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PLAGIARISM PAGE

I hereby declare that all information in this thesis has been obtained and presented by academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work; otherwise I accept all legal responsibility. 14.05.2020

Önder ÖZGÜR

To Handan, Ayça, Asya and Ömer Çağan

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ABSTRACT

Three Essays on Applied Macroeconomics

This thesis consists of three independent studies on applied macroeconomics. The first study aimed at exploring the effectiveness of negative interest rate policy on exerting its effect on various indicators in Sweden. The study covers the period between 2010:01 and 2019:04. The first study employs Factor Augmented Vector Autoregression methodology and introduces the scenario specification to offer a comprehensive and reasonable picture of the effect of monetary policy on the economic performance of the Swedish economy. The empirical findings suggest that the monetary policy changes are effective both on exerting its effect into lending and market rates and triggering economic activity in negative policy rate setting.

The second study constructs a model to explore the potential nonlinear and nonparametric relations between outstanding bank loans and bank-specific characteristics, macroeconomic indicators, and global factors. The study analyzes the performance of these factors in predicting bank lending in Turkey over the 2002Q4 to 2019Q2 period. This research, unlike previous studies, utilizes numerous machine learning methods and benefits from the potential advantages of those techniques. The empirical findings suggest favorable evidence for some nonlinearities on drivers of bank lending and confirms that bank-specific characteristics and macroeconomic indicators tend to be more important variables influencing the bank lending behavior.

Finally, the third study analyzes the impacts of the motor fuel subsidy program on domestic prices, the burden of the subsidy system on the government budget, and the real economic impacts on the output gap in the Turkish economy. The study employs Factor Augmented Vector Autoregression methodology and covers the period throughout 2015-2019. The study concludes that the subsidy program is a practical tool to eliminate the inflationary impacts of oil price changes. Also, the burden of the subsidy program seems not to create a challenge for the government to sustain budget deficit.

Keywords: bank lending, factor augmented vector autoregression, fuel price subsidy, machine learning, negative interest rate

ÖZET

Uygulamalı Makroekonomi Üzerine Üç Makale

Bu tez, uygulamalı makroekonomi üzerine üç bağımsız çalışmadan oluşmaktadır. Birinci çalışma negatif faiz oranı politikasının İsveç ekonomisine dair pek çok değişken üzerindeki etkilerinin tespit edilmesini amaçlamaktadır. Çalışma 2010:01 ile 2019:04 dönemini kapsamaktadır. Çalışmada faktörlerle genişletilmiş vektör otoregresyon metodu kullanılmış ve para politikasının İsveç ekonomisi üzerinde geniş bir yelpazedeki performansının sunulması amacıyla senaryo tanımlaması yapılmıştır. Çalışma sonuçları negatif faiz oranı politikasının hem banka kredisi ve piyasa faiz oranlarına hem de ekonomik aktivitenin canlanmasına katkı sunduğunu ifade etmektedir.

İkinci çalışmada Türkiye'de bank kredileri ile bankaya özgü değişkenler, makroekonomik göstergeler ve global faktörler arasındaki parametrik ve lineer olmayan ilişkilerin tespiti için model oluşturulmuştur. Çalışma aynı zamanda bu faktörlerin Türkiye'de banka kredilerini tahmin etme performansını 2002Q4-2019Q2 dönemi için analiz etmiştir. Literatürdeki diğer çalışmalardan farklı olarak bu çalışmada makine öğrenmesi yöntemleri kullanılmış ve bu yöntemlerin sunduğu avantajlardan faydalanılmıştır. Çalışmanın sonuçları banka kredileri ile çeşitli değişkenler arasında lineer olmayan ilişkileri ortaya koymuş ve bankaya özgü karakteristikler ile makroekonomik göstergelerin bankaların kredi davranışları üzerinde global faktörlere göre daha önemli olduğunu göstermiştir.

Son olarak, üçüncü çalışma Türkiye'de eşel mobil sisteminin yurtiçi fiyatlara etkisini, bütçeye yükünü ve çıktı düzeyi üzerindeki reel ekonomik etkilerini incelemiştir. Çalışma faktörlerle genişletilmiş vektör otoregresyon metodunu kullanmış ve 2015-2019 dönemini analiz etmiştir. Çalışma sonuçları eşel mobil sisteminin petrol fiyat değişikliklerinin yurtiçi fiyatlara geçişini engelleme açısından etkili bir araç olduğunu göstermiştir. Aynı zamanda, eşel mobil sistemi bütçe açığını sürdürülebilirliğini sekteye uğratmamıştır.

Anahtar Kelimeler: banka kredileri, eşel mobil sistemi, faktör otoregresyon metodu, makine öğrenmesi, negatif faiz oranı

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LIST OF ABBREVIATIONS

FAVAR	:	Factor Augmented Vector Autoregression
NIRP	:	Negative Interest Rate Policy
FED	:	Federal Reserve
DNB	:	Danish National Bank
CBRT	:	Central Bank of the Republic of Turkey
ECB	:	European Central Bank
SNB	:	Swiss National Bank
BOJ	:	Bank of Japan
VAR	:	Vector Autoregression
DSGE	:	Dynamic Stochastic General Equilibrium
MM	:	Money Market
IPI	:	Industrial Production Index
CPI	:	Consumer Price Index
PPI	:	Producer Price Index
REER	:	Real Effective Exchange Rate
NX	:	Net Exports
BAT	:	Banks Association of Turkey
EDDS	:	Electronic Data Delivery System
GDP	:	Gross Domestic Product
GSIFI	:	Global Systematically Important Financial Institutions
MAPE	:	Mean Absolute Percentage Error
MSE	:	Mean Square Error
NPL	:	Non-Performing Loans
ROA	:	Return on Asset
PDP	:	Partial Dependence Plot
WDI	:	World Development Indicators
IMF	:	International Monetary Fund
SVAR	:	Structural Vector Autoregression

EMRA	:	Energy Market Regulatory Authority
LPG	:	Liquified Petroleum Gas
CIF	:	Cost, Insurance and Freight

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1. INTRODUCTION

Theories are the tools generated to explain the observed phenomena with a battery of rules and assumptions in economics. Theories use empirical, statistical, and econometric techniques to build economic models (Pindyck and Rubinfeld, 2012). Economists traditionally aimed at discovering how the economic world operates, and they develop economic models as a description of the part of the economic world (Parkin, 2003). Economic models are usually expressed in mathematical forms and are used to demonstrate the interrelations among variables (Mankiw, 2015). Macroeconomics studies the forces affecting the economy as a whole and is much about relating the real-world facts with theories (Dornbusch et al., 2011). The mathematical or econometric analysis as a form of macroeconomic research are tools to shed light on how the economy works and generate insights for economic policies (Abel et al., 2013).

The main concern of macroeconomics is to analyze and undermine the factors significant on the interactions among primary aggregates such as output level, inflation, and unemployment (Snowdon and Vane, 2005). Economists have, therefore, focused on a range of analytical approaches to assess the effect of any policy change on an economy (Athey, 2015). The rapid advances in computing technology and the inclusion of the data collecting techniques have facilitated the introduction of the novel empirical methodologies, and the technological improvement has led researchers to access these tools easily (Baltagi, 2008). Therefore, one can conclude that the incorporation of the novel empirical tools has increased the number of empirical studies on macroeconomic issues, and the literature has proliferated.

This thesis consists of three independent studies on applied macroeconomics in the following three chapters. These studies concentrate on the issues in a data-rich environment. The first study contributes to the discussion of the negative interest rate policy. Central banks started to implement a negative interest rate policy after the onset of the global financial crisis in 2008. Significant reasons for central banks to adopt the negative interest rate policy is to stimulate economic activity, to stir the inflation and the inflation expectations up to its pre-

crisis period (Jobst and Lin, 2016). The negative interest rate policy is supposed to trigger economic activity by lowering the cost of investment and consumption expenditures (Jackson, 2015). However, this policy instrument also has some questions and criticisms because of its adverse effects on financial stability (Guofeng and Xiaoebi, 2018). Therefore, one might infer that the impact of the negative interest rate policy on the economy has not yet been fully comprehended. With this, this first chapter of this study aims to examine the effectiveness of negative interest rate policy in exercising its impact on bank lending and market rates, triggering inflation, and boosting Sweden's economic activity. Swedish Central Bank adopted the negative interest rate policy in February 2015. The analysis in the first study covers the period between 2010:01 and 2019:04. The first study adds to the literature by employing a data-rich Factor Augmented Vector Autoregression (FAVAR) methodology and introducing the scenario specification to discover the performance of the negative interest rate policy.

The second study adds to the banking literature for the Turkish economy. The Turkish economy faced two severe domestic crises in November 2000 and February 2001, and the domestic banking industry highly damaged during this period. These crises have spawned mainly due to the unstable nature of the banking sector. Thus, several attempts have been made to provide a sound banking sector and provide financial and economic stability (Akinci et al., 2012). The burst of the banking crisis and the subsequent economic downturn in the Turkish economy has raised awareness of scholars and policymakers on the banking sector's stability. The banking sector in Turkey also corresponds to the significant part of the financial system, and the share of deposit banks constitutes about 78 percent of the entire financial sector in the second quarter of 2019 (EDDS, 2020). This study, therefore, builds a model to discover the potential nonparametric and nonlinear linkage between numerous bank-specific, macroeconomic, and global factors on outstanding bank loans in Turkey. The data period is throughout 2002Q4 and 2019Q2. Unlike existing studies in the literature, this chapter of the thesis introduces machine learning techniques into the analysis and benefit from their distinct advantages. Machine learning techniques allow us to handle several variables in the analysis, to determine the functional form of the model flexibility and not relying on the priori distribution of selected variables.

The third study is on the strand of the literature focusing on the pass-through of international oil prices on the domestic economy. Numerous efforts have been devoted to discovering the impact of oil price spikes on the domestic economy since 1970s. These studies generally concluded that oil price changes contribute to the cyclical fluctuations in real economic activity and pass-through to domestic prices. Furthermore, it is also a common practice to absorb the adverse effects of global oil price changes and subsidize domestic fuel prices. The Turkish government enacted a motor fuel price subsidy system in May 2018. This system briefly is a tax exemption system that allows consumers to buy motor fuels at lower prices. Therefore, this program is a novel policy tool aiming to eliminate the potential adverse effects of oil price hikes. In this context, the current study addresses the impacts of the motor fuel subsidy program on domestic consumer and producer price indexes, the burden of the subsidy system on the government budget, and the real economic impacts on the output gap in the Turkish economy. The data availability restricts the period, and the study employs the monthly data between 2015 and 2019. As is the case in the first study, this study employs the FAVAR methodology. Furthermore, the study introduces a scenario specification to discover the effectiveness of the subsidy program in the Turkish economy.

The organization of the thesis study is as follows: The following three chapters introduce three independent studies, their literature reviews, empirical results, and discussions. Finally, the last chapter concludes the thesis study.

2. NEGATIVE INTEREST RATE POLICY AND BANK LENDING CHANNEL: EVIDENCE from the SWEDISH EXPERIENCE

2.1. Introduction

The process by which the monetary policy changes exert their effects on real economic activity and the price level in any economy is labeled as the monetary transmission mechanism. However, there is no consensus on how monetary policy conveys to the real economy and incorporates some intermediary forces under such a complex underlying interaction of the macroeconomic variables. In this sense, Bernanke and Gertler (1995) call the monetary transmission mechanism as a "black box."

The bank lending channel is acknowledged as one of the most crucial transmission channels of monetary policy. It is mainly based on the unique role of banks in the monetary transmission mechanism. The bank lending channel operates via transmitting the changes in policy rate (i.e., the repo rate, borrowing rate, lending rate) into banks' deposit rates, lending rates, and the volume of bank lending. In a conventional monetary policy setting, Kashyap and Stein (1994) document three benchmark conditions for the efficacy of the bank lending channel. They argue that the bank lending channel is in tune if the following conditions hold. First, bank loans and other financial instruments are not perfect substitutes for firms. Second, banks are not able to insulate reserve drains stemming from monetary tightening either by selling liquid assets or accessing non-deposit funding. Third, prices must not adjust rapidly to policy changes so that real money balances are about to change.

Traditionally, central banks intervene in the economy using policy instruments to trigger economic activity and stabilize the price level (Apergis and Chistou, 2015). After the wake of the 2008-2009 global financial crisis, central banks in major economies have implemented unconventional monetary policy tools. These tools mainly involve large-scale asset purchases of public securities and private bonds, marked as the quantitative easing policies, credit easing policies, and the forward guidance influencing the expectations of the economic agents (Bernanke, 2017; Rogoff, 2017; Thornton and Vasilakis, 2019). Though, these tools have not been easy to implement since they need legislative support.

The negative interest rate policy, NIRP hereafter, is either a substitute or complement for such unconventional policy measures to stimulate economic activity in economic downturns (Eggertsson et al., 2019). The secular stagnation, ongoing fall of inflation, declining inflation expectations, and the high debt burden leads some central banks to move their policy rates to the negative territory to struggle with these challenges (Jobst and Lin, 2016). The NIRP is based on the idea that central banks charge a fee for the excess reserves of banks and urge them to switch their reserve holdings to other assets (Arseneau, 2017). The Danish National Bank (DNB) was the first central bank that introduced NIRP in July 2012, and it was followed by the European Central Bank (ECB) in June 2014. The Swiss National Bank (SNB) adopted the negative interest rate policy in December 2014, the Sweden Central Bank (Sveriges Riksbank) in February 2015, and the Bank of Japan (BOJ) in January 2016 (Jackson, 2015; Bottero et al., 2019). These central banks adopted the NIRP for various reasons.

The NIRP is expected to stimulate economic activity through different mechanisms. Firstly, when central banks implement the negative policy rate, money market rates often decrease, and banks can access cheaper funds to cut their lending rates (Arteta, 2016). Secondly, banks may lower their excess reserve stocks in the case of negative policy rates, thus increasing their lending to bank-dependent riskier firms. Thus, positive spillover effects can be seen in the rest of the macroeconomy (Arseneau, 2017; Bottero et al., 2019). In this context, relatively low interest rates will improve the bank balance sheets and help restore sluggish economic performance (Claessens, 2017). Brunnermeier and Koby (2017) also denote two propositions in which a negative interest rate provokes economic activity: First, under the full pass-through of negative interest rates to deposit and lending rates, banks cut their lending rates and stimulate the real economy. Second, banks with longer-term assets benefit from the fall of short-term interest rates and enjoy higher profits.

However, the functioning of the NIRP on economic activity and the financial stabilization has not been transparent yet and remains unknown. The critics and concerns about the inefficiencies in the monetary transmission mechanism have increased once the interest rates turn to negative (Jackson, 2015; Amzallag et al., 2019). Arguments against the NIRP rely primarily on the reduction of the bank's interest margin and bank profitability

(Guofeng and Xiaoebi, 2018). The current literature has the possible frictions that would increase through NIRP. The one argument is that because of fears of bank withdrawals, banks cannot reduce their deposit rate to negative territory (Amzallag et al., 2019). Another argument is that a decline in the net value of banks and their ability to access new external funding reduce loan supply (Heider et al., 2019). The reduction in interest rate margins also decreases bank profits, which in turn depresses the bank lending (Borio and Gambacorta, 2017). Finally, a negative interest rate causes banks and other financial institutions to over-risk and threatens financial stability (Arteta et al., 2016; Claessens, 2017).

Therefore, it is evident that if pass-through to deposit rates is not complete -deposit rates are binding to zero lower bound- and banks cannot reallocate their financing sources, they suffer from the fall of profits. It should be noted at the moment that, when banks reach alternative sources of financing rather than deposit financing, the bank lending channel mechanism kept operating under negative interest rates. In other words, the first requirement for the efficacy of the bank lending channel is the ability of banks to cover the potential costs of the binding deposit rates. Therefore, one can infer that unlike the proposition of the traditional bank lending channel, banks need to substitute deposit financing with other financing sources in the negative policy rate environment.

The NIRP and the effectiveness of the bank lending channel in the negative policy rate environment have received much attention after the onset of the global financial crisis. However, most of these studies have concentrated solely on measuring the pass-through of central bank policy rates to banks' deposit and lending rates and its possible consequences on the banking system (i.e., Bech and Malkhozov, 2016; Jobst and Lin, 2016; Claessens, 2017). On the other hand, relatively few of these studies have investigated the impact of negative central bank rates on the broader economy using various methodological instruments (i.e., Eggertsson et al., 2017; Guofeng and Xiaobei, 2018). Most of the empirical attempts on the effectiveness of the NIRP used dynamic stochastic equilibrium (DSGE) models (i.e., Eggertsson, 2017; Jobs at and Lin, 2017; Guofeng and Xiaoebi, 2018).

DSGE models are practical tools in modern macroeconomic analysis. Although DSGE models are powerful tools for policy analysis and discussions, they still have some limitations

such that they fail to provide a complete description of the economy and suffer from considering the complete interactions in any economy (Tovar, 2009). In this sense, DSGE models have faced several criticisms after the global financial crisis since they are in little use in this period. While these models have increased the understanding of how the economy works in certain areas, it has also generated prejudices and blind spots within the profession which maintain our understanding and ability to manage the macroeconomics (Korinek, 2017). Besides, after the sharp decline in economic activity following the global financial crisis, DSGE models hotly debated since they handled by many central banks to manage their monetary policy decisions. The first group of these criticisms offers DSGE models to be revised and consider frictions, non-linearities, and heterogeneities across economic agents. In contrast, others argue that these models should be abandoned (Linde, 2018).

Based on the above discussions, understanding the way the negative interest rates may affect the broader economy is crucial to take necessary measures for future economic downturns and to solve possible macroeconomic challenges. However, the impact of NIRP on the wider macroeconomy in the bank lending channel framework remains unknown, and there are some areas in the literature with a potential room for contribution. The main aim of this study is to fill this gap by examining the effectiveness of NIRP in stimulating economic activity in Sweden. The Sveriges Riksbank introduced the negative policy rate in February 2015 due to low economic growth and deflationary pressures. Sweden serves an ideal laboratory environment for the analysis of the NIRP for various reasons. First, the Sveriges Riksbank has broken up the zero-lower bound and allowed policy rate to enter the negative territory in many times. Second, the Swedish economy and the banking system offers specific features that negative interest rates work relatively effective. The proportion of deposits in liabilities is relatively smaller in the Swedish banking industry (Eggertsson, 2019).

The first crucial contribution of this paper is to employ a wide range of internal and external variables to examine the dissemination of central bank policy rates and to assess the effect of the monetary policy changes on the economic performance of the Swedish economy. Since the global productivity and output growth have been experiencing ongoing fluctuations, understanding the effectiveness of bank lending channel under the negative interest rate environment is vital to overcome these challenges. So far, however, there has been little

discussion about the effectiveness of bank lending channel in a negative policy rate environment, and very few studies evaluated the performance of the negative interest rate policy in triggering the real economic activity.

The second significant contribution of this study is methodological. This study uses the Factor-Augmented Vector Autoregression (FAVAR) approach incorporated by Bernanke et al., (2005). FAVAR approach is well designed to investigate whether monetary policy innovations are practical when price level and output level are imperfectly observed latent variables (Fernald et al., 2014). This methodology offers some advantages over small-scale vector autoregression (VAR) models. First, the FAVAR methodology exploits all the necessary information from a set of macroeconomic variables, and it offers a data-rich environment that scholars and policymakers benefit from (Bernanke et al., 2005). Second, the inclusion of the large-scale data set of FAVAR estimation significantly reduces the misspecification problem and allows for better identification of the monetary policy changes (Boivin et al., 2009). Third, since the FAVAR models provide indexes and concentrate on large-scale data sets into a small number of factors, they solve possible degrees-of-freedom problems (Bernanke et al., 2005). In this sense, our empirical results offer a comprehensive and reasonable picture of the effectiveness of the NIRP on the economic performance of the Swedish economy.

The last contribution is that the current study extends the FAVAR model by adopting an alternative scenario in which the monetary authority does not set the negative policy rate. The adoption of an alternative scenario allows for assessing the performance of the negative interest rate policy in the Swedish economy in a bank lending channel context. In other words, the study investigates how the Swedish economy might have behaved if the Sveriges Riksbank had not experienced the NIRP.

The limitation of the study is that this study does not engage in the role of various bank characteristics in the effectiveness of the bank lending channel. Thus, it is beyond the scope of this study to analyze whether NIRP operates effectively for banks that have specific characteristics.

The remainder of this study is as follows: The second section describes the conceptual framework of the NIRP and reviews the empirical literature. The third section briefly analyzes the Swedish monetary policy and the banking system. The fourth section introduces the data and methodology. The fifth section presents the empirical findings and discusses these findings. The last section concludes the study.

2.2. Literature Review

2.2.1. The Negative Interest Rate Policy: A Conceptual Framework

Central banks traditionally have been engaging in open market operations, setting a return for the bank reserves in the central bank, and tend to influence interbank market rates and banks' average funding costs to achieve their targets (Angrick and Nemoto, 2017). However, after the onset of the global financial crisis in 2008, several central banks have implemented a set of new tools to combat macroeconomic challenges (Varlik and Berument, 2017). The new set of policy tools also includes a negative policy rate. The NIRP means the charging of the fee for the commercial banks' reserve holdings in central banks. In other words, the central banks levy a tax for hoarding cash. The negative return on reserves in the case of the NIRP is supposed to transmit into other short-term market rates. Central banks then benefit from the transmission of short-term rates to the return of long-term less-liquid assets. Therefore, the theory proposes that NIRP supports central banks to ease financial conditions and stimulate economic activity (Bernanke, 2017).

Central bankers have long argued that the nominal policy rates could not be negative. They believed that economic agents escape from keeping deposits and start to hold cash instead (Jobst and Lin, 2016). However, many countries have faced several challenges during the last decade, such as slow growth rates, deflationary pressures, exchange rate risks, capital inflow pressures, instrument limits. Several central banks have adopted negative policy rates, cut policy rates to negative levels, and thus provide additional monetary accommodation to combat these challenges (Arteta et al., 2016).

In response to these macroeconomic challenges, The Danish National Bank (DNB) first introduced the negative interest policy in July 2012. The primary purpose of the DNB is to discourage capital inflows and reduce the upward pressures on the krone to sustain the peg (Adrian et al., 2017). The European Central Bank followed the DNB and set the policy rate below zero to support previous monetary easing policies. By doing this, ECB aimed at bringing inflation up to ECB's target level (Jobst and Lin, 2016). Similarly, the Swiss National Bank (SNB) turned the policy rate into negative since the Swiss economy confronted with the upward pressures on the franc, low level of economic activity, and deflationary expectations (Jackson, 2015). Since the realized inflation is below the target inflation, and the economic activity is below the potential in Sweden, the Sveriges Riksbank cut repo rate below zero in February 2015 (Arteta et al., 2016). The Bank of Japan started to implement the negative interest rate in January 2016 to provide additional monetary easing and to accelerate inflation (Angrick and Nemoto, 2017).

After the introduction of the NIRP by several central banks, numerous arguments have been put forward for this easing policy tool. Some have argued that central banks benefit from additional monetary and financial easing without bearing the potential costs of the quantitative easing policies (Jackson, 2015). However, opponents have argued that the NIRP creates unintended purposes, increases financial instability, and generates some financial market distortions (Arteta et al., 2016).

In theoretical prospect, the NIRP transmits to real economic activity through bank lending into two main channels (Bottero et al., 2019). These are (a) portfolio rebalancing channel and (b) retail deposits channel.

First, the adoption of the NIRP increases credit supply and triggers real economic activity through portfolio rebalancing channel. This channel says that banks are encouraged to rebalance their portfolios and replace short-term liquid assets with long-term riskier loans when central banks charge a fee for excess reserves (Brunnermeier and Koby, 2017). In other words, negative interest rates allow banks to hold longer-term assets with higher yields (Bottero et al., 2019). In this context, under a specific set of assumptions, banks increase their lending to bank-dependent and riskier firms. These companies are therefore faced with lower

financing costs, which in turn causes significant real effects in any economy (Arseneau, 2017).

There are also some other arguments proposing the efficacy of the bank lending channel in the negative interest rate environment. On the one hand, Claessens (2017) notes that low-interest rates increase capital gains, support asset prices, reduce non-performing loans, and improves banks' performance. Thus, NIRP helps the recovery of real economic activity. Besides, Brunnermeier and Koby (2017) propose that banks can refinance their long-term assets cheaper when central banks cut rates into negative territory, and benefit from the rise in their equity values. They also argue that under the assumption of a perfectly competitive market without frictions, the monetary policy rate transmits to the deposit and loan rates ultimately. The low rates then increase credit growth and stimulate real economic activity. Also, they propose that the resulting increase in the bank profits and the net value feedback into their lending. In this context, Rogoff (2017) states that negative short-term interest rates increase long-term inflation expectations during deep recessions, help to overcome deflationary pressures, stimulate real economic activity, increase equity, and residential prices.

The second channel that the NIRP exerts its effect on the real economy via the banking system is the "retail deposits channel." This channel focuses on the incomplete penetration of the negative policy rates into deposit rates. Heider et al. (2017) notes that banks had no intention of transmitting negative rates to deposits as they were afraid of withdrawal or a bank run. In this sense, banks cannot benefit from the fall of short-term rates if they have a substantial share of deposit funding, and deposit rates are bounded at zero. The critical factor for the bounded deposit rates is cash or paper currency (Rogoff, 2017). When nominal interest rates on safe assets turn to negative, holding cash becomes attractive, as the nominal return rate for holding currency is zero. Thus, further rate cuts become ineffective when economic agents switch their portfolio decisions and start to hold more cash (Heider et al., 2017). Brunnermeier and Koby (2017) named the threshold interest rate at which accommodative monetary policy becomes contractionary as the "reversal rate."

