loan supply nor manage their risk when there are any sudden changes in monetary policy. These results are consistent when we evaluate the two- and three-way interactions of the banks' current and lagged characteristics with the current and lagged value of interest rate changes. The findings in this study support the two-way interaction between liquidity and interest rates and the three-way interaction between interest rates, lagged liquidity and lagged capital. From other characteristics size and the interaction term of liquidity and interest rates positively influence on the loan supply of a bank in case of any monetary policy changes. Also, liquidity, capital and interest rates positively influence the bank loan supply. The only combination where we find a negative coefficient for is the lagged value of size and lagged value of interest rate. Examining the impact of macroeconomic variables, we find that there is a negative impact of inflation on the bank responses to monetary policy changes. However, real GDP growth positively contributes to the banks' loan supply changes when there are sudden monetary policy shocks.

When this study adds the fourth characteristics of bank efficiency, the following results are found. In the case of technical efficiency, obtained results confirm more efficient banks are more flexible in reducing or expanding their loan portfolio in case of any sudden shocks compared to less efficient banks. This result can be confirmed by allocative efficiency as well. These results illustrate the importance of improving the efficiency of Turkish banks. Since one of the main sources of inefficiency in Turkish banks is the ratio of NPLs in this study, having better policies or improving regulations may help banks to improve their efficiency levels. When this study considers the long-term impact of monetary policy on the loan supply of banks, the obtained results support the indirect impact of two bank characteristics. As results demonstrate, over a longer period capitalisation is not an important factor on banks' loan supply. In addition, the findings suggest that loans are quite responsive to direct monetary policy in Turkey. The impact of liquidity and the three-way interaction of liquidity, capital, and changes in interest rate long-term are also confirmed by the results in this study. Moreover, the results from running Bayesian estimation illustrate the sensitivity of loans to interest rate changes even long-term and the positive long-term impact of other bank characteristics on the loan supply.

We examine the impact of bank characteristics on the loan supply, long-term. According to our results, monetary policy changes influence Turkish banks' loan supply directly via money lending channel and indirectly through BLC. Moreover, except capitalism, all of the bank characteristics positively influence banks' loan supply even over a long period of time. The positive impact of real GDP growth and a negative influence of inflation can be detected over a longer period of time as well.

To check the robustness of our study, we also apply the fixed effect and OLS test. The results from running these two models supports our initial findings.

Our findings are helpful for informing regulations and for policymakers to produce the most appropriate restructuring and reform plans. Regulations regarding the level of risk-taking decisions in commercial banks as well as their loan issuance process would help diminish bank default risk. The regulatory and supervisory system in Turkey is improving especially after 2000-2001; however, Turkish banks are still not fully successful in minimising their NPLs ratio — Turkish banks have reported an increase in risky and bad loans as a result of the impact of the crisis and the unstable environment. Accordingly, the ratio of NPLs increased in November 2017. Such results will be an appropriate guide for the regulators in order to maintain financial stability and improve bank performance or at least keep it steady.

Moreover, evaluating the monetary transmission mechanism through BLC in Turkish banks can be done with more detailed information about NPLs in Turkish banks. One of the limitations of the dataset in this study is that the available data for NPLs does not provide enough information about different kinds of bad loans. Thus, NPLs can be divided into many different categories based on the dataset of this thesis. However, using this dataset is beneficial as it provides both qualitative and quantitative data for almost all the commercial banks in Turkey.

6.1.3. Competition in the Turkish banking sector: Boone indicator

Reviewing the available literature on the impact of market structure on bank performance considering the SCP and efficiency structure hypothesis highlights its importance. Although this topic has been investigated thoroughly in the international literature, especially for more developed countries like the US and the UK, only limited number of studies can be seen in the Turkish literature. While other recent studies have evaluated different aspects of banks and their characteristics via a consideration of financial innovation tools and financial market nature by applying advanced methods, in the case of Turkey, studies examine only basic fundamentals in this regard. Detecting a gap in the literature about Turkey, its market structure