As retail deposit rates are bounded to zero, the NIRP decreases net profit margins for banks to reduce their profits and wears out their capital (Bottero et al., 2019). Several studies

have, therefore, found that negative interest rates often reduce bank profits and lending, which, in effect, negatively affects the economy (Guofeng and Xiaoebi, 2018). Heider et al. (2017) have found that banks that are heavily dependent on deposits cannot benefit from a decrease in their short-term financing costs. Therefore, banks with a higher amount of deposits tend to take more risks. The net interest margin of banks consequently falls, and they cut their lending to meet their capital requirements. Altavilla et al. (2018), however, suggested that banks could mitigate the decrease in net interest margin in the low-interest-rate environment by charging a higher fee for customer services. Similarly, Guofeng and Xiaoebi (2018) indicated that banks may not need deposits in practice and may use loans to make loans.

Bernanke (2017) also highlighted concern about the decline in bank capital due to the decrease in net interest and profit margins. A low-for-long period of the negative interest rates creates a strong incentive for banks to hold more wholesale market funding. Since deposit financing is more concrete and safer than other alternative financing sources, the rise in the share of wholesale funding sources increases the concerns for banks' liquidity requirements (Jobst and Lin, 2017). If banks cut their deposit rates below zero, they might face bank withdrawals and lose their role as a financial intermediary (Guofeng and Xiaoebi, 2018). All these claims seem to have implications for the potential risks of NIRP regarding financial stability.

Another obstacle for the incomplete dissemination of policy rate to deposit rates is about market shares and reputation (Rogoff, 2017). Banks refuse to impose negative deposit rates when there is stiff competition in the banking industry. Moreover, Alsterlind et al. (2015) illustrated that zero-interest-rate is the psychological threshold for downward stickiness of deposit rates since there is a cost asymmetry between banks and the depositors in storing cash.

There are also some other objections and concerns about the NIRP. Jobst and Lin (2017) noted that NIRP delays the collapse of nonviable riskier firms and damages the market demand conditions for healthier firms. Henceforth, this hurts the efficient allocation of factors and delays the corporate restructuring in higher debt overhangs. Arteta et al. (2016) illustrated the spillover effects of the introduction of the negative interest rate policy to emerging countries. They stressed that emerging economies lose some of their potential gains due to the

depreciation of domestic currencies. Lastly, Borio and Hofmann (2017) argued that the transmission of monetary policy actions is weaker in the low-interest-rate environment due to rising disparities in spending behavior.

The number of studies explaining the contextual framework of the NIRP in the literature is quite limited since the adoption of the NIRP is relatively recent. Besides, these studies do not have a consensus. Theoretical explanations in the literature present both potential benefits and the concerns of the use of negative interest rate policy. Therefore, these discussions on the effectiveness of the NIRP call for detailed empirical analysis.

2.2.2. Review of Empirical Studies

Once Bernanke and Blinder (1988) formulate additional propagation mechanisms, namely the bank lending channel, many efforts have been devoted to exploring the performance of monetary policy through this channel for several decades. As a result, an extensive literature has emerged with many empirical studies. Up to the recent global financial crisis, it was a common practice to concentrate on the effectiveness of the bank lending channel in conventional monetary policy settings. After the onset of the recent global financial crisis, many central banks adopted unconventional policy measures and negative interest rate policies. In this context, many studies in the literature have focused on whether the bank lending channel is effective in unconventional policy measures. However, relatively few studies have attempted to reveal to what extent the negative interest rate policies transmit to the banking system and the real economic activity.

In one strand of the literature, well-known earlier studies in conventional monetary policy settings employed bank-level data and concentrated on the role of bank characteristics in monetary transmission. Of them, Bernanke and Blinder (1992) investigated the link between monetary policy changes and bank lending in the United States. They discovered that bank deposits and bank loans declined following monetary contraction. Kashyap and Stein (1995) reported that bank characteristics are significant for the effectiveness of the bank lending channel. They argued that the bank lending channel operates through banks that are vulnerable to reserve drains. Ludvigson (1998) focuses explicitly on the response of

automobile credits and the households' consumption expenditures in the United States. They noticed that the relative share of bank automobile credits declined after the monetary contraction. Besides, they found that the contractionary monetary shock reduced private consumption expenditures.

De Bondt (1999) provided evidence for the existence of the bank lending channel in Belgium, Germany, and the Netherlands. The study reported that small banks and illiquid banks are more sensitive to changes in monetary policy. Similarly, Kashyap and Stein (2000) favored the role of balance sheet liquidity. They also found that government securities in bank assets play an important role in monetary policy transmission. In the same context, Favero et al. (1999) verified that the source of heterogeneity across the bank's response to monetary policy changes is related to bank reserves.

In the case of Japan, Ford et al. (2003) highlighted the significant role of small banks and small firms in the bank lending channel mechanism. Furthermore, Gambacorta (2005) has shown that after the monetary contraction, the less capitalized banks fail to protect the deposit drains in Italy. Das (2015) offered evidence for an asymmetric pass-through of policy rates to bank lending rates in India. The study showed that the bank's lending rate responds more quickly to monetary contraction periods. Khan et al. (2016) showed possible links in ASEAN countries between the structure of banking industries and the effectiveness of the bank lending channel.

Another strand of the literature deals with firm-level data. Employing the aggregated firm balance sheet data, Kashyap et al. (1993) confirmed that the monetary contraction alters the composition of the firms' external funding on behalf of the share of commercial papers in financing mix. Accordingly, the empirical results of the study are in line with the bank lending channel proposition. Huang (2003) also favors the role of bank-dependent firms for an active bank lending channel in the UK. His study concluded that the relative share of the bank-debt in the firm's balance sheets declines after monetary contraction.

The other part of the literature analyzed the efficacy of the bank lending channel during the recent global financial crisis period. These studies focused specifically on the impact of

unconventional monetary policies. Of these studies, Marquez-Ibanez and Gambacorta (2011) reported the significant role of short-term funding and loan securitization in 14 EU countries and the US. They have also shown that banks with a low core-capital ratio, a high level of market funding, and relatively higher non-interest income significantly reduce their loan supply. Similarly, Albertazzi et al. (2016) stated that the role of bank capital and the value of sovereign assets are the main drivers of successful monetary transmission in Euro Zone countries.

In an international case, Xu and La (2016) investigated the spillover effects of US unconventional monetary policies on emerging Asian countries and provided empirical support for the international bank lending channel. They illustrated that the quantitative easing in the United States significantly increased credit flows to emerging Asian firms. They also found that credit inflows are different among firms with different characteristics. In a similar context, the international bank loan channel was also supported by evidence from Grab and Zochowski (2017). They illustrated that the spillover effects of the US quantitative easing are more robust for more liquidity constrained and domestic market dependent Euro Zone banks. Heryan and Tzeremes (2017) suggested that liquidity injection after the global financial crisis would render EU countries more vulnerable to changes in interest rates, which in turn would improve monetary transmission performance. More recently, Chakraborty et al. (2019) aimed at examining the significant effects of quantitative easing purchases in the United States. They found that banks that benefit from the mortgage-based security purchases cut their commercial lending, which in turn decreases investment spending. However, the effect of government security purchases on real economic activity tends to be less significant.

The last strand of the literature focused on the bank lending channel in a negative interest rate environment. Several studies have concentrated on the transmission of central bank policy rates to deposit and lending rates. Relatively few efforts, however, have been dedicated to studying the macroeconomic effects of negative central bank rates.

Of these analyses, Apergis and Christou (2015) highlighted European banks' nonlinear reaction to the monetary policy changes. They showed that bank credits lose momentum in the low-interest-rate era, and changes in monetary policy fail to affect demand, investment, and

real economic activity. Bech and Malkhozov (2016) argued that negative policy rates have transmitted to money market rates in much the same way as positive rates. However, deposit rates seem to be bounded when central banks go into negative rates in Denmark, Euro Area, Sweden, and Switzerland.

Arseneau (2017) characterized the degree of profitability of US banks under hypothetical negative interest rate policies. The study showed that the main driver of bank-wide heterogeneity concerning profitability is the provision of liquidity. Brunnermeier and Koby (2017) provided evidence that the lower effective bound is not inherently zero, and it could theoretically be negative. They proposed a threshold level interest rate and called it as a reversal rate. They argued that the reversal rate is a rate at which accommodative monetary policy becomes contractionary. Claessens et al. (2017) demonstrated that the interest margins, productivity, and capital requirements of banks are negatively affected by the low interest rate regimes. Their results are also robust when controlling for the various bank characteristics.

Jobst and Lin (2016) introduced a DSGE model in the case of the euro area. They argued that banks benefit from asset valuations while suffering from falling net interest margins during negative interest rate periods. However, they found that the latter overweighs the former, and banks experience a decline in their profitability. By employing a difference-in-difference approach, Heider et al. (2017) analyzed the risk-taking behavior of banks in a negative interest rate setting. They identified bank and borrower characteristics. They showed that banks relying on deposit finance increase their lending to risky borrowers. They also reported that high-deposit banks are more aggressive when the policy rate is negative than low-deposit banks. Demiralp et al. (2017) compiled a bank-level dataset for the Euro Zone to examine how bank behavior changes when the ECB policy rate is in negative territory. They concentrated on banks' loan supply, security holdings, and their adjustment to wholesale funding. They constructed a dynamic panel data model and discovered that in a negative policy rate period, banks increase their lending and non-government security holdings. At the same time, they reduce the level of wholesale funding. Recently, Basten and Mariathan (2018) found that bank profitability in Switzerland remains unaffected as banks compensate for the decline in the net interest margin by charging higher fees and bearing more risks. They also stressed that banks face higher liquidity and interest rate risk because of portfolio

rebalancing as banks substitute central bank reserves with riskier loans and financial assets.

In the Italian case, Bottero et al. (2019) reported that banks decrease their liquid assets while increasing their loan supply to constrained firms as monetary authority goes into negative. Access to bank loans thus promotes investment expenditures and stimulates real economic activity. Amzallag et al. (2019) specifically focused on Italian mortgages and considered the rate-setting actions of banks during a negative rate period. They found that banks with relatively high overnight retail deposits charge higher interest rates on fixed-rate mortgages. In contrast, the rate-setting behavior for adjustable mortgages through banks with different overnight deposits does not change.

More recently, Eggertsson et al. (2019) developed a macro-model and investigated the impact of negative interest rate policy on the banking system in Sweden. They found that bank deposit rates were bounded to zero, and bank lending rates rose marginally after the policy on negative interest rates had been implemented. The study showed that Swedish banks relying on higher deposit lending have relatively low credit growth rates.

There is a limited number of studies concentrating on the detailed picture of the effects of negative interest rate policy. Eggertsson et al. (2017) constructed a macro model for Sweden. They reported that when policy rates turn to negative, the propagation of central bank rates to loan rates and deposit rates failed. Besides, the decrease in bank profitability has possible contractionary effects on production. Guofeng and Xiaobei (2018) developed a DSGE model to express to what extent the zero-lower bound affects the deposit rates in the Euro Zone and Japan. Their simulation results showed that monetary transmission is, in part, successful in economic activity, since when the policy rate is negative, the transition to banking rates is not complete.

At this moment, the existing literature does not seem to fully present (i) convincing evidence for the efficacy of the bank lending channel in negative central bank policy rate environment and (ii) the benefits associated with the adoption of the negative interest rate policy to the real economic activity and the overall macroeconomy. In this context, the literature calls for studies clarifying the role of negative interest rate policy to combat significant macroeconomic challenges in the bank lending channel framework. As a result of

this, the current study evaluates the effectiveness of negative interest rate policy in a broader context benefitting from the apparent advantages of the FAVAR methodology and scenario analysis.

2.3. The Swedish Banking System and Negative Interest Rates

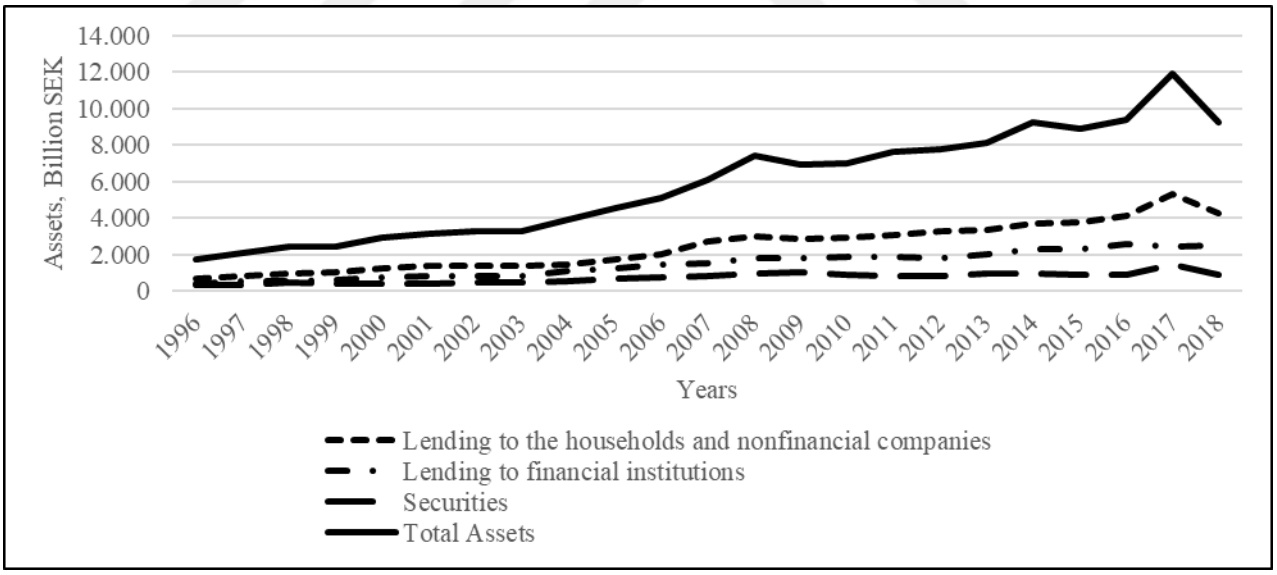
After the onset of the global financial crisis, the Sveriges Riksbank started to implement a series of policy measures to reduce the costs of the crisis. First, the Sveriges Riksbank had cut the policy rate massively below one percent up to mid-2009. Since the economic activity had not been triggered and GDP continued to fall at the beginning of 2009, Riksbank took a series of unconventional measures. To illustrate, Riksbank offered a loan in longer maturities to banks, accelerated corporate financing through accepting commercial paper as collateral, and offered emergency liquidity assistance to some banks that were not financially strong (Berg et al., 2018).

In the upcoming years, the policy rate in Sweden fluctuated around two percent and fell significantly to zero percent at the end of 2014. Persistently low inflation expectations were the main drivers of the low inflation rates in Sweden in these years. In subsequent periods, the ongoing fall of the inflation expectations forced Sveriges Riksbank to adopt a negative policy rate in February 2015. It is also worth to mention that the negative interest rate policy is used in combination with the unconventional domestic quantitative easing (asset purchase programs) measures (Jobst and Lin, 2016). In February 2015, Sveriges Riksbank began to apply negative interest rate policy and lowered policy rates in negative territory several times.

In the case of Sweden, the Sveriges Riksbank runs a corridor system. In this system, the central bank sets a policy rate, which is the repo rate representing the interest rate that banks get for the transaction holdings at the central bank. Banks that keep reserves at Sveriges Riksbank earn an interest rate that is 0.75 points below the policy rate, and banks borrow from the Riksbank 0.75 points above the policy rate. Since Swedish banks use their reserves in repo transactions with Sveriges Riksbank, the repo rate directly equals the rate that the Riksbank pays to the reserve holdings of banks (Eggertsson et al., 2019).

The Swedish financial system constitutes of four types of monetary financial institutions: Banks, housing credit institutions, financing companies, and other monetary financial institutions. The data from Statistics Sweden (2019) displays that in May 2019, banks comprised 67 percent of total assets and are the largest group in terms of total assets in Sweden. Besides, housing credit institutions and finance companies encompass 25 percent and 2 percent of the total assets, respectively, among monetary financial institutions. On the other hand, in May 2019, the Swedish banking system constituted a total of 124 banks in four categories: 39 commercial banks, 36 foreign banks, 47 savings banks, and two co-operative banks.

Before examining the policy rate transmission into bank lending and deposit rates, the study first starts by considering the balance sheet structure in the banking sector. Figure 2.1 reports the historical decomposition of the total assets in the Swedish banking sector.



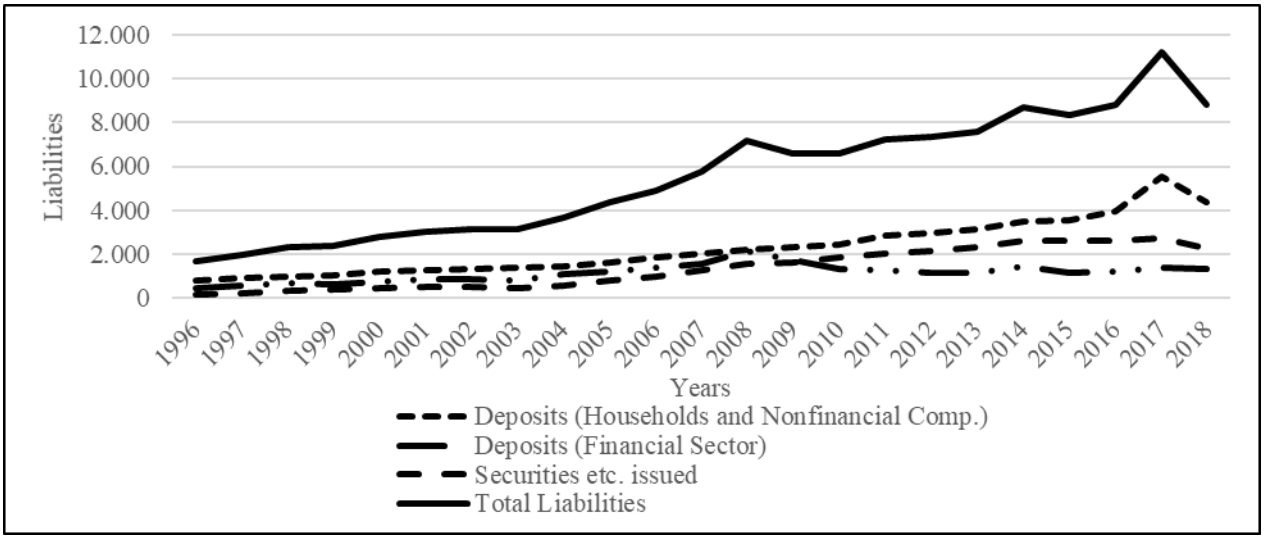
Source: Statistics Sweden

Figure 2.1. Total assets in the Swedish banking sector (billion, SEK).

Figure 2.1 shows that the main component of total assets is lending to households and nonfinancial companies (lending to the public) in the Swedish banking sector. In 2018, bank lending to public accounts for 46 percent of total assets. Lending to financial institutions and

holdings of securities constitute 27 percent and 10 percent of total assets, respectively. The share of lending to the public in total assets steadily increases and reaches about half of the total assets in 2018 while the share of securities declines. It seems that banks perform their core business and finance public rather than holding less-liquid securities.

The other main component of the bank balance sheet is the liabilities. The composition of bank liabilities in the Swedish banking sector was illustrated in Figure 2.2.



Source: Statistics Sweden

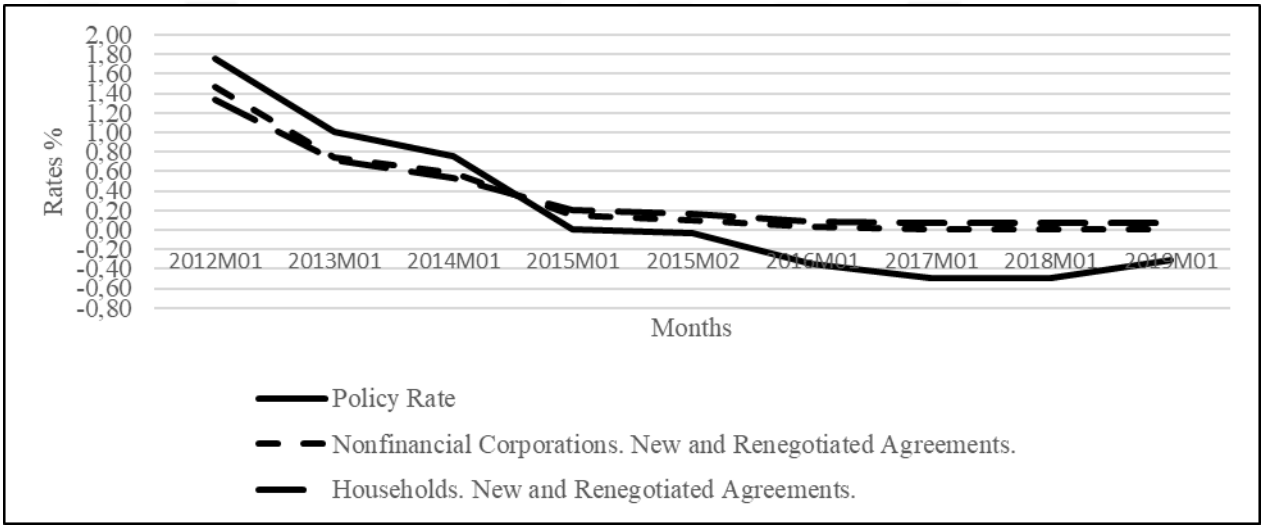
Figure 2.2. Total liabilities in the Swedish banking sector (billion SEK)

Figure 2.2 suggests that deposits are the main component of the liabilities in a given period. Deposits from households and nonfinancial companies were about half of the total liabilities in 2018. Besides, deposits from the financial sector constituted 15 percent of the liabilities. Before 2008, the level of deposits from the financial sector gradually increased. After 2008, the nominal deposits from the financial sector (i.e., interbank borrowing) started to fluctuate.

On the other hand, the share of the issued securities increased steadily and reached 25 percent of total liabilities. In this context, it is seen that (a) the primary financing source of the Swedish banks is the deposits and accounts for approximately 50 percent of the total

liabilities, and (b) Swedish banks tend to borrow from the public by issuing debt securities recently. In short, although banks have not shifted away from deposit financing, the structure of the total liabilities is about to change in time since banks have been issuing more securities.

Since the bank lending channel is active if the policy rate transmits to the banks' deposit and lending rates, the study next considers whether the deposit rates and the lending rates move closely with the policy rate. Figure 2.3 depicts the deposit rates and policy rate in Sweden.

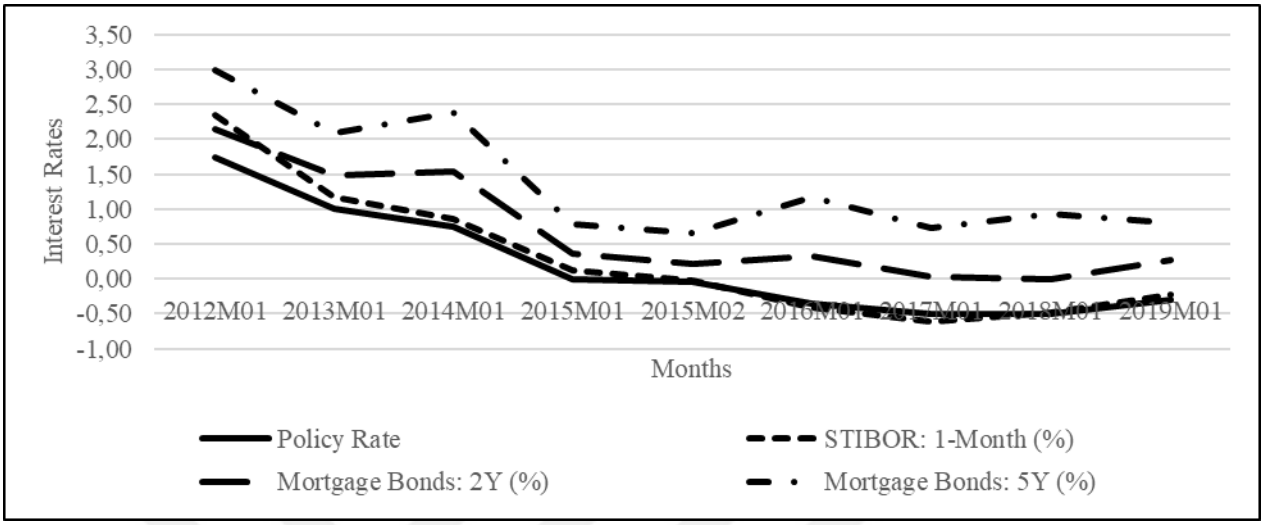


Source: Sveriges Riksbank

Figure 2.3. Deposit rates and policy rate (%)

Figure 2.3 displays that until the policy rate turns to the negative (until February 2015), deposit rates fall below the policy rate and moves firmly with the policy rate. After policy rate cuts through the zero bound. However, the deposit rates seem to be bounded at zero percent level, and there is no clear evidence for the breakdown of the transmission of the policy rate to deposit rates. Therefore, one cannot conclude that the responsiveness of the deposit rates to the policy rate to be muted in the negative interest rate environment from Figure 2.3.

As it is seen in Figure 2.2, interbank borrowing and bond issuance are the alternative sources of borrowing in the banking sector. In this sense, Figure 2.4 illustrates the relationship between the policy rate and interest rates of the alternative forms of bank liabilities.

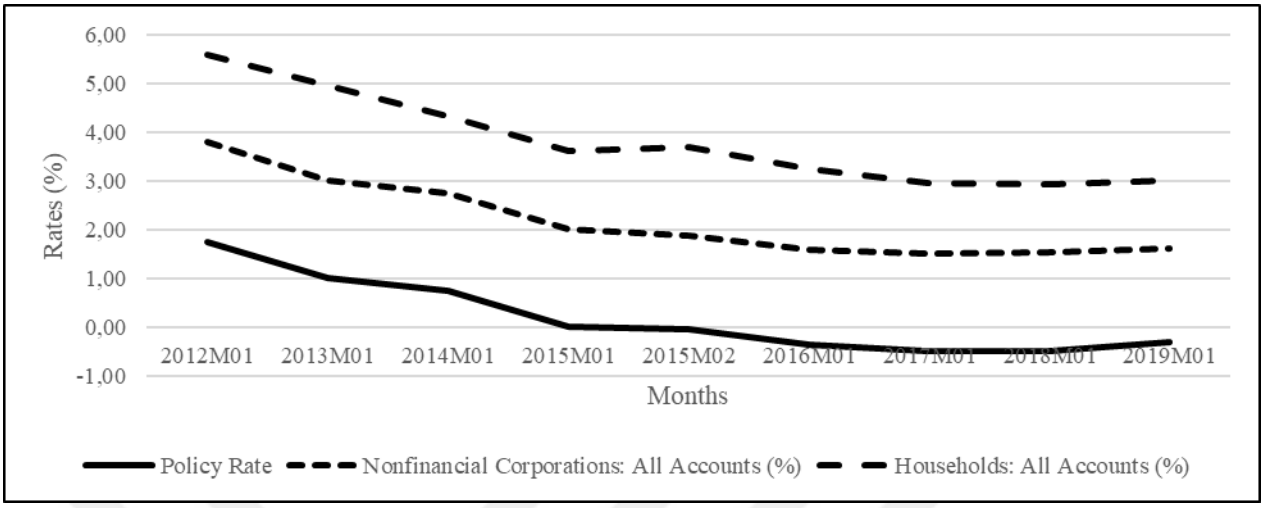


Source: Sveriges Riksbank

Figure 2.4. The interest rate for other financing sources and policy rate (%)

Figure 2.4 shows that STIBOR (interbank rate) goes in hand and fluctuates around the policy rate in a given period irrespective of the movement in the policy rate. In other words, the transmission of the policy rate to interbank interest rates is somewhat higher among other forms of bank liabilities in both positive and negative policy rate periods. However, the 2-Year Mortgage Bonds rate seems to be bounded at somewhere close to zero. On the other hand, the gap between the policy rate and the 5-Year Mortgage Bonds seems to be wider than other instruments due to the maturity premium. In this context, there is no clear evidence that banks decrease their financing costs by shifting away from deposit financing.

In this section, the study considers the policy rate transmission into lending rates. Figure 2.5 illustrates the relationship between the policy rate and the lending rates in Sweden.



Source: Sveriges Riksbank

Figure 2.5. Lending rates and policy Rate (%)

Figure 2.5 reports that the average lending rate in household loans is higher than those of nonfinancial corporations. It is also seen that the policy rate transmits into lending rates accurately. Figure 2.5 also highlights that the correlation between the policy rate and the lending rates are smoother than the link between the policy rate and deposit rates.

This section of the study provides an overview of the Swedish banking sector during the implementation of positive and negative policy rate regimes. It is shown that (a) although the deposit rates are bounded somewhere close to zero percent while the policy rate in negative territory, deposits are still the main component of bank liabilities, (b) interbank borrowing falls while banks tend to issue more securities over time, and (c) the policy rate transmits into lending rates properly following the monetary expansion in both interest rate settings.

2.4. Methodology and Data

2.4.1. Methodology

The VAR models provide a reasonable measure for the performance of the monetary policy shocks over the key macroeconomic variables and have widely used for empirical analysis (Bernanke et al., 2005). However, small-scale VAR models have several problems. The first criticism is the low dimensionality of the small-scale VAR models to identify the monetary shocks. They usually employ limited variables due to the concerns of the degrees of freedom, while central banks follow a large data series to announce their policy rate decision (Karagedikli et al., 2013). Thus, the standard VAR analysis cannot fully incorporate the information handled by central banks and other economic agents, which in turn creates a problem for the identification of the monetary policy innovations (Bernanke et al., 2005).

The second criticism is also related to the use of limited information in standard VAR models. The unique variable employed in the small-scale VAR models is not able to accurately exhibit their theoretical counterparts (An et al., 2014). In other words, the small-scale VAR models are highly sensitive to ad hoc decisions in selecting the variables (Fernald et al., 2014). The third criticism is that the standard VAR models provide impulse responses for those limited number of variables included in the analysis (Gupta et al., 2010).

Nonetheless, the empirical strategy of this study is based on the factor augmented vector autoregressive (FAVAR) model. Bernanke et al. (2005) proposed that the FAVAR approach merges the standard vector autoregression (VAR) model and the dynamic factor analysis. The dynamic factor analysis transforms many series into a few factors. The FAVAR model exploits all necessary information from a large data set, and it is constructed to decompose the series into a common and specific component (Karagedikli et al., 2009).

To explore the effects of monetary policy innovations, FAVAR models have several advantages over standard VARs. First, a FAVAR model with many variables solves the low dimension problem, dramatically reduces the risk of misspecification, and ensures the accuracy of estimates (Boivin et al., 2009). Second, FAVAR models with a large number of

variables convey the relevant information and allow factors to be a proxy for their theoretical counterpart (Fernald et al., 2014). Third, since the FAVAR model does not require to have the exact measure of the single variable (i.e., real economic activity, price level), this framework provides better identification of the monetary policy shocks than conventional VAR models (Bernanke et al., 2005). As such, the FAVAR methodology is well suited to overcome the problems faced with standard VAR models.

The FAVAR model constructed in this study follows the two-step principal component approach proposed by Stock and Watson (2002), and the model handles the general setup of Bernanke et al. (2005). Their model uses observable variables and a set of unobservable common factors. The current study extended this analysis and included the number of external variables since the Swedish economy is affected by global shocks. In this context, this study proposes that the FAVAR model is characterized by (a) one observable variable, namely the Sveriges Riksbank policy rate, which is the common component of all variables included in the dataset, (b) a set of unobserved factors, that are extracted from a large number of variables, and (c) a set of external variables that are of significance in setting the policy rates and significantly affect the domestic variables in the Swedish economy.

To incorporate these features, assume that the X_t be an *Nx1* vector of information variables, *Rt* is the observable policy rate series, and the F_t is the *n*x1 vector of unobservable common factors extracted from the set of information variables and measures most of the variability in X_t. In this context, the FAVAR model can be represented as follows (Bernanke et al. 2005):

$$\begin{bmatrix} F_t \\ R_t \end{bmatrix} = A(L) \begin{bmatrix} F_{t-1} \\ R_{t-1} \end{bmatrix} + \vartheta_t \qquad (2.1)$$

Here, $A(L)$ is the lag polynomial of order d, $A(.), A_i(i = 1, \dots, d)$, and $A(L) = I - A_1 L - \cdots - A_d L^d$ where L stands for the lag operator, and I is the identity matrix.

However, the problem here is that since the factors are unobserved, then the estimation of the Equation (1) with standard estimation procedures (i.e., ordinary least squares method) provides biased parameters (Gupta et al. 2010). Thus, the solution for the proper estimation is that the use of factor analysis proposed by Stock and Watson (1998). Here, unobservable

factors, F_t, and the policy rate, R_t, conveys the powers that account for the state of the economy and the policy rate setting. In other words, F_t and R_t capture the dynamic feature of the economy (Varlik and Berument, 2017).

The equation system for the *Xt* is displayed as follows:

$$X_t = \Lambda^f F_t + \Lambda^r R_t + e_t \tag{2.2}$$

where X_t is an *Nx1* vector of observable variables except for the policy rate, Λ^f represents the *NxK* factor loading matrix, the Λ^r is the *Nx1* coefficient matrix of the observable policy rate variable, and e_t is an *Nx1* vector of disturbances with zero mean and idiosyncratic disturbances.

Since a set of variables such as industrial production indexes and price indexes react slowly to the monetary policy innovations theoretically (Christiano et al., 1999), the current study follows Bernanke et al. (2005) and defines the set of X_t as the "slow-moving" and "fast-moving" variables. In this sense, the slow-moving variables do not respond contemporaneously to the monetary policy innovations while the fast-moving variables react contemporaneously. The study follows Bernanke et al. (2005) to classify the variables. The description of variables was displayed in Table 7.1 in the Appendix.

The current study handles a Cholesky identification, and the unobservable factors are ordered before the policy rate. In other words, this study assumes that the policy rate responds to the unobservable factors contemporaneously but not vice versa. However, factors extracted from the information variables include some variables that react contemporaneously to the policy rate changes and violates the priori ordering assumption. Therefore, following Bernanke et al. (2005) and Karagedikli et al. (2013), this study rotates the information variables against the policy rate variable to transform the factors free of the contemporaneous responses. Finally, the ordering becomes plausible and eliminates the theoretical concerns.

Following the general set up of the Bernanke et al. (2005) and similar to that of Karagedikli et al. (2013), the empirical part of this study follows the steps below:

The study:

- Gets the principal components (F_0) from the standardized information variables (X_t).
- Extracts the slow-moving components (F_s) from the slow-moving variables (X_{slow}).
- Regresses F_0 on Fs and interest rate and obtain F_n by making the residual series.
- Gets the factor loadings Λ^f and the coefficient matrix Λ^r by regressing X_t on F_n.
- Estimates a VAR incorporating F_n, the policy rate, and external variables and
- calculating the impulse-responses.
- Utilizes the Λ^f and Λ^r and the impulse-responses calculating the impulse-responses for all information variables.
- Uses the bootstrapped critical values to evaluate the significance of the impulse-responses.

Following these steps, the next section of this study presents the empirical findings and provides a discussion for such findings.

2.4.2. Data

This study employs a balanced set of 154 variables. One hundred fifty-one of these variables are information variables on the Swedish economy, while the three of them are external variables. The dataset contains monthly series spanning the period throughout 2010:01 and 2019:04. Notably, the sample period of this study starts with a rather smooth period of macroeconomic indicators after the onset of the global financial crisis. The information variables, labeled as X_t, cover series for economic activity, consumption, employment, price indexes, exchange rates, stock prices, foreign trade, monetary aggregates, and banking sector. The only observable variable is the policy rate of the Sveriges Riksbank and represented as R_t. Since the Swedish economy might be affected by global factors, external variables are also included to incorporate the global conditions into the analysis. The external variables are Brent oil prices, ECB policy rate, and Federal Funds Rate. Statistics Sweden, Thomson Reuters Eikon, and the Sveriges Riksbank are the sources for this broad-spectrum dataset. Much of these variables (seasonal change, variations, and log-differences)

are transformed for study. Descriptions of all the series in the dataset, their acronyms, transformations, and data sources were given in Table 7.1 of Appendix A.

2.5. Empirical Results and Discussion

This section illustrates the empirical findings of the study. The study handles the two-step principal component approach to specify the model. In the first step, the number of factors is needed to be defined. Then, in the second step, the study executes the FAVAR estimation and reports the impulse-response functions of the selected variables. Thus, in subsequent sections, the study illustrates the factor estimation results and displays the impulse-response results.

2.5.1. Factor Estimation

The study uses principal component analysis to determine the number of factors for the set of information variables. Table 2.1 reports the number of principal components and the cumulative variance share for each number of factors.

Table 2.1. Determination of the number of factors

Number	Value	Difference	Proportion	Cumulative Value	Cumulative Proportion
1	22.519	12.695	0.150	22.519	0.150
2	9.824	0.896	0.066	32.343	0.216
3	8.927	1.014	0.060	41.270	0.275
4	7.913	0.628	0.053	49.183	0.328
5	7.285	0.814	0.049	56.468	0.377
6	**6.471**	**0.988**	**0.043**	**62.939**	**0.420**
7	5.483	0.643	0.037	68.422	0.456
8	4.840	0.578	0.032	73.262	0.488
9	4.262	0.109	0.028	77.524	0.517
10	4.153	0.476	0.028	81.677	0.545
11	3.677	0.105	0.025	85.354	0.569
12	3.572	0.381	0.024	88.926	0.593
13	3.191	0.362	0.021	92.118	0.614

Note: Principal components are computed using ordinary correlations.

Table 2.1 displays that the principal component analysis suggests six factors for 151 information variables. Besides, these six factors account for 42% of the total variation in the information variables. The existing literature also exhibits that the share of total variance explained by the selected number of factors is around 40% (Karagedikli et al. 2013; Potjagailo, 2017). Thus, based on these findings, the study includes six factors for the FAVAR specification for two reasons: First, extra factors provide few additions to the explained variance. Second, the study aims to provide a parsimonious model.

Since these six factors do not exhibit clear and concise distinction, the study does not provide specific economic interpretation for them. Table 2.2 tabulates the share of the explained variance of the five highly correlated information variables for each latent factor.

Table 2.2. Explained variances by each factor

Series Name	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6
Industrial production index					**0.41**	
Manufacturing production index					**0.39**	
Industrial Production: intermediate goods industry					**0.30**	
Industrial Production: capital goods industry					**0.28**	
Industrial Production: engineering industry					**0.38**	
Hours Worked: Education	**0.51**					
Hours Worked: Total	**0.54**					
CNY China, yuan renminbi			**0.43**			
GBP Great Britain, Pound			**0.39**			
KRW South Korea, Won			**0.43**			
USD US, dollar			**0.40**			
Swedish TCW index			**0.55**			
OMX STOCKHOLM 30 (OMXS30)				**0.50**		
OMX STOCKHOLM (OMXS)				**0.51**		
NASDAQ OMX Stockholm Banks				**0.35**		
NASDAQ OMX Stockholm Financial Services				**0.47**		
NASDAQ OMX Stockholm Industrials				**0.42**		
Total imports		**0.67**				
Total exports		**0.79**				
Imports: Manufactured goods		**0.64**				
Exports: Manufactured goods		**0.62**				
Exports: Machinery and transport equipment		**0.69**				

Swedish Government Bonds: 2Y	**0.51**		
Swedish Government Bonds: 5Y	**0.56**		
Swedish Government Bonds: 10Y	**0.58**		
Total assets(Current Prices)			**0.56**
Total liabilities and equity(Current Prices)			**0.56**
Deposits, Total(Current Prices)			**0.47**
Debt securities issued(Current Prices)			**0.47**
Money market papers, Issued(Current Prices)			**0.46**

Table 2.2 displays that the first factor is highly correlated with the interest rate and hours worked variables. The fraction of the explained variances lies in the range of 50-60 percent for the first factor. The share of explained variances of the second factor is strongly correlated with the foreign trade variables. The second factor explains 79 percent and 67 percent of the total variation in total exports and total imports, respectively.

The third factor seems to be highly correlated with the exchange rate variables. The share of explained variance of the Swedish TCW index (effective exchange rate) by the second factor is 55 percent. The fourth factor is favorably correlated with the stock market variables. The share of the explained variance of the Swedish stock market index is 51 percent. The fifth factor seems to be related to the level of economic activity. The share of the explained variance by the fourth factor is about 40 percent for the industrial production series. Finally, the sixth factors seem to be related to the bank balance sheet variables. Thus, these factors may describe bank behaviors.

Other than the share of the explained variance by each factor separately, the study also reveals the fraction of the explained variance in some key information variables by an estimated six factors.[1] Table 2.3 reports the estimated R-squared values for some selected information variables.

[1] Explained variance for all variables are available upon request.

Table 2.3. Explained variances of the selected variables by all factors

Group	Series Name	Explained Variance (R^2)
Economic Activity	Industrial production index (2015=100, SA)	0.69
Economic Activity	Manufacturing production index (2015=100, SA)	0.69
Economic Activity	Industrial Production: intermediate goods industry (2015=100, SA)	0.55
Economic Activity	Turnover in Industry: Domestic market (2015=100, SA)	0.65
Economic Activity	Turnover in Industry: Domestic market: Manufacturing Industry (2015=100, SA)	0.67
Consumption	Household Consumption (Fixed prices, SA)	0.10
Employment	Unemployment Rate (15-74 Yrs.)	0.10
Price Indexes	Consumer Price Index (CPI), Total, Shadow Index numbers, 1980=100	0.25
Price Indexes	Core Consumer Price Index, Index, 2010 = 100. (2010=100)	0.30
Price Indexes	Producer Price Index (PPI), Total, 2015=100	0.26
Exchange Rates	CNY China, yuan renminbi	0.62
Exchange Rates	DKK Denmark, krone	0.51
Exchange Rates	EUR Euroland, euro	0.51
Exchange Rates	USD US, dollar	0.62
Exchange Rates	Swedish TCW index	0.77
Stock Prices	OMX Stockholm 30 (OMXS30) - Index	0.82
Stock Prices	OMX Stockholm (OMXS) - Index	0.82
Foreign Trade	Total imports	0.76
Foreign Trade	Total exports	0.87
Foreign Trade	Net Trade of goods	0.23
Foreign Trade	Imports: Manufactured goods classif. by material	0.70
Foreign Trade	Exports: Machinery and transport equipment	0.78
Confidence Indicators	Consumer Confidence Indicator	0.21
Confidence Indicators	Total Industry Confidence Indicator	0.16
Interest Rates	STIBOR: 1-Month	0.27
Interest Rates	Swedish Treasury Bills: 1-Month	0.31
Interest Rates	Swedish Government Bonds: 10Y	0.64
Interest Rates	Mortgage Bonds: 5Y	0.54
Interest Rates	Bank Lending Rates: Nonfinancial Corporations. New and Renegotiated Agreements. All Accounts	0.20
Interest Rates	Bank Lending Rates: Households. New and Renegotiated Agreements. All Accounts	0.26
Interest Rates	Banks' Deposit Rates. Nonfinancial Corporations. Outstanding Agreements. All Accounts.	0.21
Interest Rates	Banks' Deposit Rates. Households. Outstanding Agreements. All Accounts.	0.19
Interest Rates	Interest Rate Spread (1to5-year lending to nonfinancial firms minus Swedish Govt Bonds 5Y)	0.18
Interest Rates	NIM: Nonfinancial firms	0.17
Interest Rates	NIM: Households	0.32
Banking Sector	Total assets(Current Prices)	0.92

Group	Series Name	Explained Variance (R^2)
Banking Sector	Lending, Total(Current Prices)	0.70
Banking Sector	Total liabilities and equity(Current Prices)	0.92
Banking Sector	Deposits, Total(Current Prices)	0.85
Banking Sector	Deposits, Swe, Non-financial corporations(Current Prices)	0.11
Banking Sector	Deposits, Swe, Households(Current Prices)	0.24
Banking Sector	Debt securities issued(Current Prices)	0.69
Banking Sector	Money market papers, Issued(Current Prices)	0.61

Table 2.3 displays that the estimated six factors have quite reliable explanatory power for some of these essential information variables. For these variables, the share of the explained variance lies in the range of 1 percent and 92 percent. Among the groups, the highest R-squared values are observed in the set of Banking Sector and Foreign Trade variables. Of the banking sector variables, overall factors explain 92 percent of the total variation in total assets and the total liabilities and equity. Among the set of foreign trade variables, the R-squared value for the total exports and total imports series is 87 percent and 76 percent, respectively.

The explanatory power of estimated factors is also reliable for the economic activity and stock market variables. In these groups, overall factors explain more than 60 percent of the total variation in each selected key variable. The R-squared values for the exchange rate variables are also reasonably high. The factors explain 77 percent of the total variation for the Swedish TCW index, and the R-squared value for the exchange rates of several currencies against Swedish Krone is more than 50 percent. The explanatory power of overall factors is also reasonably well for the interest rates. The fraction of the interest rate variation explained by the factors is between 17 and 64 percent. However, the R-squared value for the consumer confidence, employment, and unemployment rate and net trade of goods is not driven by common factors; instead, they are accelerated by the idiosyncratic elements. Therefore, one may infer that a great deal of crucial variables has common factors and are not driven by the idiosyncratic elements.

2.5.2. Impulse Responses

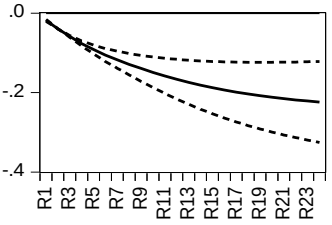
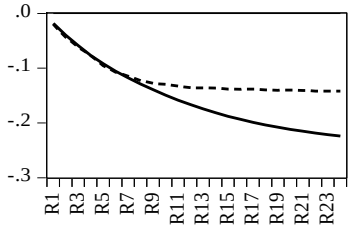
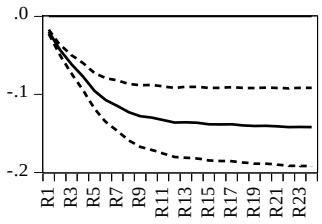
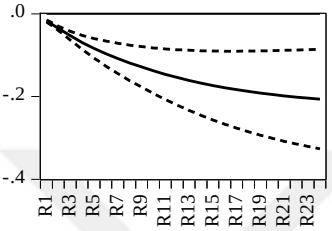
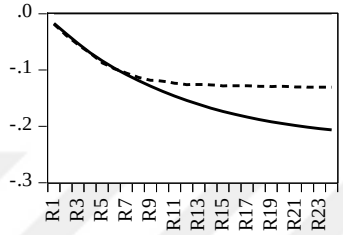
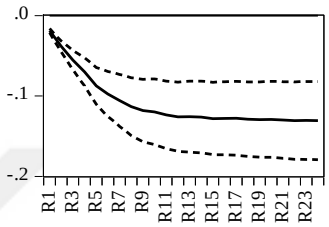
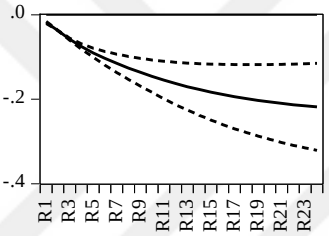
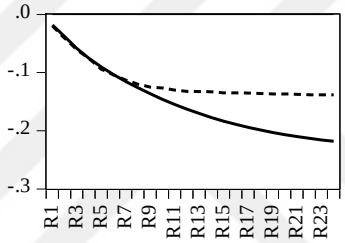
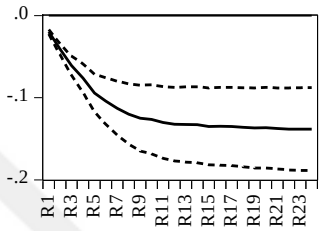
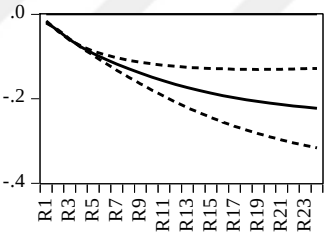
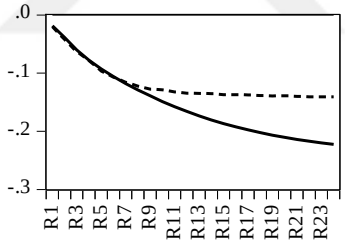
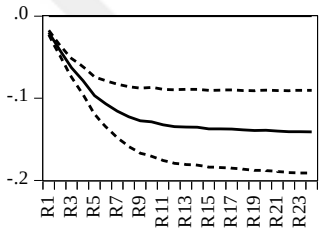
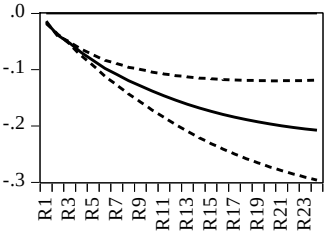
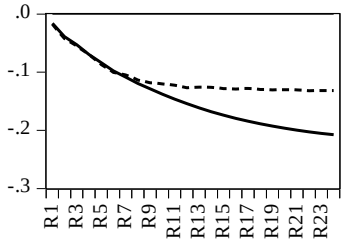
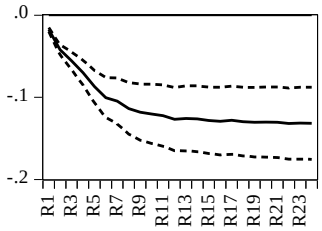
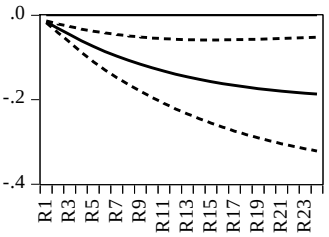
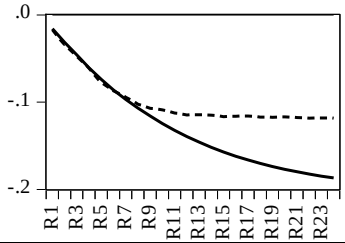
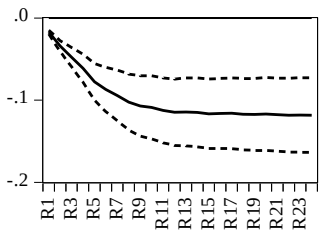
This section examines the transmission of the policy rate to the bank and market interest rates. It discusses the responses of selected information variables to a monetary policy shock in the Swedish economy. The study mainly concentrates on the responses of the following set of variables: bank interest rates, bank balance sheet variables, market interest rates, economic activity, employment and price indexes, exchange rate, and foreign trade variables.

The study compares the responses of the baseline FAVAR model with these of an alternative scenario FAVAR model. As it is noted, the scenario FAVAR model assumes that the Sveriges Riksbank does not set policy rates into negative territory and keeps the policy at zero since February 2015. Thus, the study analyzes how the Swedish economy might have performed if the Sveriges Riksbank had not experienced the NIRP.

Figures 2.6 to 2.10 display the cumulative impulse response results of the set of variables when a negative 0.25 percentage point (25 basis point) shock (expansionary monetary policy shock) is given to a Bank of Sweden Policy Rate up to 24 months. Although the VAR specification offers two lags as optimal, we used three lags to get rid of the autocorrelation problem.[2] In Figures 2.6 to 2.10, the left panel displays the baseline FAVAR model, the right panel displays the scenario FAVAR model, and the middle panel tabulates the comparison of these two models. In the left and right panels, the thick line shows the responses while the dashed lines represent the two-standard deviation confidence intervals. In the middle panel, the thick line reports the responses in the baseline FAVAR model. In contrast, the dotted line displays the responses of the variables in the case of a scenario FAVAR model.

First, the study analyzes the transmission of policy rates into bank interest rates. For this purpose, Figure 2.6 reports the impulse responses of bank interest rates when a negative 0.25 percentage point shock is given to the policy rate.

[2] Diagnostic tests results were displayed in the Appendix A in Table 7.2, and Figure 7.1.