and its competitive context whilst also considering bank characteristics (efficiency and its importance, and the attendant impact of NPLs) has motivated the current study. Thus, in Chapter Five, we examine the relationship between competition, stability, and efficiency in the Turkish banking sector. Our study contributes to the current literature on Turkey by considering the role of efficiency while measuring for the competition scores. The relationship between competition and other elements, such as bank size and stability, does perhaps have a richer history for developed countries while the record for developing countries, like Turkey is still growing. In this chapter, we deployed the Boone indicator, which was used initially by Boone (2008), to compute competition scores for Turkish banks. Reviewing the literature highlights the two hypotheses tested: 'competition-stability', which highlights the importance of competition in boosting growth and stability, and 'competition-fragility', which supports the negative impact of competition on bank stability. Our competition scores measured by the Boone indicator support the competition-stability theory.

Moreover, we deployed the Boone indicator in this study because it reduces the profit elasticity to the marginal cost. Hence, in this study we assumed the ROA as a proxy for profitability in a bank. In computing the competition scores, this measure also represents the market share for each Turkish bank. Since the emphasis of this study is on Turkish commercial banks, our focus is to investigate the competition in loan market. Considering the aim of our study and the feature of our data, applying the Boone indicator to measure for the competition scores is superior in comparison with other measures since Boone measures the effect of efficiency on performance in terms of profits. Thus, using Boone enables us to have a thorough evaluation of all the selected factors in computing for competition, including NPLs in an indirect way when we measure technical efficiency. In addition, the Boone indicator requires a comparatively small amount of data. We only consider Turkey in our analysis of the relationship between competition, stability, and efficiency. Using a single country is beneficial

as it gives a specific concentration on a single financial market. It also enables us to evaluate the Turkish banking sector without disruption of any external impacts (Liu and Wilson, 2013). Hence, this study provides the estimation of competition on a quarterly basis for Turkish banks. As a result, the assessment of developments in competitive conditions over timeline of this study, which is from 2002 to 2017, would be easier. Additionally, the Boone indicator considers different forces which can cause an increase in competition. For instance, an increase in the number of banks in the market, entry barriers, and the more aggressive interaction of banks can make a difference. In particular, in devising the Boone indicator (2008) Boone took into consideration the impact of efficiency on the traditional Boone indicator, which is helpful for this study.

A drawback of the Boone indicator, however, is that this measure like many other model-based measures, ignores the differences in product quality and design across banks, as well as the attractiveness of innovations. In detail, our results support the notion that more competition would motivate banks to reduce costs and maximise outputs (Andrieș and Căpraru, 2014; Schaeck and Cihak, 2008), which supports the competition-stability theory.

In light of the history of monopolistic markets in Turkey and the changing patterns in the market after the introduction of the restructuring programmes, we re-analysed the linkage between competition and stability, which we measure by applying *Z*-score, and technical efficiency. We measure technical efficiency in our study applying modified DEA through which we can maximise the good outputs, including total loans and receivables, net securities, total off-balance sheet activities, and non-interest income at the same time as minimising bad outputs (NPLs) and inputs (capital and deposit).

For a thorough investigation we divide banks into four groups based on ownership. Similar to chapters three and four, we have foreign, state-owned, private, and investment and development banks. Out of 44 commercial banks in our sample the competition scores for 42

of them from 2002 to 2017 are negative. Only two of the banks in the sample, Diler Yatırım Bankası A.Ş. and İstanbul Takas ve Saklama Bankası A.Ş, have a positive Boone score. Following Leuvensteijin *et al*. (2011), these positive scores show these banks are competitive on equity. These two banks are development and investment banks in Turkey. The rest of the banks in the four ownership groups represent negative Boone scores. This score fluctuates between 0.33 to -2.33 for all banks in our sample. The Boone scores for all the banks in our sample fluctuates during the time period of our study. When we investigate the relationship between competition, stability, and technical efficiency, we apply 2SLS regression. While defining the equation, each one of these three variables becomes a dependent variable and the rest are independent variables. We also take other variables into account such as ROA, liquidity, logarithmic value of total asset, the ratio of off-balance sheet activities to total assets, and total loans and receivables while defining the equations to investigate the relationship between competition, stability, and technical efficiency. Our results show that there is a positive relationship between competition and stability, which is in line with competition-stability theory argument, discussed by Boyd and De Nicolo (2005). Our results also confirm a positive relationship between competition and technical efficiency in Turkish banks. Hence, we can argue that performing in more competitive market motivates Turkish banks to improve their technical efficiency scores by cutting the NPLs ratio or optimising their non-interest activities. Our findings also illustrate a negative relationship between efficiency and risk. Since our results show higher market power results in higher stability and there is a negative relationship between the risk and stability, we can say that the relationship between efficiency and stability also is positive.