Variables	Baseline	Baseline vs. Scenario	Scenario
BLRates_NF			
BLRates_H			
BDRates_NF			
BDRates_H			
NIM_NF			
NIM_H			

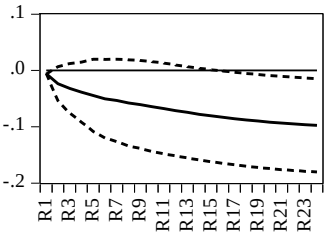
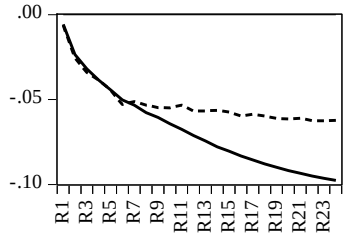
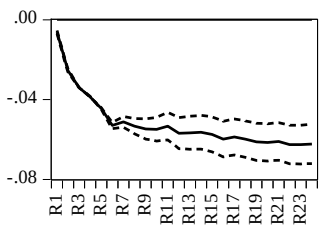
Variables	Baseline	Baseline vs. Scenario	Scenario
SPREAD			

Figure 2.6. Estimated impulse responses of bank interest rates

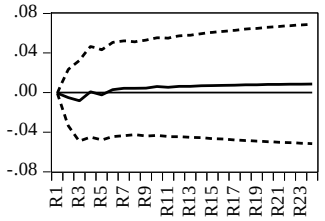
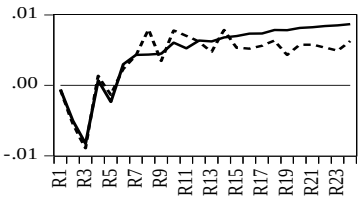
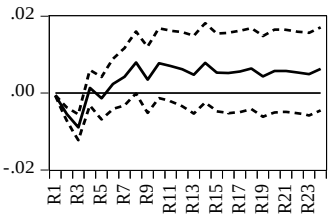
The first four rows of Figure 2.6 show that a negative 0.25 percentage point shock seems to have a significant influence on lending and deposit rates. Following the expansionary monetary policy shock, both FAVAR models denote a rapid and robust decline in lending and deposit rates. It seems that the lending rates decline around 0.20 percentage point within two-year period. Besides, the impact of the monetary expansion dies out within two years period in the baseline FAVAR model. At the same time, as a response to a negative 0.25 percentage point policy shock, the fall of lending rates are around 0.15 percentage point. Also, the impact is significant within two-years period in the scenario FAVAR model. This means that the expansionary monetary policy would not have been more effective in terms of the transmission of the policy rate into banking rates if the Sveriges Riksbank had not gone into the NIRP. The comparison of the baseline and scenario FAVAR models shows that the transmission of the policy rate is virtually identical in the first few months. However, the transmission of the policy rate is more long-lasting in the baseline FAVAR model. This demonstrates the adequate performance of the monetary policy seems in the long-run when the monetary authority goes into a negative policy rate.

As noted, the retail deposits channel argues that the policy rate fails to transmit to bank deposit rates. Thus, banks' net interest margin decreases when policy rates turn to negative. The fifth and sixth rows of Figure 2.6 display the impulse responses of the net interest margin (NIM) to a 25-basis point negative policy rate innovation. In our specification, the NIM variables represent the difference between lending rates and deposit rates. It seems that the response of the interest rate margin for both households and nonfinancial firms is significantly negative in both baseline and scenario FAVAR models. However, the negative 25 basis points

policy rate innovation has a less pronounced effect in the scenario FAVAR model. Further, the comparison of the baseline and scenario FAVAR models display that banks would have enjoyed with higher net interest margins if the central bank had not set the policy rate below zero. These findings seem to be in line with the concluding proposition of the retail deposits channel.

Finally, the bottom row of Figure 2.6 provides the results for whether banks respond to monetary easing by altering their portfolio structure and finance riskier borrowers. As noted above, the portfolio rebalancing channel proposes that firms switch their asset portfolio and increase their lending to riskier firms, charge higher interest rates to borrowers and enjoy higher profits in the negative policy rate environment. The SPREAD variable is used in the analysis to evaluate bank actions in terms of portfolio rebalancing. The SPREAD indicator refers to the difference between the long-term lending rate, which is the proxy for riskier assets, and the five-year Swedish government bond rate, which is the safer asset. The impulse response results suggest that the wedge between riskier and safer assets decline following the monetary expansion in both FAVAR models. However, it seems that the SPREAD would have been higher if the central bank had not implemented the NIRP. In particular, the comparison between the baseline and scenario FAVAR models reflects that the results are inconsistent with the portfolio rebalancing channel argument. It seems that banks have not responded to negative rates by taking more risks. Instead banks avoided financing riskier firms if the central bank had kept the policy rate at zero percent level.

Figure 2.7 reports how bank loans, deposits, and issued securities respond to a negative 25 basis points shock to the policy rate in baseline and scenario FAVAR models.

Variables	Baseline	Baseline vs. Scenario	Scenario
Lending_NF			

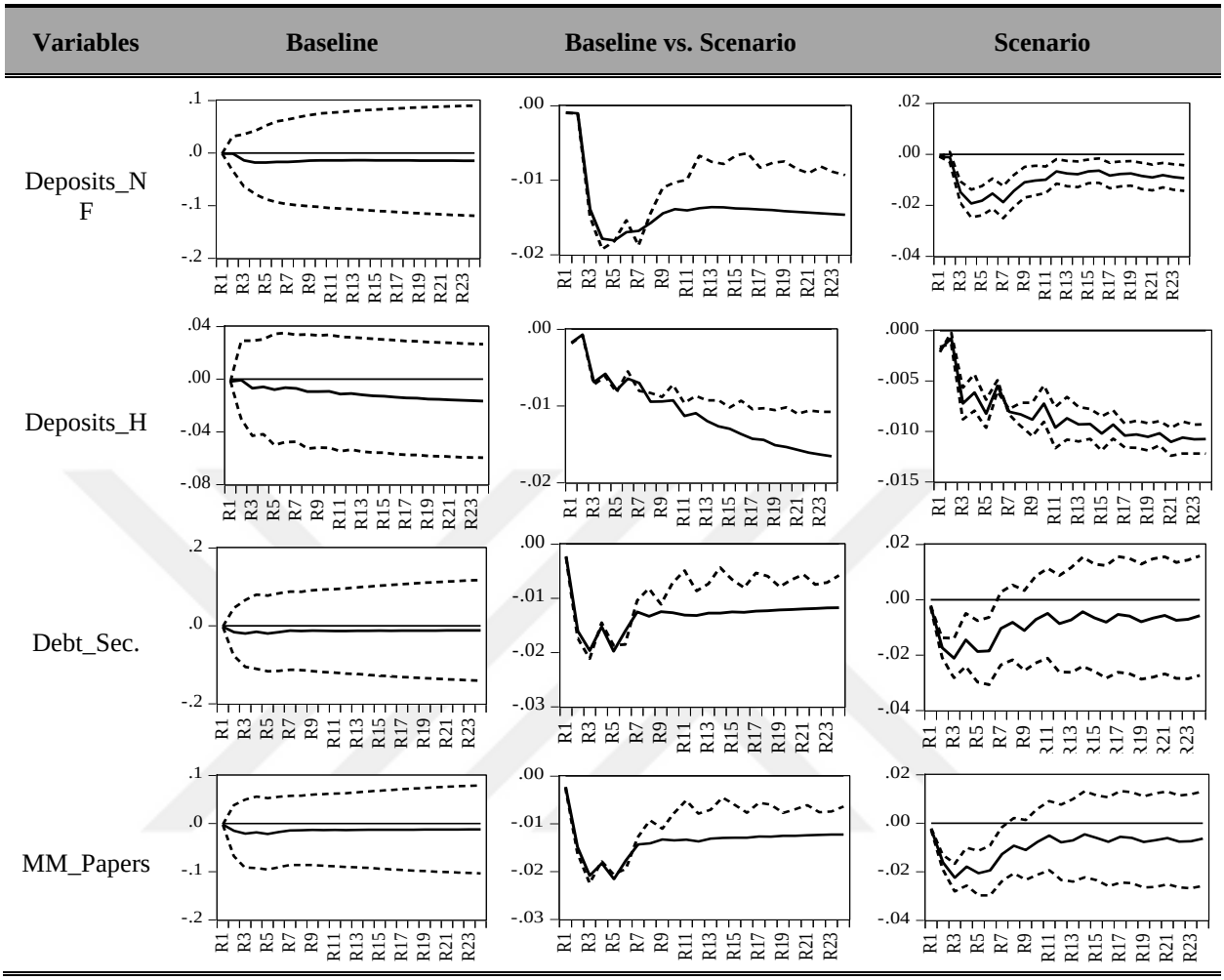


Figure 2.7. Estimated impulse responses of bank balance sheet variables

The first row of Figure 2.7 shows that the first response of the total lending to negative 0.25 percentage point policy rate shock is negative for up to three months. Although the response of total lending is not significant, the cumulative response of the total lending becomes positive after sixth months of monetary expansion in the baseline FAVAR model. In the scenario FAVAR model, the positive response of the total lending is also not significant. It seems that the response of the bank lending in the zero-rate scenario fluctuates around the baseline model in 15 months period after the monetary expansion. In general, it is expected that the lower loan rates trigger the total lending, which in turn increases bank profitability and feedback into bank lending. Not entirely consistent with the prior expectations, the monetary expansion seems to be insignificant on triggering bank loan supply. It is also safe to conclude, however, that the implementation of the NIRP marginally promotes long-term bank lending,

because the supply of bank loans seems to be lower if the central bank had kept the policy rate at zero percent.

The second and the third rows of Figure 2.7 demonstrates that the negative response of deposits following the negative 0.25 percentage point shock to policy rate is insignificant in the baseline model. Compared to the baseline model, the results of the scenario model are more pronounced. Under a zero-rate scenario, deposits decrease significantly in response to expansionary monetary policy. The figure also shows that bank deposits would have fallen less if the central bank had not gone into NIRP. Therefore, following the adoption of the NIRP, it could be argued that banks suffer from the deposit withdrawals. It is also shown that depositors adjust their portfolio decisions since, in the negative interest rate setting, the pass-through to deposit rates are not weaker.

The last two rows of Figure 2.7 report the impulse responses of issued securities when a negative 0.25 percentage point shock is given to a policy rate. These two series are the proxy measures whether banks switch their financing sources after the onset of the NIRP. Both measures of the issued securities decline in response to a negative policy rate innovation. In this sense, we could not find any evidence that in response to a negative 0.25 percentage point shock, banks switch their financing sources and substitute deposit financing with other debt instruments. One possible explanation might be that the ongoing transmission of the policy rate to the market interest rates in the negative interest rate setting (see Figure 2.8).

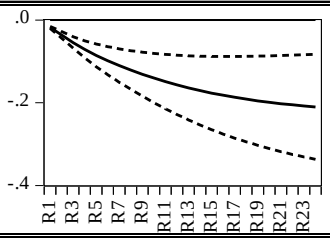
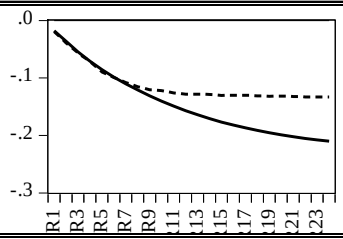
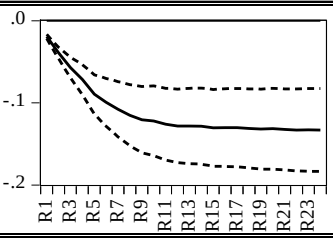
Overall, the baseline and scenario FAVAR models in Figures 2.6 and 2.7 suggest four main shortcomings: First, the introduction of the NIRP does not destroy the transmission of the policy rate into lending and deposit rates. The baseline model results, and the zero policy rate scenario results demonstrate that the expansionary monetary policy is effective in exerting its effect on banking rates. This means that innovation to policy rate would have exerted its effect on banking rates actively even the Sveriges Riksbank had gone into a negative rate. These findings are not consistent with Eggertsson et al. (2017), where they illustrated the limited transmission of the policy rate to banking rates in the negative policy rate environment in Sweden. Second, the baseline and scenario FAVAR models demonstrate that low-interest rates reduce banks' net interest margin. This argument is consistent with the retail deposits

channel proposition. Jobst and Lin (2016) and Claessens et al. (2017) also provided evidence favoring the fall of banks' net interest margins for various countries.

Third, the current study finds evidence not favoring the portfolio rebalancing channel. This means that banks do not tend to finance riskier borrowers in Sweden. This is contrary to the suggestions of Heider et al. (2017) and Eggertsson et al. (2019), where they found support for increased risk-taking. The probable explanation for this inconsistency might be the use of aggregated data in our study. Finally, partially consistent with prior expectations, monetary easing leads to higher bank lending in both baseline and scenario models. The rise of bank lending seems to be partly muted in the case of a negative policy rate. In other words, these models suggest that, if the policy rate had remained constant at zero percent level, the Swedish economy would have experienced a slightly lower rise in total lending compared to the negative policy rate model.

Similar to our findings, Demiralp et al. (2017) found that European banks increase their lending in response to a negative policy rate innovation. Our models suggest in this sense that the rate cuts in the negative territory are as successful as those in the positive territory in Sweden. Our results, therefore, confirm the existence of the bank lending channel in Sweden, which is not consistent with Eggertsson et al. (2019) findings.

Further, Figure 2.8 shows how money and capital market rates respond when a negative 0.25 percentage point shock is given to a policy rate.

Variables	Baseline	Baseline vs. Scenario	Scenario
STIBOR_1M			

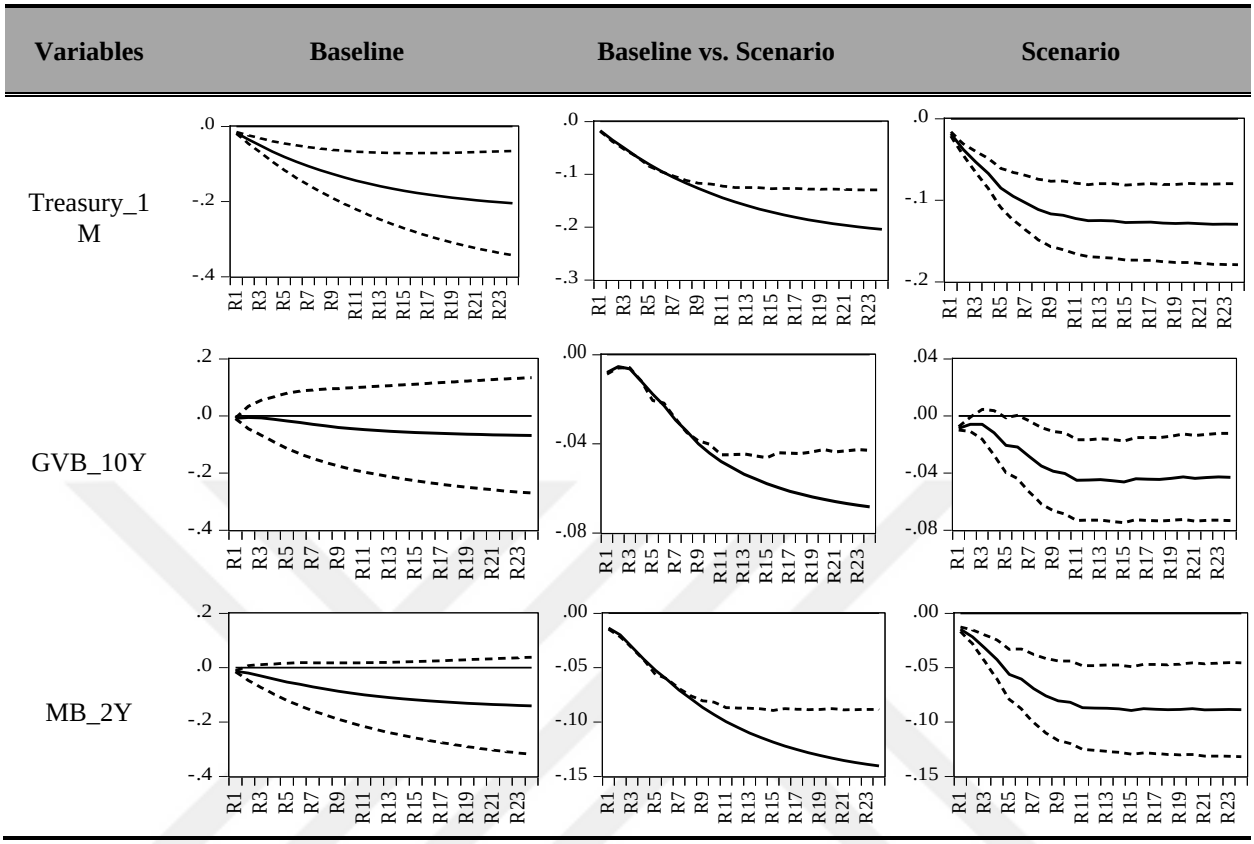


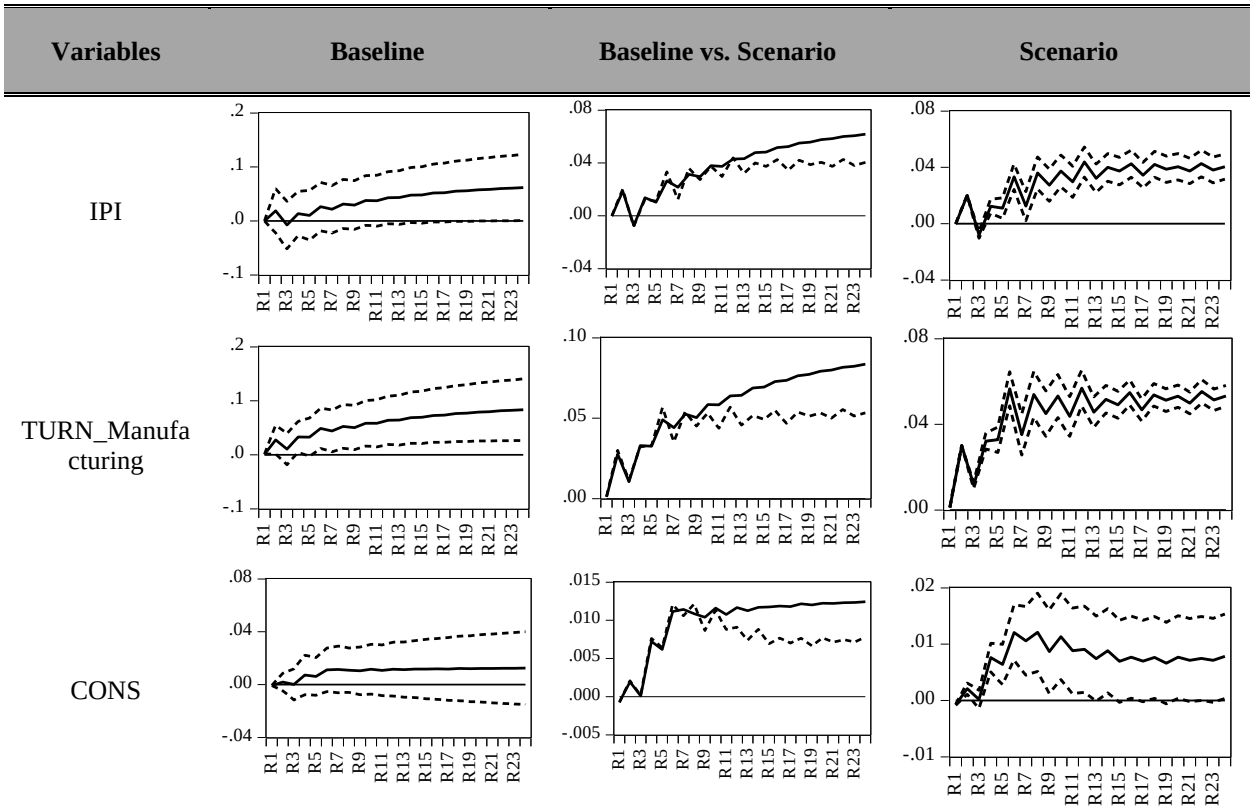
Figure 2.8. Estimated impulse responses of market rates

Figure 2.8 displays that in response to a negative policy rate innovation, the interbank rate, STIBOR, the Swedish 1-month Treasury Bills rate, and the 2-Year Mortgage Bonds rate decline in both models. The short-term market rates decline around 0.20 percentage point when the negative 0.25 percentage point shock is given to policy rate. It appears that policy rate changes transmit into the short and the middle term market rates and can affect the cost of borrowing in the market. The significant responses of the short- and middle-term money market rates are relatively robust in the baseline FAVAR model. Therefore, it seems that the degree of pass-through to market rates is more pronounced when the central bank implemented the negative rate policy.

Furthermore, Figure 2.8 depicts that an expansionary monetary policy shock decreases the 10-Year Swedish Government Bonds rate, but the effect is not significant in the baseline model. This shows that the policy rate does not transmit significantly to longer-term market rates. However, in the scenario FAVAR model, the negative response of the 10-Year Swedish

Government Bonds rate is significant after the first few months. However, although the response of long-term market rates is not significant, the transmission is somewhat higher under the negative interest rate setting.

Figure 2.9 depicts that in the baseline model, the impulse responses of selected economic activity, employment, and price level variables to an expansionary monetary policy shock. The shape of the impulse responses for economic activity variables is quite similar. Following the monetary expansion, industrial production, and turnover in manufacturing sector increase with a delay. The positive response of the industry confidence is quite significant. Unlike Apergis and Christou (2015) and Eggertsson et al. (2017), where they find the inability of monetary policy changes to trigger economic activity in the Euro Zone and Sweden, respectively, our results seem to favor the effectiveness of monetary expansion in Sweden. Although consumer confidence increases following the preferred specification, the positive response of household consumption is insignificant. Further, the consumer price index and producer price index go up with a delay, but they seem to be insensitive to expansionary monetary policy shock.



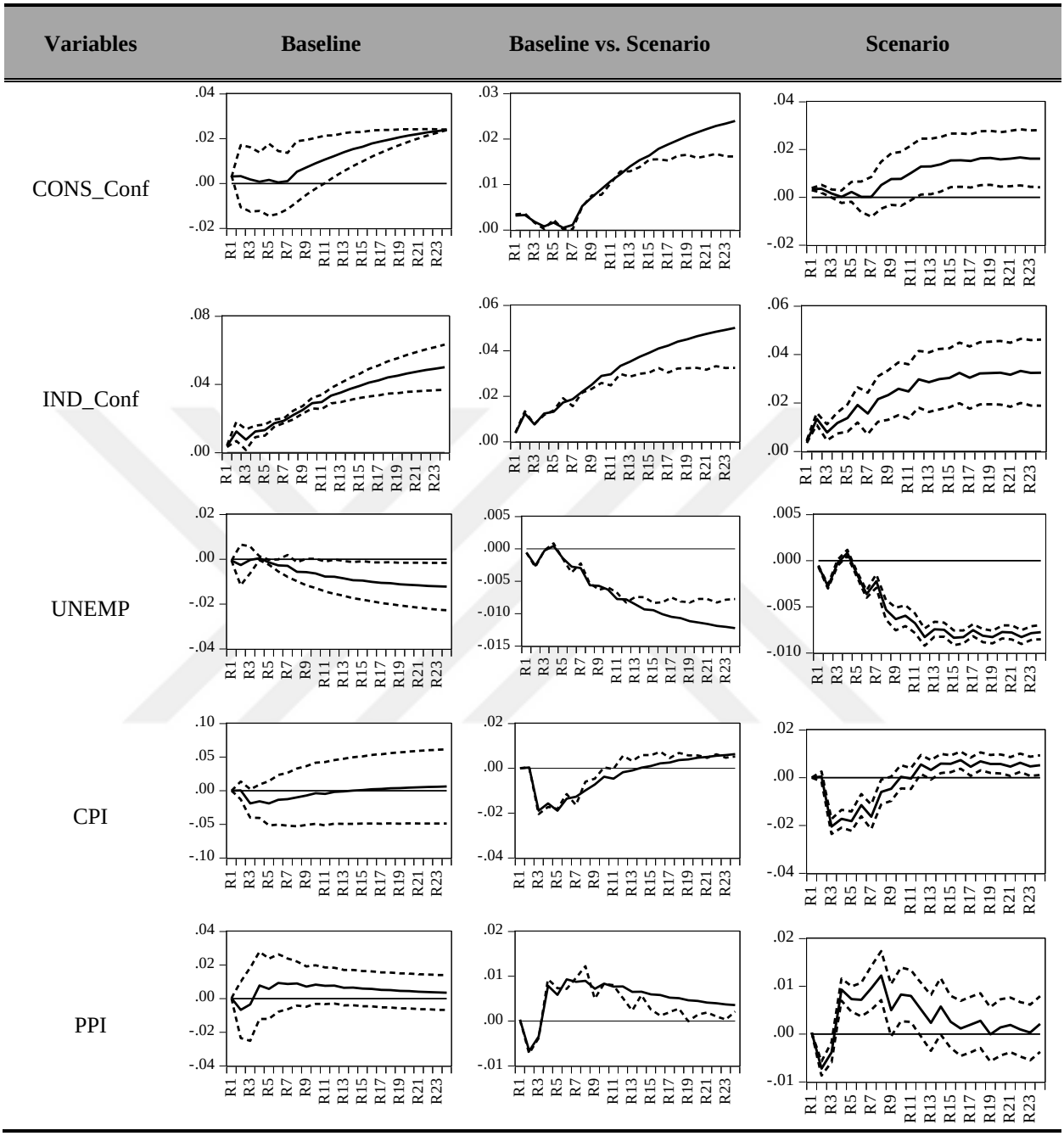


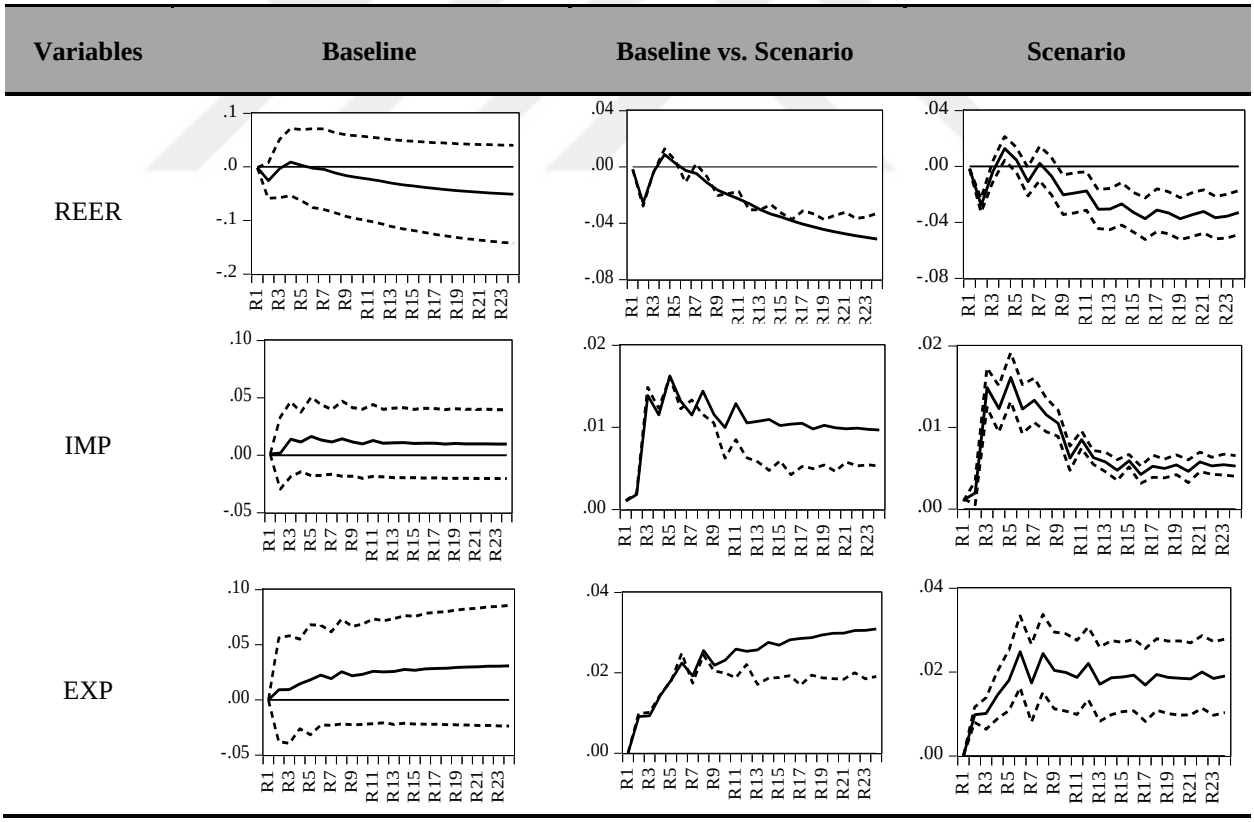
Figure 2.9. Estimated impulse responses of economic activity, employment and price indexes

On the other hand, the scenario FAVAR model provides a significant but less noticeable impact on industrial production, manufacturing turnover, household consumption, and consumer price index. The negative innovation to policy rate in negative territory appears to increase the impact of monetary expansion on economic performance after about ten

months. The response of the consumer price index seems to be quite similar in both the negative policy rate model and the zero-policy rate scenario.

In the labor market, the negative response of the unemployment rate is significant after ten months in the baseline model. Compared to the zero-policy rate scenario, the response of the unemployment rate is quite reliable in the baseline model. Importantly, the impact of the negative interest rates on economic performance, and the labor market is entirely consistent. Therefore, one might infer that the introduction of the negative interest rates triggers economic activity and reduces the unemployment rate in Sweden.

Finally, Figure 2.10 illustrates the impulse response of the reel effective exchange rate and the volume of foreign trade to a negative innovation to the policy rate.



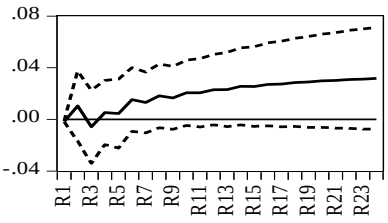
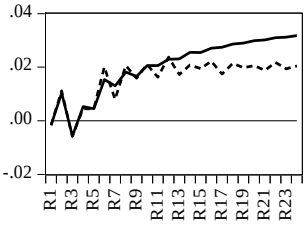
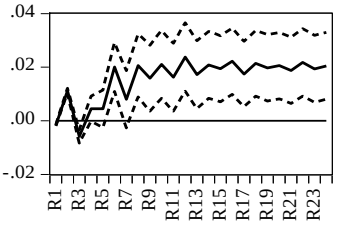
Variables	Baseline	Baseline vs. Scenario	Scenario
NX			

Figure 2.10. Estimated impulse responses of the real effective exchange rate and trade variables

In the baseline model, the negative response of the reel effective exchange rate seems to be insignificant to a negative policy rate innovation. In other words, Swedish Krona seems to be depreciated following the expansionary policy, but the impact is insignificant. Further, the responses of imports and exports are quite similar. Both exports and imports rise instantaneously after the expansionary shock, but these responses seem to be weak and transitory. The monetary expansion exerts its effect, and both imports and exports start to increase immediately. The response of the exports is stronger than imports, which in turn results in a rise in net exports following the monetary expansion. It appears that the depreciation of the domestic currency encourages exports in Sweden.

On the other hand, it would appear that increasing consumption expenditures could also boost import demand. Finally, the rise in exports dominates the increase in imports, which in turn improves the trade balance. The baseline model results provide evidence for the effectiveness of monetary policy via the exchange rate channel in Sweden.

However, the zero-rate scenario model provides significant results. The scenario model reflects that Swedish Krona would have been depreciated significantly if the central bank had not implemented negative policy rates. However, consistent with the economic intuition, the Swedish Krona would have been less depreciated if the central bank had not gone into negative and set policy rate as zero. The impact of the currency depreciation in the scenario model is also consistent with the prior findings. One can conclude that the exports and the trade balance would have been lower in the zero-policy rate scenario compared to the negative

policy rate model. These models show that the introduction of the negative rates repairs the functioning exchange rate channel accurately in Sweden.

Overall, these results for the preferred specification seem to provide evidence favoring the monetary policy effectiveness on triggering economic activity in the Swedish economy. These results show that monetary policy is active via the bank lending channel and exchange-rate channel. However, one can argue that the introduction of the negative rates could contribute to the transmission of monetary policy changes to economic activity through the bank lending channel and the exchange rate channel in Sweden. In this sense, our findings are not entirely in line with Eggertsson et al. (2019), where they support the ineffectiveness of the bank lending channel in Sweden.

Besides, monetary expansion can stimulate economic activity via other possible channels. First, in Figure 2.9, a negative monetary innovation seems to transmit into market rates properly. This reflects that monetary policy might exert its effect on economic activity through the traditional interest rate channel. Second, the impulse response results in Figure 2.9 illustrate that monetary expansion increases consumer confidence and industry confidence. Accordingly, one may also argue that monetary expansion is useful in economic activity via wealth channels. Such findings are not consistent with Eggertsson et al. (2019), whose results suggest that the implementation of the NIRP undermines both the traditional interest rate and wealth channels in the Swedish economy.

2.6. Conclusion

It is crucial to explore whether the negative interest rate policy is a powerful tool to get rid of the negative consequences of economic downturns and solve possible macroeconomic challenges. However, the effectiveness of the negative interest rate policy on the broader macroeconomy in the bank lending channel framework remains unknown, and there is still a potential room to contribute to the literature. In this regard, this study aims to analyze the effectiveness of the bank lending channel and, more broadly, the role of negative interest rates on various macroeconomic indicators in the Swedish economy.

The study uses the Factor-Added Vector Autoregression (FAVAR) approach to address these issues. The FAVAR approach is a well-designed and practical tool to examine the effectiveness of monetary policy innovations in which large-scale information variables are concentrated into a few factors. By doing so, this methodology significantly reduces the misspecification problems and solves the degrees of freedom problems.

In this context, this study contributes to the literature in the following ways: First, this paper assesses the effectiveness of negative interest rate policy in a broader context. Second, by employing the well-designed methodology, the study benefits from the distinct advantages of the FAVAR methodology. Third, introducing the scenario analysis into the FAVAR model, the study can assess what would have been the impact of monetary innovation on various macroeconomic indicators if the central bank had not gone into the negative policy rate.

In this study, the incorporated baseline and scenario FAVAR models for the Swedish economy throughout the period between 2010:01 and 2019:04 have some noteworthy implications. First, following a negative interest rate innovation, the policy rate transmits into the banking rates, and the volume of bank lending appears to increase. This reflects that the bank lending channel is active in the Swedish economy. Under the negative policy rate setting, these results are more apparent. Second, the policy rate seems to transmit money market rates and capital market rates significantly. Results of the baseline and scenario FAVAR models display that the introduction of the NIRP does not damage the transmission to short-term and longer-term rates. Third, the depreciation of Swedish Krona would promote exports and improves the trade balance in the Swedish economy. Fourth, in response to monetary expansion, various economic activity measures increase with a delay. Assessing these implications, one can infer that the monetary policy exerts its effect on economic activity through the bank lending channel, exchange rate channel, and traditional interest rate channel. Fifth, it is also worth noting that the degree of pass-through to banking rates and market rates is somewhat robust in the case of the negative policy rate. This means that monetary policy adjustments have had an influence on economic activity across various channels, and the implementation of the NIRP has not diminished the effectiveness of monetary policy in Sweden.

In this sense, our empirical results might offer a comprehensive and reasonable picture of the effect of monetary policy on the economic performance of the Swedish economy and have important policy implications. First, it seems crucial for policymakers to find out the threshold level interest rate at which the accommodative monetary policy becomes contractionary, namely the reversal rate, and find potential room for the extra reductions in the negative territory to implement policies accordingly (Brunnermeier and Koby, 2017). Second, policymakers need to take additional steps beyond the negative interest-rate strategy to influence bank lending behavior and to promote bank lending more strongly. For instance, the central bank might impose fewer requirements (i.e., lower required reserve ratio) to banks whose credit growth rates are above a certain level. This would offset the fall of net interest margin and encourage banks to increase their lending in the negative rates environment (Goodhart, 2013). Third, central bank authorities might charge higher negative rates to banks beyond a certain level of excess reserves held in the central banks. In this way, charging negative rates to excess reserve holdings can decrease the wholesale funding rates (i.e., interbank interest rates), reduce the cost of banks, and inhibit the fall of banks' net interest margin (Apergis and Christou, 2015). Fourth, since policy rates transmits into government security interest rates properly, the fall of the policy rate into negative territory would decrease the cost of government borrowing. Therefore, expansionary fiscal policy can be implemented with expansionary fiscal policy in balance to trigger economic activity and accelerate inflation. Finally, beyond the measures offsetting the income lost from the fall of net interest margins, banking authorities need to take precautionary measures to support bank capitalization and increase the soundness of banks to external shocks (Claessens et al. 2017).

Since the Swedish economy offers some favorable characteristics, negative policy rates seem to be effective in stimulating bank lending and triggering economic activity. However, the possible idiosyncratic reactions of households and firms to monetary policy changes might be at play and creates variability across countries adopting negative policy rates. Further research might be evaluating the performance of negative interest rates in all sample countries.

3. A MACHINE LEARNING APPROACH to DRIVERS of BANK LENDING: EVIDENCE from an EMERGING ECONOMY

3.1. Introduction

There is a considerable amount of studies on the importance of financial intermediaries in the existing literature. Financial intermediaries support lenders to organize their wealth into activities that yield smooth returns, and borrowers to increase their real asset holdings. (Brainard and Tobin, 1963). Due to the asymmetric information problems and numerous financial frictions in financial markets, the role of financial intermediaries becomes more critical. Diamond (1984) notes that financial intermediaries are delegated monitors specializing in minimizing potential information problems between borrowers and lenders. Boyd and Prescott (1986) also claim that financial intermediaries reduce the cost of collecting information to assess the creditworthiness of the borrower and reduce the cost of information processing. Financial intermediaries, therefore, generate an investment opportunity for savers (Greenwood and Jovanovic, 1990; Levine, 2005).

Earlier studies of Goldsmith (1969), Mc Kinnon (1973) and Shaw (1973) advocate the link between financial deepening and economic growth. These preliminary studies primarily claim that financial deepening decreases financial frictions, raises domestic savings, encourages the flow of funds, and lowers funding costs. Financial development, therefore, increases capital accumulation and foster economic growth (Bloch and Tang, 2003). Levine (2005) also argues that financial intermediaries could reduce asymmetric information problems, provide better resource allocation, and facilitate economic growth when many economic actors reach financial markets.

The finance literature argues that banks are, among others, regarded as the most prominent financial intermediaries, especially in developing countries. Banks perform tasks related to size, maturity, and risk transformation by balancing borrowers' larger and longer-term funding needs with the collection of small and short-term savers' deposits (Casu et al. 2006). Banks also channel financial sources to productive investment opportunities (Beck et al. 2001). Bernanke (1993) briefly notes that the reasons for attributing a particular role to

banks are banking officials' experience in lending to specific industries, banks' ability to determine the creditworthiness of potentially less risky borrowers, and the provision of various financial services to clients beyond lending. Also, Kashyap and Stein (1994) note that banks are specialized institutions as monetary authorities could adjust monetary policy by affecting the amount of loanable funds in the banking industry. They also note that bank dependence of some borrowers makes other non-bank financial intermediaries a marginal lender.

Firms need internal or external support to promote their operations. As firms, especially small firms, cannot provide their financing needs entirely from internal sources, they need external funding to fulfill their goals (Imran and Nishat, 2013). The inadequate financial reports of small and medium-sized firms are at the center of asymmetric information problems, which create obstacles for these firms to reach bank loans for their financial need (Sarath and Van Pham, 2014). Gertler and Gilchrist (1993) argue that small firms and households do not have various financial options and are dependent on bank loans. Since banks perform a special role in monitoring, they can provide external funding for companies that have relatively expensive alternatives. Thus, bank loans and other forms of external financing appear to be imperfect substitutes (Ramey, 1993).

In this context, banks play a crucial role in a real economy, and any shocks to bank lending are expected to have a significant impact on real economic activity (Çavuşoğlu, 2002). From the perspective of banking institutions, bank loans are an essential part of bank assets and are the primary source of income for them in the market (Malede, 2014). Thus, the expansion or contraction of bank loans tends to be a vital indicator of the country's monetary conditions, overall price level, and economic activity (Calza et al. 2003). Bank loan patterns are also an indicator of financial stability and are seen as a warning to the economic and financial crisis ahead (Pham, 2015).

Turkey, as an emerging economy, experienced two damaging banking crises in November 2000 and February 2001. These crises have dramatic consequences, both in the real sector and the financial sector. The real GDP had declined by approximately 6 percent in 2001, while the unemployment rate increased from 6.5 percent to 10.3 percent during 2000-2002. The financial stability in Turkey was dramatically damaged during these severe crises.

The costs of these crises to the financial sector were also tremendous. After these crises, the financial system was highly damaged, and the government had to take critical measures to provide a sound financial system that encourages financial and economic stability (Akinci et al. 2012). After the reform program started, twenty banks that account for twenty-five percent of the banking sector were transferred to the Saving Deposit Insurance Fund (SDIF) (Ozkan-Gunay and Tektas, 2006). In terms of fiscal and organizational reform, the government also took various steps and enforced legal and structural regulations to transform the banking system into a stable environment.

Before these banking crises, the domestic bank credit to the private sector over GDP was 17 percent in 2000. In the subsequent years after the crisis, this ratio declined to 14 percent in 2003. However, after the implementation of the consistent measures in the restructuring period, financial stability was accelerated, and bank credit to the private sector over GDP increased to 21 percent in 2005, and it reached up to 63 percent in 2018 (WDI, 2020). The total assets of the banking sector were doubled within four years after the burst of the 2001 February crisis. After these developments, the share of the banking sector reaches up to 89 percent of the total financial system. Deposit banks are more dominant in the financial system, and they constituted 78 percent of the total assets in the financial sector in the second quarter of 2019 (EDDS, 2020). Currently, 32 deposit banks operate in the Turkish banking industry, with 10,113 domestic branches (TBA, 2020). Thus, it is worth noting that the banking sector is the backbone of the Turkish economy in financing real economic activity.

Due to the crucial role of bank loans on economic activity, the financial stability, and financial stance of a country, there exist many attempts to clarify the factors on drivers of bank lending in both emerging and advanced economies, and an extensive literature has grown. The literature on factors affecting bank lending has grown in two main strands. The first group of studies primarily concentrates on the role of banks and bank characteristics in monetary transmission mechanism and are mainly based on the bank lending channel (i.e., Kashyap and Stein, 2000; Çavuşoğlu, 2002; Gambacorta and Mistrulli, 2004; Gambacorta and Rossi, 2010; Brinkmeyer, 2014; Cantero-Saiz et al. 2014; Cantu et al. 2019). Bernanke and Blinder (1988) formulate the bank lending channel as an additional propagation mechanism. The bank lending channel mechanism based on an effort of central banks to affect bank lending via

monetary policy changes. This channel argues that changes in the monetary position can affect bank lending as banks are unable to protect themselves from reserve drains by issuing any other debt certificates (Gambacorta and Rossi, 2010). Studies aiming at analyzing the set of indicators on bank lending in Turkey (i.e., Çavuşoğlu, 2002; Sengonul and Thorbecke, 2005; Akinci et al. 2012; Alper et al. 2012) follows bank lending channel framework.

The second strand of the literature concentrates on the determinants of bank lending (i.e., Egert et al. 2007; Brei et al. 2011; Shijaku and Kalluci, 2013; Ivanovic, 2016; Kapounek et al. 2017; Naceur et al. 2018). This avenue of the literature aimed at examining the role of supply-side versus demand-side factors on bank lending by employing bank-specific characteristics, macroeconomic indicators, and global factors. Although there is an increasing awareness of scholars on factors affecting bank lending behavior due to the critical role of bank loans, especially in emerging economies, existing studies produce mixed results. The literature on the driving factors of bank lending evolved in time and coupled with the introduction of new econometric techniques. Although considerable literature is grown in this area, there is a potential room for contribution.

Therefore, this chapter of the dissertation aims to build a model to explore the potential nonlinear and nonparametric linkage between outstanding bank loans and bank-specific, macroeconomic, and global factors and their predictive ability on bank lending behavior. To this end, the study analyzes the impact of 19 bank-specific, macroeconomic, and global variables on bank loans over the period from 2002Q4 to 2019Q2 in Turkey. The variable specification depends on the literature, and the data set includes numerous explanatory variables that are considered as significant on bank lending behavior.

As a result, this chapter contributes to the literature in some ways. The first contribution of the chapter is about dimensionality. Conventional models cannot handle more than a handful of variables in existing literature (Fornaro and Luomaranta, 2020). However, the empirical specification of the current study allows employing a total of 19 bank-specific, macroeconomic, and global variables to examine the drivers of bank lending.

The second contribution of this chapter is about the methodological advantages of the machine learning techniques. Studies in existing literature typically utilize econometric

techniques and general equilibrium models. Unlike previous studies, this chapter employs various machine learning techniques (regression tree, boosting, bootstrap aggregating (bagging), and random forest predictors) to determine the drivers of bank lending in Turkey. The machine learning techniques are designated to create algorithms to be applied for the datasets in prediction, classification, and clustering purposes (Athey, 2018). The perception of machine learning techniques in economic analysis is a relatively novel approach (Varian, 2014). These techniques can provide an alternative for existing methodologies to fill the gaps in the literature and have several benefits. First, machine learning techniques allow selecting the functional form of the model flexibly (Athey, 2018), and they do not require any prior assumptions on the distribution of variables (Alessi and Detken, 2018). Thus, these techniques provide the best suiting functional forms for the data (Mullainathan and Spiess, 2017). Second, machine learning techniques do provide the out-of-sample predictive ability of the variables and allow them to rank variables according to their out-of-sample fit measures (Basuchoudhary et al. 2017). Thus, these techniques offer more confidence for both scholars and policymakers in understanding economic problems.

The structure of this study is as follows: The second part reviews the literature, and the third part gives an overview of the Turkish banking sector. The fourth part introduces the data and variables, and the fifth part explains the methodology. The sixth part provides empirical results, and the last section concludes the study.

3.2. Literature Review

As noted, several papers have attempted to clarify the factors significant in bank lending behavior in the literature. While the literature on determinants of bank lending may be classified under several headings, this chapter classifies the studies into two distinct subcategories. The first strand of the literature includes the studies concentrating on the role of bank-specific factors in the bank lending channel context.

The literature on the bank lending channel started to grow up after the seminal work of Bernanke and Blinder (1988). In one of the earlier attempts, Kashyap and Stein (1995) found that the bank lending behavior of small banks is more sensitive to monetary policy changes

than large banks in the United States. Favero et al. (1999) discovered that the monetary policy is ineffective through the bank lending channel in France, Germany, Italy, and Spain. They found that small banks use their excess liquidity in Germany, Italy, and France, while large German banks use their balance sheet strength to ensure that their loans are not affected by monetary policy fluctuations. On the contrary, De Bondt (1999) provided a piece of evidence favoring the bank lending channel in Germany, Belgium, and the Netherlands. Their empirical findings support the idea that size and liquidity are significant bank-specific factors on the sensitivity of bank lending to monetary policy changes. Kashyap and Stein (2000) also argued that the effects of monetary policy changes would be more limited in US banks with higher liquidity. The main focus of the study by Berrospide and Edge (2010) was the impact of bank capital on bank loans in the United States. They adopted a panel data model and used a fixed-effects estimation methodology for the period between 1992-2009. Their findings revealed that the capital surplus is a significant measure as a driver of bank lending. Their findings also demonstrated that liquidity, loan quality, lending standards, and GDP are significant measures to explain the volume of bank lending.

For the Euro Area case, Gambacorta and Rossi (2010) analyzed the possible nonlinearities in the response of bank lending to monetary policy changes. They employed asymmetric vector error correction model (AVECM) and examined the period between 1985 and 2005. Their findings provided evidence favoring the asymmetric response of bank lending to monetary policy changes during expansions and contractions. They found that the impact of monetary shocks is more significant in contractionary periods. Cantero-Saiz et al. (2014) analyzed the impact of sovereign risk on bank lending behavior in Eurozone countries using a sample of 3,125 banks over the period between 1999 and 2012. Their findings provided evidence for nonlinearities on the link between sovereign risk and bank loan supply. They demonstrated that the significant negative impact of sovereign risk on bank lending during monetary contraction slightly disappears during monetary expansion periods.

In a more comprehensive study, Brinkmeyer (2014) focused on the role of bank-specific characteristics, monetary indicators, and macroeconomic measures on bank lending activity in the bank lending channel context. The study consisted of 2,153 banks throughout 1999-2011. He constructed a dynamic panel data model, and his findings suggest that there are

some asymmetric effects of bank characteristics on bank lending during regular periods and crisis times. Among bank-specific characteristics, capital, total assets, short-term funding ratio, share of non-interest income are significant factors influencing bank lending behavior during the global financial crisis. GDP and EURIBOR are other measures that are significant in lending behavior in Euro Area countries. Demiralp et al. (2017) investigated whether bank behavior changes when the ECB goes into a negative policy rate policy. They focused on the loan supply, security holdings, and wholesale funding adjustments of banks. They constructed a dynamic panel data model. Their empirical findings demonstrate that banks increase their lending and their non-government security holdings and reduce their wholesale funding during a negative interest rate environment.

The dynamic panel data study of Gambacorta and Mistrulli (2004) analyzed the role of capitalization in the bank lending channel context in Italy over the period between 1992 and 2001. They demonstrated that banks with higher excess capital ratios are less sensitive to monetary policy changes due to their ability to reach uninsured financing sources. They also gave support in favor of the role of liquidity in bank loan supply. Another study concentrating on banks in Italy was carried out by Bonaccorsi and Sette (2010). They investigated whether the role of bank balance sheets changes the monetary shock transmissions during the recent global financial crisis. They found that securitization, bank capital, loan quality, and profitability were significant measures to explain the differences in bank lending during the 2007-2008 period.

By employing a more comprehensive variable set, Jimenez et al. (2012) examined whether macroeconomic conditions, bank characteristics and firm characteristics are significant on granted loan applications in Spain. They employed a panel regression model and analyzed the period between 2002 and 2008. Their findings suggested that the negative impact of the higher short-term interest rate and lower GDP growth is somewhat more significant in banks with more reliable capital and higher liquidity. Santis et al. (2013) examined whether the impact of standard monetary policy in France, Germany, Italy, and Spain may vary across countries and banks. They used both OLS and instrumental variable regression models over the period between 1999 and 2011. They found evidence on bank lending channel in Germany and Italy, while banks in France and Spain seem not to respond to monetary policy changes.

The study also suggests that the bank lending channel operates through banks with weaker capital position and low liquid asset holdings in Germany and Italy. These results, therefore, are in favor of the mixed responses to monetary policy changes across banks and countries.

Some of the studies analyzed the drivers of bank lending and the impact of monetary policy changes on bank lending across a set of countries. Of these studies, Gambacorta and Marquez-Ibanez (2011) concentrated on the role of bank-specific variables, monetary policy indicators, and institutional measures on bank lending behavior. The study covered more than 1,000 banks from 15 European countries and the United States over the period between 1999-2009. Their empirical results do not particularly indicate significant variations on the effectiveness of monetary policy changes during regular times and crisis periods. They also demonstrated that the market funding share of a bank, volatile non-interest income, and core capital level has a significantly higher impact on lending behavior during the crisis. In another comprehensive study, Bertay et al. (2012) concentrated on the link between bank ownership and bank lending, covering a sample of banks from 111 countries. They constructed a dynamic panel data model over the period between 1999 and 2010. They discovered that the lending behavior of state banks is countercyclical even in advanced countries.