To check the robustness of our initial findings, following Kick and Prieto (2015), we measure the competition scores using the (in) efficiency-adjusted Lerner Index. Our results from running this (in) efficiency-adjusted Lerner Index confirm a low degree of competition in

the Turkish banking sector, which is in line with our initial results. To investigate further the relationship between competition, stability, and efficiency we test this relationship applying quantile regression. To do so, we divided our banks into two groups based on their efficiency scores. The results of technical efficiency scores demonstrate that the most efficient type of ownership are investment and development banks and foreign banks. Hence, we consider these two ownerships as a group of most efficient banks. Consequently, the least efficient banks, based on their technical scores, are private and state-owned banks. Moreover, we consider both competition scores from the Boone indicator and the (in) efficiency-adjusted Lerner Index while evaluating the relationship between competition and technical efficiency in Turkey. Running quantile regression to investigate the relationship between competition, stability, and technical efficiency confirms our initial findings about the positive relationship between competition and stability and competition and technical efficiency. Furthermore, our results confirm the impact of bank-specific characteristics on bank performance in a competitive environment. We find that the more efficient banks have a higher profitability ratio. Moreover, our findings support the positive impact of capitalisation, size, and liquidity on bank efficiency in Turkey. The negative coefficient of the ratio of off-balance sheet activities to total assets and technical efficiency also indicates that Turkish banks should improve their off-balance sheet activities.

Our findings are in line with the competition-stability hypothesis stating wherein competition positively influences financial stability in Turkey. Furthermore, our findings help us to understand the apparently conflicting empirical evidence. Most studies tend to find results in favour of the competition-fragility view. However, if a study sampled banks from countries/regions with less strict restrictions on activity and capital, less homogenous bank revenue structures, no deposit insurance and credit registries, obtaining insignificant or contrary results need not be inconsistent with previous findings.

6.2. Further research directions

Throughout this thesis, the main target has always been to detect the most fundamental and recent gaps in the literature. Examining the literature around Turkish banking highlighted some important gaps in bank performance in competitive environments and for all of the implemented principals. These gaps had not been previously appropriately addressed, if at all. Hence, this thesis answered three main questions. The first question was an assessment of technical, allocative, and cost efficiency and their attendant impact on the performance of banks operating in Turkey. According to our results the main source of inefficiency in Turkey, apart from inappropriate managerial decisions on non-depository sources, is a significant and negative relationship between bank efficiency and the ratio of bad loans.

The results from Chapter Three provide motivation for this thesis to investigate the monetary transmission mechanism through BLC in the Turkish banking sector by applying a new estimator and considering the role of NPLs. Hence, we contribute with the current literature by introducing an additional bank characteristic, namely technical and allocative efficiency. Therefore, the second question was to examine how monetary policy changes in Turkey may influence the bank lending portfolios considering different bank characteristics. As discussed above, although there is a rich literature for developed countries regarding this topic, examining financial channels, in particular the BLC, is much unexplored in the Turkish banking sector. Our results indicate that changes in conventional monetary policy in a form of interest rate changes can directly influence the Turkish loan supply through money channels and indirectly through BLC during the selected time horizon of our study. Unlike the only other available study in Turkey about the impact of efficiency on banks' loan supply, our study confirms the positive impact of efficiency on the loan supply of Turkish banks. Hence, more efficient banks in our study can control and reduce their loans supply in case of any monetary

policy shocks. This finding encourages the thesis to expand the investigation on the relationships between competition, stability and efficiency in Turkey.