In the same vein, Laidroo (2016) examined the role of ownership type and some bank characteristics on bank lending in 11 Central and Eastern Europe (CEE) countries for the period between 2004 and 2012. Their findings provided no evidence for the variations in bank lending behavior across ownership types and during the crisis and regular times. They indicated significant differences across banks for bank capital and balance sheet liquidity measures. Borio and Gambacorta (2017) analyzed the effectiveness of monetary policy in a sample of 108 large international banks by constructing a dynamic panel data model over 1995-2014. Their findings suggest that the monetary policy becomes less effective at a lower policy rate. They also confirmed their results by controlling financial and real economic conditions and bank-specific characteristics.

In a developing country case, Ciro et al. (2018) aimed at examining the effectiveness of monetary policy under different scenarios of banking sector concentration in Colombia. They analyzed the period between 2007-2017 and formed a dynamic panel data model. Their

empirical results are in favor of an active bank lending channel. They also demonstrated that the monetary policy becomes less effective under a higher banking concentration scenario. Recently, Cantu et al. (2019) analyzed the role of bank characteristics to absorb the impact of the monetary shocks on bank loan supply in Mexico over 2009-2017. They found that bank size, liquidity, bank capital, loan quality, efficiency, and bank deposits are critical factors on the bank's response to monetary policy shocks.

In Turkey's case, Çavuşoğlu (2002) investigated the bank lending behavior in 58 deposit banks throughout 1988-1999. Dynamic panel data estimation results of this study provide no significant link between monetary policy indicator and the volume of bank loans in Turkey. However, these results demonstrate that security to asset ratio, capital ratio, and security to asset ratio is significant bank-specific factors on bank lending. Sengonul and Thorbecke (2005) concentrated on the link between balance sheet liquidity and bank lending during monetary policy changes in Turkey. They analyzed the period between 1997 to 2001 and used two-stage least squares estimation. They stated that in banks with less liquid balance sheets, the effect of contractionary monetary policy on credit supply becomes more severe. In another study for Turkey, Aktaş and Taş (2007) concentrated mainly on the impact of capital adequacy ratio on bank lending behavior. They adopted a dynamic panel data model and analyzed the period between 2001 and 2006. They indicated that monetary policy changes are more significant in bank lending supply of banks that are capital unconstrained.

Akinci et al. (2012) also provided evidence of a bank lending channel in Turkey. They utilized several panel data models and examined the period between 1991 and 2007. They employed both monetary policy indicators and numerous bank-specific variables. Empirical results of their models show that bank capital and GDP growth have a significantly positive impact on bank loan growth. Conversely, bank size, inflation, and efficiency measures are insignificant on the growth of bank lending.

Similarly, the study of Alper et al. (2012) concentrated on the impact of monetary stance on bank lending. They used a panel regression model covering the period between 2002 and 2011. Their findings revealed that the significant negative effect of the policy rate on bank lending is an illustration of an active bank lending channel. They also proved that changes in

the bank's liquidity position through monetary policy actions significantly lower bank lending. In a comparative analysis, Macit (2012) studied the impact of monetary policy on lending behavior of participation and commercial banks in Turkey over 2006 and 2010. His findings suggest that participation banks' lending is more responsive to monetary policy changes. His study also found that liquidity has a significantly positive impact on bank lending, whereas the bank size affects lending negatively.

The second strand of the literature comprises the studies concentrating on numerous bank-specific characteristics, macroeconomic indicators, and global factors. In an earlier attempt, Berger and Udell (1994) focused mainly on the role of risk-based capital ratios and other capital measures to explain the credit crunch in the United States at the beginning of the 1990s. They utilized a comprehensive dataset for US banks from 1979 to 1992. As a result of their study, they concluded that there is no significant impact of alternative capital ratios on loan growth during this period. In another study, Carlson et al. (2013) examined the impact of capital ratios and some other bank-specific factors on bank lending behavior in the United States. They used bank-level data over the period between 2001 and 2011 and employed a metropolitan statistical area (MSA) fixed effects model. Their findings show that the capital ratios are significant in bank lending during and slightly after the global financial crisis. They also revealed some non-linearities on the impact of capital ratios over bank lending since the capital ratio elasticity of bank lending is somewhat higher when capital ratios are lower. In a recent study on US banks, Kim and Sohn (2017) investigated whether liquidity matters on the link between bank capital and loan growth. They studied the period between 1993 and 2010. Their findings suggest that the impact of the capital ratio is significantly negative on loan growth for banks that have a lower liquidity ratio. Conversely, the effect of the capital ratio on loan growth for those that have enough liquidity is significantly positive.

In the Euro Area case, Calza et al. (2003) investigated the cointegration relationship between real loans, GDP, and interest rates covering the period between 1980 and 1999. Their findings indicate that the impact of GDP on real loans is positive, while the impact of both short-term and long-term interest rates are negative in the long run. Kapounek et al. (2017) analyzed the drivers of bank lending in a more comprehensive set of variables, including bank-specific, macroeconomic, and institutional factors in European banks over 2000-2013.

They found that the lending rate spread, asset quality, and capital ratios are significant bank-specific factors on loan supply. They also provide evidence favoring the significant role of both macroeconomic and institutional indicators on loan supply. Besides, their findings reflect that supply-side factors are more relevant for large banks lending decisions, while small banks are more sensitive to demand-side measures.

Of the single European country studies, Panagopoulos and Spilliotis (1998) investigated the cointegration relationship among firm-specific characteristics, interest rates, and macroeconomic indicators in Greece over the period 1971 and 1993. However, their findings failed to provide a significant impact of interest rates on credit expansion. In the German case, Blaes (2011) analyzed to what extent the bank-related factors are significant in bank lending behavior during the post-crisis period. Their sample constituted the bank lending survey data and covered the period between 2003 and 2010. Their findings demonstrate that the bank lending survey variables are significant in bank lending behavior during the sample period. They also confirmed that a set of bank-related factors, including the cost of capital, market financing, and liquidity position, have a more substantial impact on bank lending following the financial crisis. In a similar vein, Cucinelli (2015) concentrated exclusively on the impact of credit risk on bank lending across commercial and cooperative banks in Italy following the financial crisis. The study used a ratio of non-performing loans to total loans as a measure of credit risk and found that credit risk is a significant factor in bank lending during the post-financial crisis in both groups of banks.

Blundell-Wignall and Roulet (2013) focused on the impact of unconventional monetary policy settings on bank lending behavior for an unbalanced panel of 468 US and European banks. Their findings indicate that the share of risk-weighted assets among total assets is a significant measure of the bank loan supply of global systematically important (GSIFI) banks. Conversely, the loan supply for other banks in the sample responds significantly to the bank solvency measure, the spread between lending rates, loan quality, and demand-side measures. On the other hand, Brissimis et al. (2014) investigated the role of market power in monetary propagation via bank lending in the Euro Area and the U.S. They analyzed the period between 1997 and 2010 and utilized a dynamic panel data estimation methodology. They found that banks with higher market power can buffer against negative

impacts of monetary shocks in both the Euro Zone and the U.S. Their findings also showed that the impact of market power becomes more significant during the global financial crisis. In a recent study, Naceur et al. (2018) analyzed the impact of newly constructed capital and liquidity measures on bank loan growth following the global financial crisis in 22 European countries and the United States. They demonstrated that the capital ratios and liquidity measures are significant on bank lending during the post-global financial crisis. They also provided heterogeneity across bank characteristics across Europe and the United States.

Hoffman (2001) analyzed the determinants of bank lending in 16 industrialized countries over the period between 1980 and 1998. Their cointegration model results exhibit that the impact of short-term and long-term interest rates is significant on bank credit to the private sector. Their findings also are in favor of the significant effect of real estate prices on bank lending in sample countries. By employing a sample of large international banks settled in 14 advanced countries, Brei et al. (2011) investigated the potential nonlinearities of the impact of bank capitalization on bank loan supply. They provided evidence on the significant impact of capitalization on bank lending. Their results also suggest that the marginal impact of the capital ratio is more significant during the crisis than regular times. In another study, Caglayan and Xu (2016) examined the role of economic sentiment on bank lending behavior in G7 countries. Their findings suggest that the volatility in the economic agents' sentiments significantly affect bank lending. They also argued that the transmission of the economic sentiment varies depending on the bank characteristics.

The study of Kosak et al. (2015) employed a worldwide sample of 91 countries and analyzed the factors affecting bank lending behavior during the financial crisis. Their study covers the period between 2000 and 2010. Although their results are albeit with conflicting results for different measures of capital during the crisis and regular times, they support the significant impact of capital on bank lending in both periods. In a more comprehensive study, Pham et al. (2015) used a sample of banks from 146 countries over 1990 and 2013. Their findings reflect heterogeneous reactions of banks and provide evidence of country-specific factors on bank lending behavior. Their study suggests that a healthy financial system plays a crucial role in absorbing external shocks to the banking system.

The literature also offers plenty of studies concentrating on drivers of bank lending in emerging countries. Imran and Nishat (2013) studied the impact of supply-side variables on bank credit to the private sector in Pakistan over the period between 1971 and 2010. They formed a cointegration model to determine the short-run and long-run determinants of bank lending. Empirical results of their study show that foreign liabilities, deposits, GDP growth, domestic monetary conditions, and exchange rate are significant long-run determinants of bank lending. In contrast, the general price level and monetary policy indicators are not significant in the long-run. Sarath and Van Pham (2014) aimed at investigating the variables affecting the lending behavior of Vietnamese private and state-owned banks covering the period between 2008 and 2012. They revealed that the growth of deposits, equity growth rate, liquidity, the share of security holdings, and real economic growth have a significant impact on bank lending. Empirical results of their model also illustrate the divergence between private and state-owned banks.

Recently, Baoko et al. (2017) focused on the factors influencing the allocation of bank lending to the private sector in the Ghanaian economy. They used a cointegration methodology and gathered a sample covering the period between 1970 and 2011. Their findings suggest that the bank size, real rate of bank lending, bank deposit rate, and broad money supply are significant on the bank credit both in the long-run and short-run. Of the existing studies, Ladime and Osei (2013) emphasized the role of competition in the banking industry in Ghanaian economy; Shijaku and Kalluci (2013) stressed the impact of financial liberalization in Albania; Malede (2014) focused on internal and external factors in Ethiopia; Rababah (2015) analyzed the impact of bank-specific and macroeconomic indicators in Jordan, and finally, Ivanovic (2016) made a distinction between post- and pre-crisis periods.

Overall, the vast majority of the existing studies employed econometric techniques and provided somewhat mixed results in an attempt to justify the impact of bank-specific variables, macroeconomic indicators, and global factors on bank lending behavior. In this context, the literature calls for the studies clarifying the role of these factors using a comprehensive set of variables and adopting a novel methodology to the existing literature and getting benefit from the apparent advantages of the machine learning techniques.

3.3. Banking Sector in Turkey

There are three main groups of banks in the lending market in Turkey, which are deposit banks, development and investment banks, and participation banks. Deposit banks are the leading participant and dominate the sector. Currently, the sector consists of 51 banks with 32 deposit banks, 13 investment and development banks, and six participation banks. Regarding the share of total loans in the market, the deposit banks provide 86.86 percent of the total loan supply in June 2019. On the other hand, development and investment banks and participation banks have relatively lower shares in the market and provide 8.24 percent and 4.89 percent of total loan supply, respectively.

The Turkish banking sector has experienced a set of structural changes over time. Up to the 1980s, the banking sector was underdeveloped and operated with higher intermediation costs. There have also been other issues, such as lack of competition, high entry barriers, and some restrictions and regulations (Ozkan-Gunay and Tektas, 2006). The introduction of the financial liberalization program in January 1980 and the following regulations in the financial system have contributed to the development of the banking sector in Turkey (Çavuşoğlu, 2002). During this period, the elimination of the entry barriers and the liberalization of the exchange rates and interest rates increased competition in the banking sector (Günalp and Çelik, 2006). The introduction of the new domestic and foreign banks increased the number of branches and the employment in the banking industry (Akinci et al. 2012). The number of banks grew by 72 percent, the number of branches rose by 1,500, and employment increased by 30 percent between 1984 and 1999 (Demir et al. 2005). Moreover, banks started to offer new services to their customers and constructed rather new technologies in which increased productivity in the sector (Mercan et al. 2003).

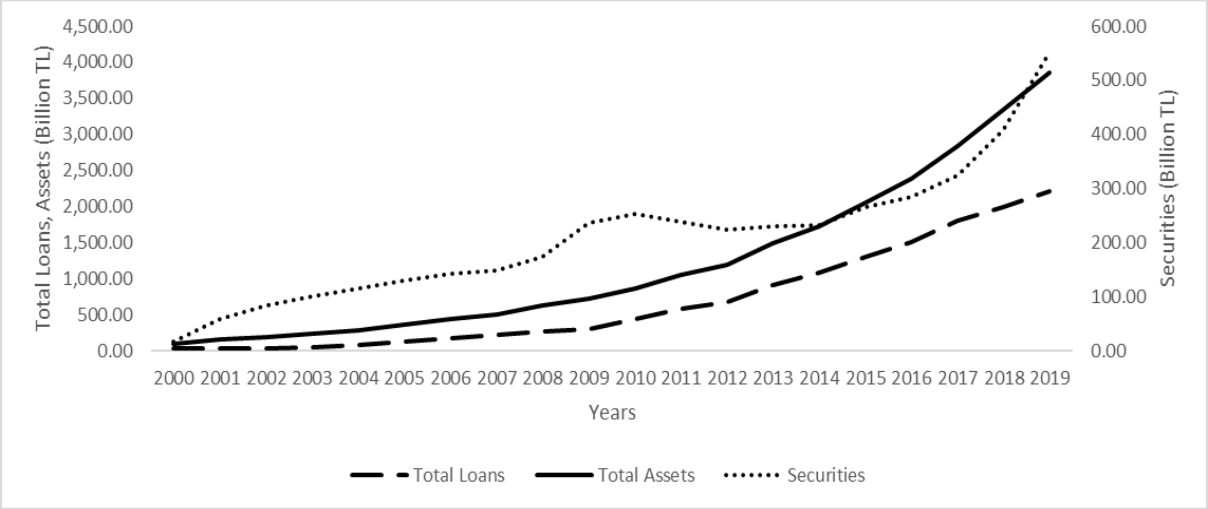
At the beginning of the1990s, the higher public sector borrowing requirements and the resulting increase in inflation created a spiral and generated instabilities in the banking sector. The higher budget deficits boosted the public sector demand for loanable funds and increased real interest rates. Therefore, economic agents arranged their portfolios in favor of foreign currency denominated assets, and banks meet the public sector borrowing requirements (BAT, 2019). As non-bank operations became more profitable than lending, the banks tended to

abandon their financial intermediation functions (Isik and Hassan, 2002). These challenging developments end up with the crisis in 1994. The larger balance of payment deficits put pressure on exchange rates and the Turkish Lira devaluated by 60 percent, the overnight interest rates skyrocketed and reached 1000 percent, and banks faced with substantial liquidity problems. In the following years, the IMF supported the stabilization program to help create stability in the financial markets and reduce the balance of payment imbalances (Ozkan-Gunay and Tektas, 2006). Nevertheless, the government signed a monitoring agreement with the IMF to resolve macroeconomic problems following political instabilities coupled with financial shocks transmitted through the Russian crisis (BAT, 2019).

However, the program lost its credibility due to the postpone of several regulations, and the rising public sector borrowing requirements in unfavorable global financial conditions at the end of 2000. Afterward, the Turkish economy experienced more massive capital outflows, interest rates soared, and banks faced with vitally increasing liquidity problems (Akinci et al. 2012). At the end of this period, the Turkish economy confronted with two severe crises in November 2000 and February 2001, and the banking sector bore huge losses (Mercan et al. 2003).

After these two severe crises, the government took a set of regulatory measures to stabilize the macroeconomic environment, which led to significant changes in the banking sector. The Transition to a Stronger Economy System was initiated to restructure the Turkish economy and to fix macro-economic imbalances. Besides, the “Banking Sector Restructuring Program” was launched to sustain the operational and financial restructuring of the banking sector (Abbasoğlu et al. 2007). This program aims to take over the banking sector’s fiscal and operational reform and to enforce the legal and regulatory regulations on banking supervision, and to increase competition and efficiency in the banking sector (BRSA, 2001). Consequently, the subsequent banking sector regulations have led to the banking sector with a sound and a healthy structure.

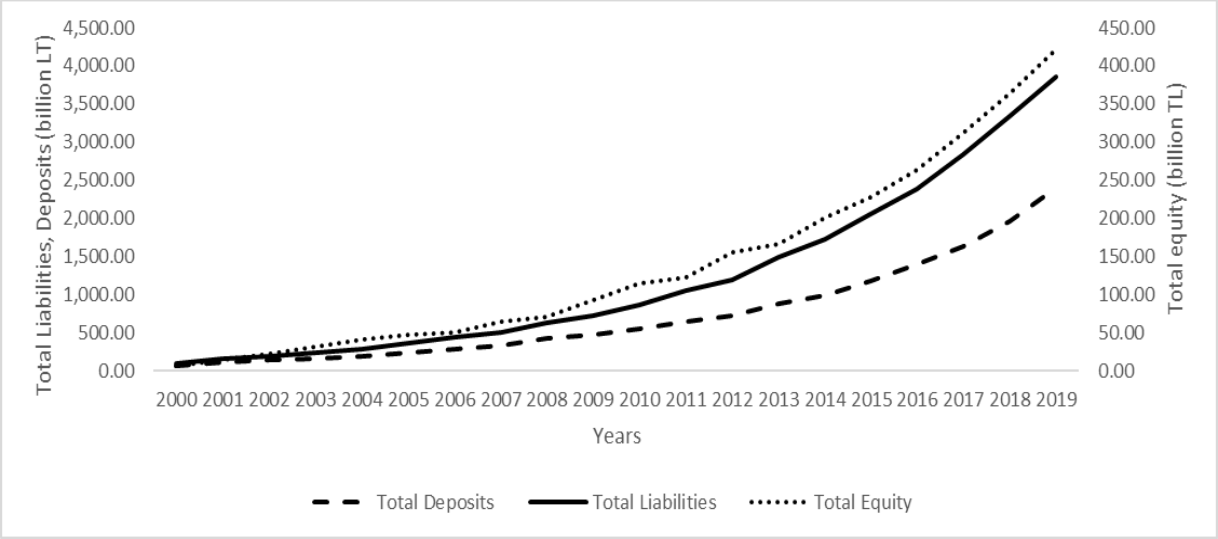
The following figures aim to provide a snapshot of the deposit banking industry in the post-crisis period.



Source: Electronic Data Delivery System provided by CBRT.

Figure 3.1. The asset structure of the banking sector

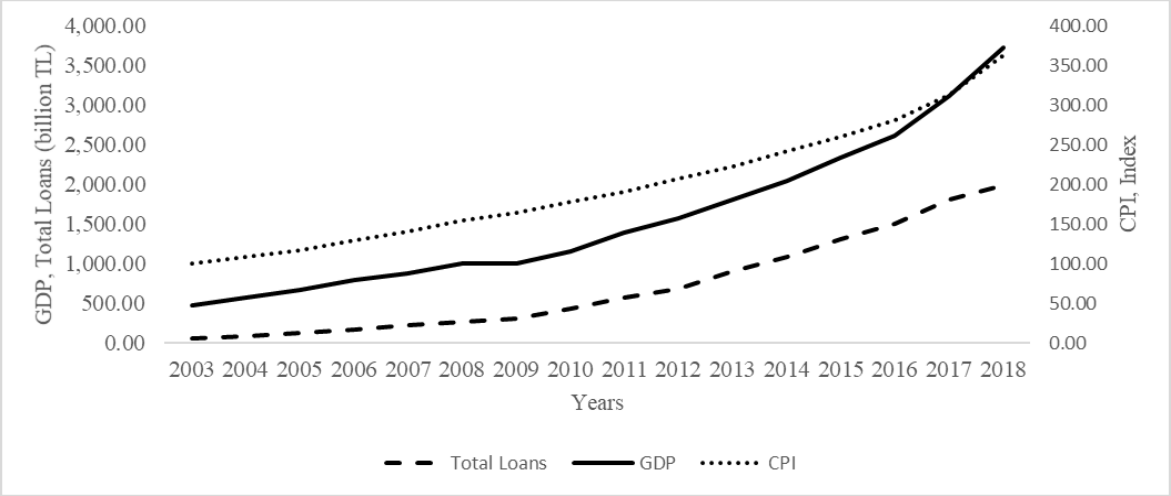
As reflected in Figure 3.1, the total assets of the deposit banks increased over time, coupled with the rise in the total loans. Despite its more volatile nature, the security portfolio also had an increasing trend during 2000-2019. Both total assets and total loans followed a similar pattern, but the increasing trend was somewhat higher in total loans after 2012. It seems that the share of total loans in total assets declined during the 2012-2019 period. The fall of the share of total loans in total assets appears to be accompanied by a significant rise in the security portfolio. Therefore, such an outcome might indicate that the growth in the size of the deposit bank balance sheet is partly due to the increases in security holdings and other types of assets in the last years.



Source: Electronic Data Delivery System provided by CBRT.

Figure 3.2. The liability structure of deposit banks

Figure 3.2 illustrates the liability side of the deposit bank balance sheet during the 2000-2019 period. As shown in the table, the rise in total liabilities increased total deposits and total equity. This means that total assets have been financing with the surge in both external and internal financing in the deposit banking sector. However, a rising gap between total liabilities and deposits in the last decade indicates the more pronounced role of non-deposit funds. Financing with alternative debt instruments, therefore, might provide the reallocation opportunity for deposit banks during any unintended shocks to deposits (Çavuşoğlu, 2002).



Source: Electronic Data Delivery System provided by CBRT.

Figure 3.3. Overview of bank loans, GDP and CPI in the Turkish economy

The figure above gives an overview of the relationship among total deposit bank lending, GDP, and the CPI in the Turkish economy. It seems that all of these have similar patterns and an increasing trend over time. Therefore, the figure particularly illustrates the procyclical behavior of deposit bank loans in Turkey.

The role of deposit bank loans in financing real economic activity increases over time. The ratio of total bank loans to GDP was 13.63 percent at the end of 2002 and reached about 64.29 percent in 2018. The share of deposit bank loans in GDP also has an increasing trend, from 12.45 percent in 2002 to 56.07 percent at the end of 2018. The ratio of deposit bank loans in GDP, therefore, provides the favorable role of deposit banks in financial intermediation in the Turkish economy.

Finally, Table 3.1 provides the structure of the deposit banking industry by exhibiting some selected ratios. These ratios reflect the improvements in the deposit banking industry following two severe crises in November 2000 and February 2001.

Table 3.1. Selected ratios in deposit banks

Ratios/Years	2003	2005	2010	2015	2016	2017	2018	2019
Loans/Assets (%)	26.93	40.07	55.12	65.42	65.46	65.78	62.61	59.86
Deposits/Assets (%)	68.26	67.67	67.20	57.22	57.66	56.50	56.94	60.95
Loans/Deposits (%)	44.90	62.24	85.21	117.98	117.49	120.14	114.70	104.17
Equity/Assets (%)	13.78	13.22	13.23	11.14	11.03	11.07	11.02	11.04
NPL Ratio (%)	12.12	4.85	3.73	3.09	3.37	3.10	4.13	5.71
ROA (%)	3.50	2.51	3.03	1.49	1.91	2.05	1.75	1.40

Source: Banking Regulation and Supervision Agency

The ratio of loans to total assets, deposits to total assets and loans to deposits has had a growing trend over the post-crisis period, which in turn indicates that banks are more confident in their primary duty of fulfilling their intermediation role. The capital ratio, which followed a more stable trend during that period, decreased from 13 percent to 11 percent. This shows that the banks are more focused on external financing sources than on internal sources and use more deposits to finance their lending activities and other assets. One of the most noticeable changes that emerged following the crises was the improvement in the non-performing loan ratio. The ratio of non-performing loans, which is an indicator of asset quality, decreased from 12 percent in 2003 to 4 percent in 2018. However, the non-performing loans ratio increased slightly in 2019 and rose to 5.71 percent. Finally, we see that the ROA, which shows the banks' asset profitability, dropped from 3.5 percent to 1.40 percent in this period. As noted, the probable explanation is that the restructuring regulations and macroeconomic measures eliminate the more profitable non-banking activities that emerged in the 1990s after the crises. Therefore, banks rely more on their primary functions in the financial system.

Overall, the Turkish banking sector has faced several crises, undergone many structural changes, and experienced a set of regulatory measures, particularly after the introduction of the financial liberalization process in the 1980s. Although the steps taken as a result of developments in this period are sometimes unsuccessful, the measures taken after the crises of 2000 and 2001 guided the banking sector in a sound and healthier structure. They strengthened the role of the banks in financing real economic activity.

3.4. Data and Variables

3.4.1. Data

The empirical analysis of this chapter concentrates on the sample of 19 deposit banks in Turkey that conduct their operations with at least ten branches. These banks constitute 97.13 percent of the total assets and 97.35 percent of the total loans in the deposit banking sector. The sample banks were listed in Table 7.3. in the Appendix. The dataset contains nine bank-specific variables, seven macroeconomic indicators, and three global factors to determine the factors that are critical to explaining bank lending behavior. Thus, the dataset employs 19 explanatory variables. Such variables consist of the indicators used to determine the factors affecting bank loans in previous studies. The next section gives detailed explanations of the variables used in the analysis. The sample consists of quarterly observations and covers the period between 2002 Q4 to 2019 Q2. The starting date coincides with the post domestic crisis period for Turkey. The total number of bank-year observations is 23,940.

The only source for bank-level data is the statistical reports of the Banks Association of Turkey (BAT). The BAT delivers quarterly balance sheets of each bank settled in Turkey. Other sources for the wide-range dataset are Thomson Reuters Eikon and Electronic Data Delivery System (EDDS) provided by the Central Bank of the Republic of Turkey (CBRT). The full list of these variables, their acronyms, descriptions, units, and sources, were given in Table 7.4. Appendix B.

3.4.2. Variables

The model specification of this chapter to estimate the drivers of bank lending in Turkey employs the natural logarithm of nominal bank loans (Ln(Loans)) as a measure of the extended bank loans. This variable includes a total of consumer and commercial loans in both domestic currency and foreign currency. However, all figures are in TL since banks' balance sheet includes foreign currency dominated loans in TL terms. As explanatory variables, the model embodies a comprehensive set of variables in three groups. These are bank-specific

variables, macroeconomic indicators, and global factors. These selected variables have been shown to play a significant role in the bank's lending behavior by existing studies (see Table 7.4. in Appendix B for variable definitions and groupings).

Table 3.2 provides the correlations between the natural logarithm of nominal bank loans and the set of employed variables up to their fourth lags.

Table 3.2. Correlations of explanatory variables

Variable	Ln(Loans)	Variable	Ln(Loans)	Variable	Ln(Loans)	Variable	Ln(Loans)
Ln(Loans)	1.000	FATA	-0.279	LEAD	0.482	OIL	0.130
CAPR	-0.409	FATA(-1)	-0.285	LEAD(-1)	0.478	OIL(-1)	0.158
CAPR(-1)	-0.418	FATA(-2)	-0.287	LEAD(-2)	0.474	OIL(-2)	0.184
CAPR(-2)	-0.410	FATA(-3)	-0.287	LEAD(-3)	0.470	OIL(-3)	0.203
CAPR(-3)	-0.409	FATA(-4)	-0.294	LEAD(-4)	0.466	OIL(-4)	0.219
CAPR(-4)	-0.398	FFR	-0.235	LENDINGR	-0.188	ON	-0.199
CPI	0.494	FFR(-1)	-0.230	LENDINGR(-1)	-0.213	ON(-1)	-0.260
CPI(-1)	0.497	FFR(-2)	-0.230	LENDINGR(-2)	-0.220	ON(-2)	-0.326
CPI(-2)	0.499	FFR(-3)	-0.231	LENDINGR(-3)	-0.237	ON(-3)	-0.374
CPI(-3)	0.504	FFR(-4)	-0.231	LENDINGR(-4)	-0.288	ON(-4)	-0.414
CPI(-4)	0.508	GVT2Y	-0.374	LIQR	0.275	REER	-0.236
DEPOVER	0.305	GVT2Y(-1)	-0.393	LIQR(-1)	0.273	REER(-1)	-0.208
DEPOVER(-1)	0.315	GVT2Y(-2)	-0.408	LIQR(-2)	0.268	REER(-2)	-0.164
DEPOVER(-2)	0.325	GVT2Y(-3)	-0.422	LIQR(-3)	0.261	REER(-3)	-0.101
DEPOVER(-3)	0.332	GVT2Y(-4)	-0.434	LIQR(-4)	0.258	REER(-4)	-0.034
DEPOVER(-4)	0.340	GVT9M	-0.266	LLPTA	0.170	ROA	0.262
DFR	-0.136	GVT9M(-1)	-0.326	LLPTA(-1)	0.173	ROA(-1)	0.274
DFR(-1)	-0.124	GVT9M(-2)	-0.358	LLPTA(-2)	0.177	ROA(-2)	0.289
DFR(-2)	-0.099	GVT9M(-3)	-0.390	LLPTA(-3)	0.180	ROA(-3)	0.298
DFR(-3)	-0.074	GVT9M(-4)	-0.420	LLPTA(-4)	0.181	ROA(-4)	0.291
DFR(-4)	-0.064	GVTTA	0.121	Ln(GDP)	0.524		
ECB	-0.389	GVTTA(-1)	0.119	Ln(GDP)(-1)	0.523		
ECB(-1)	-0.383	GVTTA(-2)	0.113	Ln(GDP)(-2)	0.524		
ECB(-2)	-0.385	GVTTA(-3)	0.111	Ln(GDP)(-3)	0.527		
ECB(-3)	-0.389	GVTTA(-4)	0.107	Ln(GDP)(-4)	0.527		
ECB(-4)	-0.396						

Table 3.2 reflects that the GDP, CPI, and leading indicators are those that have the highest positive correlation with the nominal bank loans. On the other hand, long-term

government bond yield, short-term treasury bill yield, and capital ratio are the variables that have the highest negative correlation with nominal bank loans. It is observed that macroeconomic indicators are highly correlated with bank loans. Of the bank-specific variables, capital ratio, deposit overhang, asset structure, profitability, and liquidity measures seem to be more correlated than their counterparts. Among the global factors, it is apparent that the European Central Bank's (ECB) main refinancing rate and oil prices have relatively higher correlations with nominal bank loans. Besides, it is noteworthy that lags of some variables are more correlated with a dependent variable.

Since bank lending does not respond contemporaneously to the changes in bank-specific characteristics, macroeconomic indicators, and global factors, the empirical model of this chapter was specified, inserting the highly correlated lag of each variable into the analysis. Most of the explanatory variables were lagged to mitigate the unintended feedback effects due to the endogeneity issues (Berger and Udell, 1994). Based on this definition, the list of current or lagged values and the descriptive statistics of the variables used have been provided in Table 3.3.

Table 3.3. Descriptive statistics

Group	Acronym	Lag	Unit	Mean	Median	Max.	Min.	Std. Dev.
Dep. Var.	Ln(Loans)	Current	TL	16.005	16.175	19.665	3.611	2.064
Bank-Specific Characteristics	LLPTA	4	Ratio	0.017	0.015	0.085	0.000	0.012
	LIQR	Current	Ratio	0.253	0.241	0.781	0.006	0.121
	GVTTA	Current	Ratio	0.172	0.144	0.774	0.000	0.128
	FATA	4	Ratio	0.020	0.013	0.516	0.001	0.030
	DFR	Current	Ratio	0.629	0.621	0.875	0.012	0.091
	DEPOVER	4	Ratio	-0.082	-0.020	1.640	-0.984	0.310
	CAPR	1	Ratio	0.121	0.114	0.916	0.033	0.051
	ROA	3	Ratio	0.008	0.008	0.059	-0.176	0.014
	LENDINGR	4	Ratio	0.083	0.074	1.589	0.018	0.065
Macroeconomic Indicators	Ln(GDP)	4	Thousand TL	19.554	19.487	20.609	18.383	0.595
	LEAD	Current	Index	152.992	139.380	215.910	120.770	30.806
	CPI	4	Index	106.766	99.731	195.931	48.800	38.714
	ON	4	%	12.659	10.500	44.000	1.500	8.885
	REER	Current	Index	101.348	101.355	118.183	76.655	9.351
	GVT9M	4	%	14.617	11.001	54.700	4.460	10.576

	GVT2Y	4	%	24.407	11.300	81.690	5.670	26.726
Global Factors	FFR	Current	%	1.339	0.400	5.260	0.070	1.662
	ECB	4	%	1.467	1.000	4.250	0.000	1.301
	OIL	4	US Dollar	71.114	66.725	121.477	26.067	28.389

The dependent variable in our specification is the natural logarithm of the nominal bank loans. The nominal bank loans are the outstanding amount of loans to households and firms in a sample of 19 deposit banks. This measure of the bank loans has been used by the existing studies (i.e., Panagopoulos and Spilliotis, 1998; Gambacorta and Rossi, 2010), and some studies used a similar measure as a dependent variable (i.e., Hoffman, 2001; Calza et al. 2003).

The first set of explanatory variables is the bank-specific characteristics that are derived from deposit banks' balance sheets and income statements. These variables stand for assessing the role of bank characteristics on bank lending. The literature suggests that the response of bank lending is heterogeneous among banks with different characteristics (Kashyap and Stein, 1995).

Among the bank characteristics that might affect bank lending behavior, this study first introduces the loan loss provisions to the total assets variable (LLPTA). This ratio is an indicator of the bank's credit risk perceptions (Brissimis et al. 2014). As non-cash expenses for expected future losses in banks, loan loss provisions are seen as a measure of credit risk for banks (Santis et al. 2013). This ratio is also used as a measure of credit quality (Cucinelli, 2015). Bonaccorsi and Sette (2010) argued that the loan loss provisions ratio, unlike the stock of non-performing loans, is a stronger measure of the quality of bank assets since it demonstrates the ongoing deterioration of the bank's asset portfolio. This measure has been widely used in bank lending literature (i.e., Cantero-Saiz et al. 2014; Brissimis et al. 2014; Kosak et al. 2015; Blundell-Wignall and Roulet, 2013). The reverse relationship between LLPTA and Ln (Loans) is expected because banks with higher credit risk or worse portfolio quality could intend to lower the loan supply.

The second bank-specific characteristic is the balance sheet liquidity. This study measures the balance sheet liquidity by two variables. The first one is the ratio of liquid assets

to total assets (LIQR). In this measure, the liquid assets include cash and balances with the central bank and government securities. Many studies employed similar measures of balance sheet liquidity in their analyses (i.e., Gambacorta and Mistrulli, 2004; Sengonul and Thorbecke, 2005; Bonaccorsi and Sette, 2010; Demiralp et al. 2017). The higher liquidity ratio means that a bank can better manage its loan supply (Laidroo, 2016) and shows the bank's soundness in sustaining its credit growth (Bertay et al. 2012). Thus, the expected link between liquidity and bank loans is definite (Cantero-Saiz et al. 2014). The second measure is government securities over total assets (GVTTA). The portfolio of government security stands for the buffer against potential drains of deposits (Çavuşoğlu, 2002; Sengonul and Thorbecke, 2005; Berrospide and Edge, 2010)

The asset structure of banks may also affect their lending behavior. The ratio of fixed assets to total assets (FATA) can be used as a proxy for the bank's asset structure. Technology equipment, facilities, buildings, branch networks are included in the bank's fixed assets (Casu et al. 2006). The ratio of fixed assets to total assets could be a measure of bank asset tangibility (Kosak et al. 2015) and might be a significant factor in bank lending behavior.

Examining the role of financing structure on bank lending is also a common practice in the literature. The ratio of total deposits to total assets (DFR), namely the deposit funding ratio, is used as an indicator of bank's funding structure in many studies (i.e., Gambacort and Marquez-Ibanez, 2011; Bertay et al. 2012; Rabab'ah, 2015). Since the response of non-deposit funding sources of banks tends to respond quickly to instabilities in financial markets, the DFR is an indicator of the bank funding stability (Bertay et al. 2012). The second financing source indicator is the deposit overhang (DEPOVER). The DEPOVER is calculated as the ratio of total loans to total deposits minus one. The bank is illustrated as in deposit overhang when the amount of deposits (insured source of funding) is higher than the number of loans. It is argued that banks in a deposit overhang finance their loan portfolio and other assets more efficiently, especially during the crisis (Brinkmeyer, 2014). Thus, the expected association between deposit overhang and bank lending is positive.

Another bank-specific characteristic that is highly debated on bank lending literature is capitalization. Similar to many existing studies, (i.e., Berrospide and Edge, 2010; Bertay et al.

2012; Brissimis et al. 2014; Cucinelli, 2015, Borio and Gambacorta, 2017) this study uses the ratio of total capital over total assets (CAPR). Many studies argue that capitalization is critical for bank solvency against adverse shocks (Gambacorta and Mistrulli, 2004). Besides, Gambacorta and Marquez-Ibanez (2011) proposed two conditions that the bank capitalization significantly affects bank lending. The first argument proposes that if bank capital and other sources of market funding are imperfect substitutes, and the capital stock is less costly than alternatives, the capital stock will be a buffer for financial shocks. In this context, the positive association is expected between bank capital and bank lending. On the other hand, the second argument suggests that as the capital adequacy requirements are related to the amount of outstanding credit increase, banks may limit their credit risk since capital requirements are costly. In this vein, we expect a negative association between bank lending and capital stock.

Another bank-specific characteristic that may affect outstanding loans is bank profitability. Like many other existing studies (i.e., Bonaccorsi and Sette, 2010; Brissimis et al. 2014; Pham, 2015), this study uses return on assets (ROA), which is calculated as the ratio of profit before-tax over total assets. Since the higher profitability of any bank coincides with the balance sheet strength and quality of assets, banks enjoying higher profits may intend to lend more (Kim and Sohn, 2017). However, the opposite argument suggests that in more competitive banking sectors, lower profit margins force banks to increase their lending (Naceur et al. 2018).

The last variable included as the bank-specific characteristic is the bank's lending rate (LENDINGR). Since we do not have any direct data source providing the bank-level lending rate data, we followed Kapounek et al. (2017) and found the bank-level average lending rate by dividing the interest income to gross loans at the same period. Although high lending rates encourage banks to increase their loan supply, borrowers might reduce their loan-demand. Therefore, the impact of the bank lending rate on outstanding loans might be ambiguous (Rabab'ah, 2015).

This study introduces a set of macroeconomic indicators into the model to control for the bank lending behavior. The first macroeconomic indicator is the natural logarithm of the nominal GDP. As in many of the previous studies (i.e., Egert et al. 2007; Kapounek et al.

2017), Ln(GDP) variable controls for the impact of demand shocks on bank lending. Besides, the GDP is handled to provide the procyclical behavior of bank lending in previous studies (Pham, 2015; Kapounek et al. 2017). Calza et al. (2003) discussed the impact of economic activity on bank lending and proposed two opposing forces. First and the most common argument is that the rising income level increases the opportunity for profitable projects and triggers the demand for bank-loans (Kashyap et al. 1993). The second argument suggests that the increasing income level reduces the demand for loans since firms prefer to use internal financing sources.

Similarly, to capture the impact of demand factors on bank lending, the study alternatively employs the composite leading indicators index (LEAD). The LEAD stands for the provision of early signals of business cycle fluctuations. The study of Caglayan and Xu (2016) handles the volatility in leading indicators.

This study employs the consumer price index (CPI) to analyze the impact of price stability on bank lending. Rousseau and Wachtel (2002) argued that banks would not finance longer-term projects and would be unintended to lend during inflationary periods (Pham, 2015). Another argument is that the rising revenues after price level changes decrease the demand for bank credit (Panagopoulos and Spilliotis, 1998). Thus, the increasing price level is expected to be associated with diminishing bank loans.

The interbank overnight interest rate (ON) is used to account for the impact of monetary policy stance on bank lending behavior. Although the response of banks to monetary policy changes is heterogeneous regarding their financial structures, the rise in monetary policy rates will probably decrease their lending (Hoffman, 2001). From the banks' perspective, the monetary policy rate stands for the cost of short-term marginal funding (Borio and Gambacorta, 2017). It is also an anchor for banks' refinancing costs (Gambacorta and Rossi, 2010). This study alternatively employs the 9-month treasury bill yield rate (GVT9M) and the 2-year government bond yield rate (GVT2Y) to control for the impact of short-term and long-term market rates respectively on bank lending behavior.

The real effective exchange rate (REER) is the last macroeconomic indicator in our empirical specification. The rise in the REER represents the appreciation of the domestic

currency in our specification. The exchange rate variable is expected to be significant in bank lending, especially in emerging economies. Following the depreciation of the domestic currency, the bank loans in domestic currency measure pick up the valuation effect of the foreign currency, which in turn creates a negative association between real effective exchange rate and bank lending (Imran and Nishat, 2013). Besides, Pham (2015) argued that the level of the exchange rate might affect bank lending in two potential ways. First, the appreciation of domestic currency would decrease exports, which causes the fall of both credit demand and credit supply. Second, the ongoing depreciation of the domestic currency might create a risky economic and financial environment and decrease the outstanding loan supply.

Together with bank-specific characteristics and macroeconomic indicators, this study also aims at examining the role of global factors on bank lending. Since Turkey is a small open economy, global financial and economic development might affect the domestic economy (Varlik and Berument, 2017). To this extent, the study employs the US Federal Funds Rate (FFR), ECB Main Refinancing Rate (ECB), and the crude oil price (OIL). Of these variables, FFR and ECB are specified to account for the impact of global liquidity (Pham, 2015) and reflect the cost of foreign banks' borrowing (Ivanovic, 2016) on outstanding bank loans. Finally, the oil price variable is added to the analysis to capture global developments (Potjagailo, 2017). Changes in oil prices might have adverse effects on investment and consumption expenditures, increases production costs, and reduces firms' cash flows (Kocaarslan and Soytas, 2019). Therefore, one would control the impact of oil prices on bank lending behavior.

3.5. Methodology

This research follows the approach proposed by Basuchoudhary et al. (2017) and employs four machine learning techniques (tree regression, bagging, boosting, and random forest) and a linear regression estimate for comparison purposes of analyzing the factors affecting commercial bank lending activity in Turkey.

It is noteworthy to address the properties of such techniques before introducing the empirical specification of the study. The purpose of the machine learning techniques is to

predict the output variable (Y) in an independent test sample by using the learning sample where both input (X) and output variables are observed (Athey, 2018). In machine learning techniques, algorithms repeatedly resample within the learning sample and try to find the one that fits the data best (Basuchoudhary et al. 2017).

The standard linear regression models are an illustration of the parametric models, and they assume a linear functional form $Y = f(x)$. These models are generally not difficult to implement, the estimated coefficients are easy to interpret, and it is easy to decide the statistical significance of these coefficients (James et al. 2013). However, these models generally cannot handle large dimensional datasets (Fornaro and Luomaranta, 2020). In other words, they only estimate a small number of variables in any specification. On the other hand, if the linearity assumption is not in place, it is reasonable to assume that these models fail to fit the data best.

Unlike standard techniques, the machine learning techniques, therefore; allows researchers to handle a large dimensional dataset (Fornaro and Luomaranta, 2020), provides model flexibility without forcing the specification into a specific functional form (Mullainathan and Spiess, 2017), and do not need any prior assumptions regarding the distribution of variables (Alessi and Detken, 2018).

The structure of the empirical part of the study is as follows: First, the data set is split into two categories as the learning sample and the test sample randomly. Then, we calculate the predictive ability of these empirical methodologies. The study calculates the mean square error (MSE) as a measure of the out-of-sample predictive ability of these empirical techniques. The next step assesses the variable importance measures and ranks bank characteristics, macroeconomic indicators, and global factors regarding their role in predicting bank lending behavior. Finally, this study provides partial dependence plots to illustrate the direction, magnitude, and the form of the impact of input variables on bank lending behavior.

The theoretical illustration of the employed machine learning techniques was presented in the following sections.

3.5.1. Regression Tree Prediction

A regression tree prediction aims to divide the sample into subsamples regarding the impurity of the target variable (y_i) by using if-then statements as parameters, unlike the parametric coefficients of the linear models (Basuchoudhary et al. 2017). The regression tree prediction starting with the learning sample, $L = \{(y_1 x_1, \dots, y_N x_N\}$ internally determines the terminal nodes and internal nodes, which are splitting variables and splitting points, respectively (James et al. 2013). Here x is the vector of input variables, and N represents the number of observations.

The tree prediction divides the learning sample into subsamples by a decision rule $\hat{d}(x)$. The decision rule determines the splitting points for each node by minimizing the impurity within the node. The most common measure of node impurity is the mean square error (MSE). The MSE is denoted as $R(d)$ and calculated with the following formula (Breiman, 1984):

$$R(d) = \frac{1}{n}\sum_{i=1}^{N}(y_i - \hat{f}(x_i))^2 \tag{3.1}$$

Here, the $R(d)$ is the mean of the squared difference between the target variable y_i and the predicted value of the target variable, $\hat{f}(x_i)$. Therefore, the best terminal node and the best internal node produce a higher node impurity change. The best splitting point also needs to meet the externally determined minimum decrease in impurity and the minimum number of observation requirements within each node (Basuchoudhary et al. 2017).

Regression trees offer many advantages. They are easy to interpret and explain, and they can include qualitative variables in the analysis without the need for dummy variables (James et al. 2013).

3.5.2. Boosting Prediction

The boosting algorithm is a technique to improve the prediction and based on the decision tree. The boosting methodology was first proposed by Freund and Schapire (1997). It was initially developed for classification purposes, but also has been benefited for regressions (Hastie et al. 2017). Boosting algorithms construct several copies of the learning sample. The tree fits on a revised version of the learning data. The algorithm fits each copy into a different decision tree and then incorporates all the trees to create a single predictive model. The steps for boosting regression is as follows (James et al. 2013):

Consider many decision trees in which provide the predictions as $\widehat{f^1}(x), \widehat{f^2}(x), \dots, \widehat{f^M}(x)$. First, set $R_i = 0$ and $y_i = \hat{f}(x_i)$. Then, repeat the following procedures for $m = 1,2, \dots, M$ where M represents the number of trees: Fit a tree $\widehat{f^m}(x)$ with a total of k splits and (k+1) nodes to the learning sample. Update the tree by adding the shrinkage parameter-augmented tree prediction $(\boldsymbol{\lambda} * \widehat{f^m}(x))$ to the initial tree prediction $\hat{f}(x)$. Then, update R_i by subtracting the shrinkage parameter-augmented predicted observation from an initial residual, $R_i - \boldsymbol{\lambda} * \widehat{f^m}(x))$ where the R_i is an initial residual and the $\boldsymbol{\lambda} * \widehat{f^m}(x))$ is the shrinkage parameter-augmented predicted observation. Finally, calculate the boosted model by $\hat{f}(x) = \sum_{m=1}^{M} (\boldsymbol{\lambda} * \widehat{f^m}(x))$. Briefly, given the current model, the algorithm fits a decision tree prediction, $\hat{f}(x)$, to the residuals from the model. The algorithm slowly improves $\hat{f}(x)$ where it performs not well by fitting small trees to the residuals. The role of the shrinkage parameter, ($\boldsymbol{\lambda}$), here is decelerating the process further and to allow more trees to fit the residuals.

3.5.3. Bagging (Bootstrap Aggregating) Prediction

The bagging predictor first proposed by Breiman (1996) is a technique by which multiple versions of a predictor are generated and used to get an aggregated predictor. The experimental procedure of the bagging predictor is as follows (Breiman, 1996):

Assume that we have a learning data $L = \{(y_1 x_1, \dots, y_N x_N\}$, and fit a model to the learning sample. The $\hat{f}(x)$ represents the tree prediction to fit a model from the learning sample. Here, the methodology takes M random samples from the learning data in which each

includes N independent observations. As noted, N is the number of observations in the learning sample. Since the aim is to provide a better predictor than a single tree predictor by reducing the variance, the bagging technique takes the bootstrapped learning samples and get a series of the three predictions, $\widehat{f^1}(x), \widehat{f^2}(x), \ldots, \widehat{f^M}(x)$. The bagging predictor is the average of the sequence of tree predictions and illustrated as $\widehat{f^{ave}}(x)$.

Notably, the bagging methodology forms the learning sample by randomizing the selection of observations with replacement and defines splits for each node by minimizing the node impurity to grow M trees. The bagged tree is the average of the prediction form M trees (Hastie et al. 2017).

3.5.4. Random Forest Prediction

The random forest algorithm is another tree-based algorithm used for regression purposes. The random forest algorithm was first proposed by Breiman (2001). The random forest predictor randomizes the trees, both selecting bootstrapped observations as learning samples and by selecting input variables for nodes of each tree (Basuchoudhary et al. 2017). Specifically, learning samples are independently drawn and the tree predictors of random forests for regression, $\widehat{d^1}(x), \widehat{d^2}(x), \ldots, \widehat{d^m}(x)$, depend on random vectors $\Theta_m = 1,2, \ldots, M$. (Breiman, 2001).

After drawing a bootstrap sample of size N from the learning sample, the random forest methodology randomly selects k variables out of total p of them ($k \leq p$), and these variables are the possible candidates for splitting in each node. Then, the M random forest trees $\hat{d}(x;\ \Theta_m)$ are grown repeatedly until the minimum node size is reached. The random forest methodology selects k variables and gets the best splitting variable and best splitting point for each terminal node of the tree. The random forest regression predictor is $\widehat{f_{rf}^{ave}}(x)$ is the average of total M trees, $\hat{d}(x;\ \Theta_m)$.

3.5.5. Variable Importance and Partial Dependence Plots

The study provides the variable importance measure to demonstrate the relative importance of input variables on bank lending behavior and presents partial dependence plots (PDP) to display the functional form and direction of the relationship between these input variables and bank loans.

The machine learning algorithms utilize a variable importance measure to provide the relative predictive power of the input variables (Hastie et al. 2017). The importance of any specific variable is calculated by summing the impurity reduction when this specific variable is selected in splits (Tuffery, 2011). Specifically, the error reduction at each split in each tree is the importance measure of the splitting variable and is measured separately for each variable over all the trees (Hastie et al. 2017). In our algorithms, the variable importance is specified by using their contribution to the reduction of the MSE. Therefore, each variable leads to the decrease of the MSE in each node and the overall reduction of the MSE by the particular variable decides its relative importance.

The partial dependence plot is also an illustrative measure for visualizing the relationship between the input variable and the output variable. The PDP illustrates the following function graphically (Basuchoudhary et al. 2017):

$$\hat{f}(x) = \frac{1}{n}\sum_{i=1}^{N} f(x_k, x_{i,-k}) \tag{3.2}$$

Therefore, the PDPs demonstrate the marginal impact of a selected input variable on the target variable after holding the impact of other variables constant (James et al. 2013).

3.6. Empirical Results

As noted, the empirical specification of this chapter is based on the general set up, followed by Basuchoudhary et al. (2017). The model specification comprises panel OLS regression and the following four machine learning algorithms. These are tree regression,

boosting, bagging, and random forest algorithms. Before proceeding the predictive ability of the employed algorithms, the study first divides the data sample into learning data and training data. In this specification, the randomly chosen seventy percent of the banking data was used as a learning sample, and the remaining part stands for the out-of-sample validation purpose. Then the study selects the algorithm that best fits the out-of-sample (training) data. Given the predictive power, the study then the study ranks the variables regarding their prediction strengths. Finally, the empirical analysis demonstrates the marginal impacts of bank-specific, macroeconomic, and global factors on bank lending behavior.