Thus, the remaining element is to examine the relationship between competition, stability, and efficiency in the Turkish banking sector by deploying the Boone indicator, which enabled this thesis to introduce efficiency in competition measures into the literature. The most novel and recent discussions and models have been used to address the questions raised above. However, there are some suggestions for further research and studies based on this thesis.

More detailed data and information regarding the different categories of bad loans, deposits and loans could be used to provide more hypotheses and deeper questions and evaluations. The impact of the political environment on the performance and soundness of the Turkish banking sector is another dimension that can be used in evaluating efficiency and the BLC. Moreover, applying more recent methodologies to measure and assess the questions above and comparing the results from different methods is something that can provide more insightful investigations. Furthermore, there are still many determinants and bank characteristics, such as the impact of diversity that can be taken into consideration to provide more appropriate regulatory suggestions. Additionally, something that is very much missed in the literature about Turkey is the evaluation of innovative financial tools and activities, such as electronic money. Because not all categories of NPLs were available to collate, it was not possible to determine the proportion of defaults on derivatives contracts and electronic activities over, for instance, the overnight market in Turkey.

6.3. Recommendation and limitations of the study

In terms of the generalisability of the current thesis' findings, it is worth mentioning their applicability in the Eurozone setting, especially considering the current status of the Turkish economy and banking sector. Although the structures of the banking systems in the Eurozone and Turkey are different, it is important to consider the European framework because Turkey

is negotiating its accession to the EU as a member state, following its application to accede to the European Economic Community, the predecessor of the EU. There are some insightful implications to be drawn from our results, especially as the ECB also implemented some policies to eliminate or minimise the ratio of NPLs, and European banks suffered from the global financial crisis and the sovereign debt crisis.

We have learned from Turkey that NPLs are detrimental to bank performance and that encouraging competition could reduce the NPLs ratio. For countries with NPLs (for example, Greece, Slovenia, Portugal, Italy, Ireland), the national Central Banks should initiate restructuring. They are the experts who have the specific, detailed and privileged knowledge about the current financial situation of the banking systems, and therefore would be able to develop appropriate regulations or structural changes to regain or safeguard financial stability. As indicated in the European Banking Authority report on NPLs (2016), policy options to ease the NPLs issue are under consideration. Among them are i) the call to enhance the quality, accuracy, and completeness of data (for example, asset quality, the state of NPLs, or collateral valuation); ii) improvements in the judicial system (for example, timeliness of the procedure, accounting and tax regimes); and iii) a functioning secondary market facilitating the disposal of NPLs. Based on our research on Turkey, the first area would be the key factor in addressing the problems in the banking sectors, as policymakers would then be able to predict and identify the areas of risk and respond in timely fashion. One of the limitations we faced in investigating the relationship between competition, stability, and efficiency was to find the best measure to calculate competition. This thesis defines the main concepts, such as stability and bank performance, in the most accurate ways following the current literature. Multi-method studies provide more detailed evaluations of the main elements, which can be considered for further studies in future. Moreover, having access to different types of deposits and various NPLs

categories would enable us to define more detailed scenarios to have a better understanding of the Turkish banking sector.

Since Turkey is a bank-oriented country, addressing the banking issues will help in resolving economic challenges as well. This, in turn, strengthens the coordination between national regulators and the ECB in the Single Supervisory Mechanism. The ongoing quantitative easing, extended until the end of 2017, and emergency liquidity assistance from the ECB could be effective. However, caution is needed to prevent unwanted moral hazard problems and anti-competitive behaviours. In this thesis, we take a very different perspective to the previous literature in evaluating different angles of the Turkish banking system not only by applying various models to measure technical, allocative, and cost efficiency and competition scores but also by introducing employee gender as a new efficiency determinant. This thesis also expands the empirical findings about the less investigated efficiency determinants, like education, and less explored banking areas, like transmission monetary mechanisms via BLC by considering more bank characteristics.

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