3.6.1. Predictive Quality

The prediction performance of the employed algorithms is measured by the mean square error (MSE). The MSE measures the predictive quality of the algorithm and calculated by taking the average of the square of the differences between the sample value and its estimated value (Tuffery, 2011). MSE is the one measure that is frequently used in deciding to predict quality (Alpaydin, 2014). Table 3.4 reports the MSE of the employed algorithms.

Table 3.4. The predictive quality of empirical methods in the test sample

Methods	MSE	Reduction in MSE (%)
Panel OLS Regression	1.92	13.75
Tree Regression	3.29	-47.26
Bagging	2.09	6.45
Boosting	1.73	22.50
Random Forest	**1.53**	**31.36**

Note: The total MSE of the model is 2.235, and the % reduction in MSE is calculated by (Total MSE-Model MSE)/Total MSE. $Total\ MSE = \sum(Y_i - E(Y))^2$ in the test sample.

Table 3.4 demonstrates that there are not many differences in the predictive quality of the employed algorithms. Among these specifications, the random forest provides the lowest mean square error in which it has the best predictive ability.[3] The MSE of the random forest algorithm in the test sample is 1.53. The random forest algorithm also reduces the total MSE

[3] Mean Absolute Percentage Error (MAPE) measure also provided similar results.

by 31.3 percent. Therefore, it seems that the random forest algorithm reduces approximately one-third of the total errors in the model. Among these algorithms, the performance of the tree regression is much worse than its counterparts, and it provides a relatively higher mean squared error than the total mean squared error.

Moreover, Figure 3.4 displays that the random forest algorithm reduces the out of sample error rate immediately, and it reaches an equilibrium.

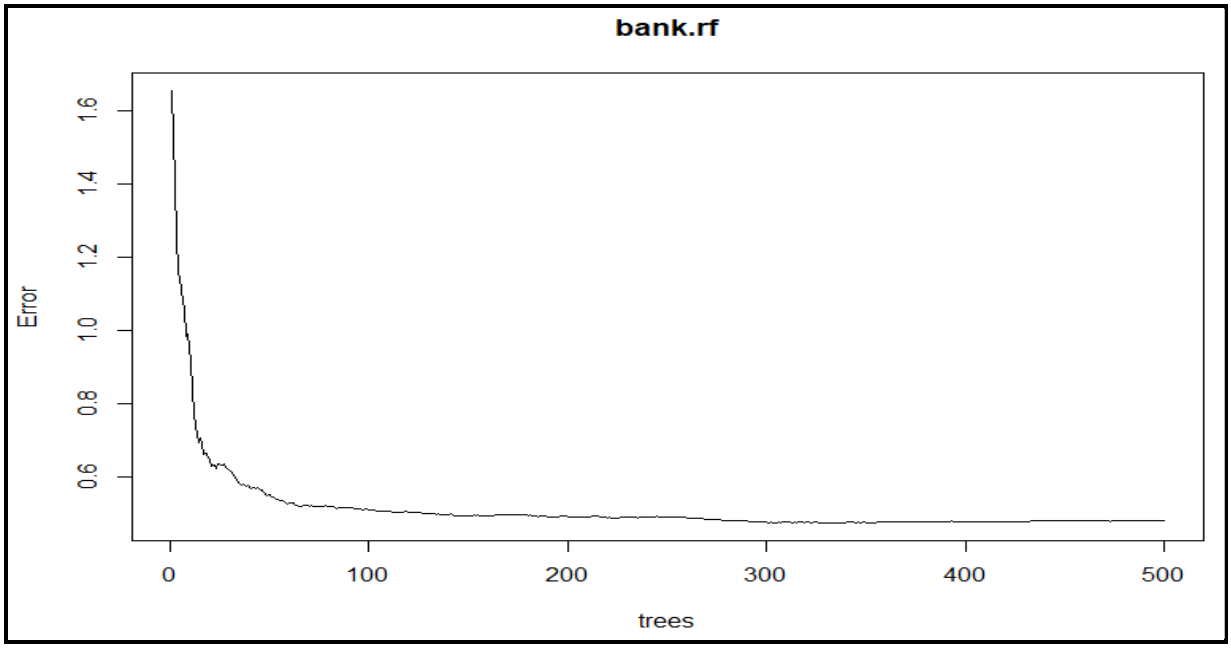


Figure 3.4. The fall of error rate

3.6.2. Variable Importance

The increase in the MSE calculates the variable importance in each algorithm at this moment after removing the specific variable. Table 5 reports the rank of the 19 variables regarding their importance in predicting the outstanding bank loans.

Table 3.5. The rank of variable importance

Rank	Variable	Tree	Forest	Bagging	Boosting
1	CAPR	12.513	**11.621**	27.543	21.043
2	DEPOVER	6.524	**10.695**	7.705	7.950
3	LLPTA	5.271	**8.476**	12.714	15.632
4	CPI	10.248	**8.070**	12.702	7.676
5	LIQR	5.422	**7.279**	3.934	3.945
6	DFR	4.713	**7.184**	6.239	7.005
7	GDP	9.181	**6.910**	5.919	7.258
8	LEAD	6.819	**6.708**	2.362	2.943
9	FATA	6.137	**6.242**	8.969	8.127
10	ROA	5.787	**6.059**	6.186	10.170
11	GVTTA	5.415	**5.916**	2.441	2.626
12	ECB	5.388	**3.866**	0.378	0.117
13	GVT2Y	4.721	**2.583**	0.284	0.262
14	ON	1.652	**2.436**	0.361	1.173
15	GVT9M	1.446	**2.171**	0.280	0.500
16	OIL	0.702	**1.382**	0.433	0.344
17	FFR	5.911	**1.006**	0.463	0.714
18	REER	1.696	**0.897**	0.528	0.356
19	LENDINGR	0.453	**0.502**	0.558	2.160

Note: The ranking is based on the variable importance in the random forest model, and numbers are in %.

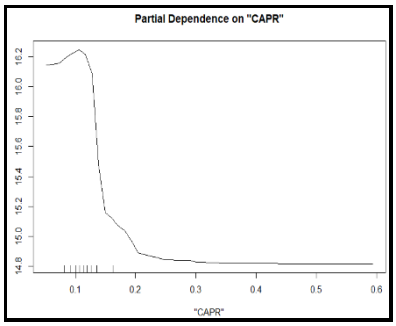
Table 5 shows the percentage increase in Model-MSE if a variable for each algorithm is removed from the model. To illustrate, if CAPR is removed from the model, the MSE increases by 12.51% in the tree model, 11.62% in the random forest model, 27.54% in the bagging model, and 21.04% in the boosting model. So, the total is 100% in each column.

The table above illustrates that most of the bank-specific characteristics and macroeconomic indicators do have relatively more predictive power than global factors. These findings would seem to suggest that capital ratio, deposit hangover, and credit risk measures are the most powerful predictors. Besides, CPI, GDP, and leading indicators index have more predictive power, among other macroeconomic indicators. Although its relative importance is lower among the input variables, the ECB main refinancing rate seems to be the most influential global factor.

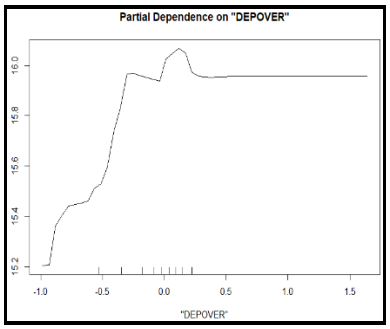
3.6.3. Partial Dependence Plots

As having the most predictive power, random forest algorithm results turn out to provide meaningful policy implications for policymakers. Unlike many other empirical methodologies, the random forest algorithm is not parameter-based. Instead, they offer partial dependence plots (PDP). As noted, partial dependence plots illustrate the direction, impact, and the functional form of the relationship between the input variable and output variable, holding the impact of others constant. The distinct benefit of the random forest methodology through the illustration of the PDPs is that they illustrate the incremental effect of the selected variables over the range of a specific variable.

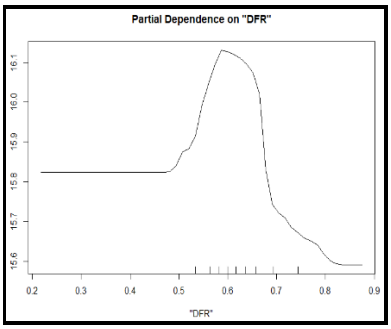
In this context, the following figures display the partial dependence plots and visualize the incremental impacts of bank-specific variables, macroeconomic indicators, and global factors on the outstanding bank loans. In each PDP, the vertical axis represents the volume of bank loans in natural logarithm and the horizontal axis displays the range of input variables. Figure 3.5 illustrates the partial dependence plots for bank-specific characteristics.



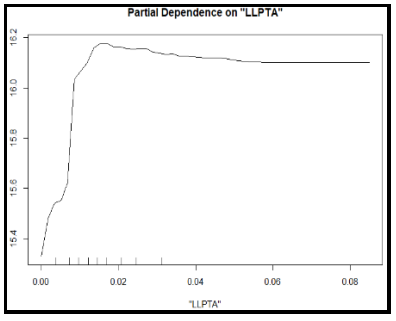
a) CAPR



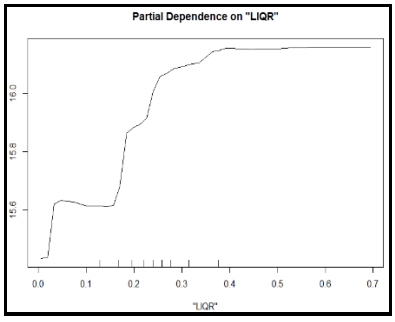
b) DEPOVER



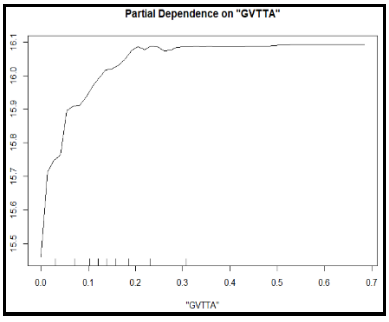
c) DFR



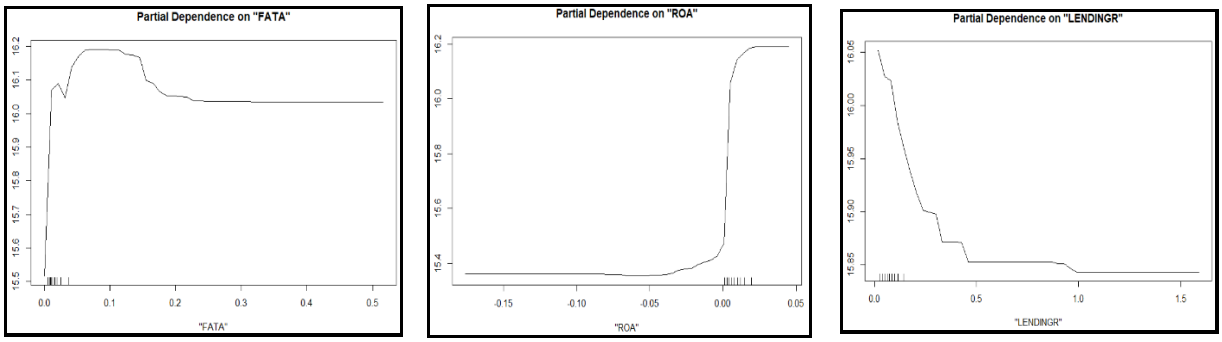
d) LLPTA



e) LIQR



f) GVTTA



g) FATA h) ROA i) LENDINGR

Figure 3.5. Partial dependence plots for bank-specific characteristics

The PDP for CAPR in Figure 3.5(a) suggests that the effect of the capital ratio on bank loans is not linear over the spectrum of capital ratio. The figure shows that the positive impact of the capital ratio on bank loans increases slightly until the capital ratio hits just over 10 percent. This finding is consistent with studies providing a positive relationship between capital ratio and bank lending (i.e., Berrospide and Edge, 2010; Cantero-Saiz et al., 2014; Ivanovic, 2016; Kapounek et al., 2017). Such studies suggest that bank capital is vital against adverse shocks to bank soundness, and support banks to overcome the negative consequences of these shocks.

Even a small increase in the capital ratio will produce a more substantial adverse effect on bank loans after the capital ratio hits marginally above 10 percent. It suggests that after ten percent, a small increase in CAPR would result in an equilibrium shift. In particular, a capital ratio rises to twenty percent has a negative impact on bank lending. These results provide evidence that regulatory capital plays a conservative role in bank lending (Cucinelli, 2015; Pham, 2015). The negative association between bank capital and bank lending in Turkey is also consistent with the findings of Aktaş and Taş (2007) and Macit (2012). After twenty percent, further capital ratio improvements have a minor and smoother effect on bank loans. Some studies produced somewhat mixed results and indicated that bank capital plays an insignificant role in bank loans (i.e., Bertay et al., 2012; Rabab'ah, 2015).

The PDP for the effects of deposit overhang on bank loans was shown in Figure 3.5(b) As noted, the bank is in deposit overhang when deposits are more significant than the bank

loans. To illustrate, when bank loans and deposit are equal to each other the DEPOVER measure is equal to zero. Figure 3.5(b) shows that bank lending is positively affected by deposit overhang. It seems that the impact of deposit overhang measure steadily increases up to the point where there is a balance between deposits and loans in the bank balance sheet. It should also be noted that if bank loans exceed bank deposits, the relationship between deposit overhang and bank loans reaches an equilibrium. Such findings are consistent with Brinkmeyer's (2014) findings and suggest the critical role of insured deposits in financing lending activities.

Figure 3.5(c) further illustrates the relationship between the share of deposit financing and bank loans. Although the predictive salience is relatively lower than DEPOVER, similar evidence is provided about the impact of the deposit funding ratio on outstanding bank loans. The partial dependence plot for DFR further supports the nonlinear linkage between the share of deposits in total assets and bank lending. It seems that the impact of DFR on bank loans reaches an equilibrium until there is a balance between the share of deposits and the non-deposit source of liabilities. These findings are similar to those of Bertay et al. (2012) or Rabab'ah (2015). Such studies suggest a positive but insignificant coefficient of deposit funding ratio in their studies.

However, the small rise in the share of deposits causes a relatively higher increase in bank lending after the specific threshold level of fifty percent. This finding might propose that the optimal share of deposit financing stands around sixty percent. This specific range of the DFR somewhat supports the proposition that banks with a relatively higher share of the deposit than other liabilities increase their lending. In this sense, our findings are partially consistent with previous studies (i.e., Gambacorta and Marquez-Ibanez, 2011; Sarath and Van Pham, 2014; Malede, 2014; Ivanovic, 2016) arguing the role of deposit financing to stabilize the adverse effects of financial downturns. However, Figure 3.5(c) indicates that the following rise in the share of deposits contributes to a decrease in bank loans. Therefore, our findings suggest that reliance on deposit financing is contractionary after some degree.

The loan loss provisions to total assets as a measure of credit risk also have relatively higher predictive power on bank lending behavior. As can be seen from Figure 3.5(d), the

LLPTA has a positive impact on bank loans when credit risk measure is relatively low. Surprisingly, it seems that the positive marginal impact steadily increases until the LLPTA approaches two percent. A possible explanation for this might be that banks remain silent to credit risk measures up to a threshold level and prefer to increase their lending.

However, after the credit risk measure reaches just below two percent level, the impact of LLPTA alternates and turns to be negative. Our findings with this confirm that worsening credit quality reduces bank lending. Therefore, it may be inferred that the rise in the credit risk measure puts pressure on banks' capital and causes banks to limit their lending. (Naceur et al. 2018). These results are partially in accord with previous studies (i.e., Cantero-Saiz et al. 2014; Sarath and Van Pham 2014; Cucinelli 2015; Kim and Sohn 2017; Naceur et al. 2018) indicating that banks with higher credit risk tend to curtail their loans.

Figure 3.5(e) illustrates the relationship between the ratio of liquid assets to total assets and outstanding bank loans. The PDP reflects that banks with higher balance sheet liquidity tend to issue more loans over a specific range of LIQR values. This suggests that banks hold liquid assets to stimulate their lending activities (Naceur et al. 2018). Another possible inference from a gradually rising liquidity ratio is that banks compensate for the cost of holding liquidity by granting more loans. The secular increase in the marginal impact of bank loans on outstanding bank loans becomes stable when the liquidity ratio is higher than the forty percent. The PDP reflects that the association between liquidity ratio and bank lending reaches an equilibrium after this specific point.

It seems safe to conclude that these results are in accord with those of previous studies (i.e., Imran and Nishat, 2013; Malede, 2014; Demiralp et al., 2017; Kim and Sohn, 2017). Our findings suggest that banks with higher liquidity can benefit from having more liquid balance sheet to absorb the impact of adverse shocks on their loan supply. The literature also includes some studies reaching somewhat mixed results on the impact of liquidity in lending behavior (i.e., Akinci et al., 2014; Sarath and Van Pham, 2014; Cantero-Saiz et al., 2014, Rabab'ah, 2015) which are contrary to our conclusion.

The ratio of government securities over total assets is an alternative measure of balance sheet liquidity in our specification. The partial dependence plot for government securities over

total assets in Figure 3.5(f) suggests that the rise in the share of government security portfolio up to twenty-percent increases bank lending gradually. In other words, banks that have a large number of government securities in their asset portfolio increase their lending more appropriately. After the government security portfolio exceeds twenty percent, the relationship between GVTTA and bank loans reaches an equilibrium.

It seems that our findings are in line with those of Çavuşoğlu (2002), Berrospide and Edge (2010). Thus, these results first argue that the government security portfolio triggers bank lending since banks use their security stock as collateral to borrow from the central bank. The positive impact of government security portfolio on bank lending is called as the crowding-in-effect (Çavuşoğlu 2002). This means that, when banks hold government securities in their asset portfolio, they do not cut back their private lending. Second, government securities seem to play against the possible adverse effects of the deposit drains in the banking system.

The asset structure of a bank balance sheet seems to be a more salient predictive measure of bank loans than the share of government securities. In our description, the asset structure of a bank is indicated by the share of fixed assets over total assets. Figure 3.5(g) displays the partial dependence plot for the ratio of fixed assets to total assets. As noted, fixed assets consist of bank buildings, equipment, networks, intellectual properties, and some other tangible and intangible assets. All these assets facilitate the financial intermediation task of banks and ease their credit-granting operations. Thus, one can expect a positive relationship between the share of fixed assets and bank lending (Kosak et al., 2015). Our results, therefore, are in line with prior expectations. The partial dependence plot suggests that the small increase in the ratio of fixed assets to total assets leads to a substantial rise in bank loans. However, the outstanding relationship between the share of fixed assets and bank loans reaches an equilibrium, and when the share of fixed assets arrives at the twenty percent of total assets.

The bank profitability is also a probable measure of bank balance sheet strength and might have a direct impact on several soundness indicators (Kim and Sohn, 2017). The potential positive relationship between bank lending and bank profitability is likely to be related to the role of bank profits to serve as a buffer to absorb the shocks. It is safe to

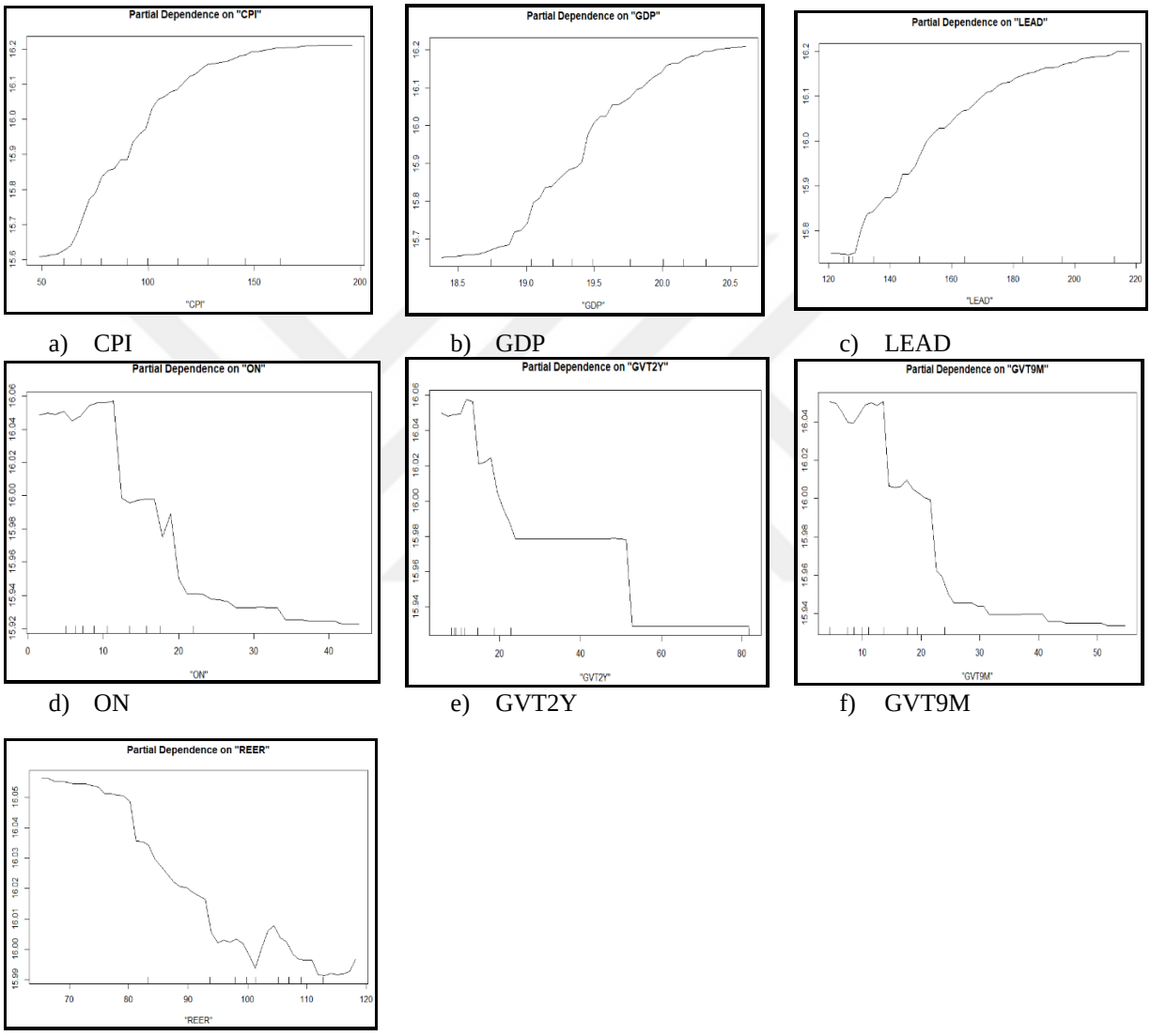
conclude that the link between the bank profitability measure and bank lending is in equilibrium, and the fall of the loss is silent to affect bank loans until banks perform a positive profit. The range of negative values for ROA provides evidence for the insignificant impact of the profitability of bank lending behavior.

However, outstanding bank loans considerably increase when banks experience a positive profit. Thus, it seems that the break-even point is a certain threshold level, and positive profitability causes an equilibrium shift on an outstanding relationship. Briefly, as the income generated from their operations exceed the cost of these operations, banks increase their lending. These findings are similar to those providing a positive and significant impact of profitability on bank lending (i.e., Brissimis et al., 2012; Jimenez et al., 2012; Naceur et al., 2018). Following a small increase in profitability in a positive range provides an equilibrium between ROA and bank loans. These findings that support the insignificant impact of a rise in profitability on bank lending behavior is consistent with the findings of Pham (2015) or Ivanovic (2016). The probable theoretical explanation for this finding underlies in two opposing forces. First, the potential link between profitability and riskier asset portfolio directs the bank to lower its lending to improve its asset quality. Second, profitability is a signal for the sound balance sheet and encourages banks to increase their lending (Kim and Sohn 2017). Thus, one can conclude that these two forces might be in balance, and there might be no impact of profitability on bank lending behavior.

Surprisingly, the lending rate seems to be the less salient predicting measure in our random forest model. The partial dependence plot for LENDINGR suggests that the relationship between the lending rate and bank loans steadily decreases until our lending rate measure arrives at fifty percent. The PDP also provides evidence that when the lending ratio measure exceeds fifty percent, an equilibrium prevails between the lending rate and bank loans.

The two opposing forces interact when the lending rate decreases. First, the lower lending rates stimulate loan demand of borrower firms and households (Rabab'ah, 2015). Second, the lower rates discourage banks, and they decrease their loan supply (Pham, 2015). Thus, it is safe to conclude that the former outweighs the latter, and a rise in the lending rate

increases the bank lending. The negative relationship between the lending rate and bank lending is similar to the findings of Gambacorta and Rossi (2010), Demiralp et al. (2017), and Baoko et al. (2017).



a) CPI b) GDP c) LEAD

d) ON e) GVT2Y f) GVT9M

g) REER

Figure 3.6. Partial dependence plots for macroeconomic indicators

Among macroeconomic indicators, CPI is the most potent variable in predicting bank lending behavior. Figure 3.6(a) provides the PDP showing the marginal impact of CPI on nominal bank loans. The figure clearly illustrates that there is a secularly increasing

relationship between CPI and nominal bank loans. Our results, therefore, do not support a theoretical proposition suggesting the critical role of inflation to create distortions in financial markets. In this sense, contrary to the findings of several previous studies (i.e., Panagopoulos and Spilliotis, 1998; Egert et al., 2007; Jimenez et al., 2012), our results imply that inflation tends to accelerate the volume of nominal bank loans. The one possible explanation for this result is that the nominal bank loans might take up the valuation effect of a rise in the general price level. The literature also suggests that nominal bank loans increase in inflationary periods due to an increase in loan demand (Kapounek et al., 2017). One might also argue that since holding cash at hand is costly during inflationary periods, households and investors invest in deposits, which in turn triggers the money creation process (Baoko et al., 2017). The positive impact of the consumer price index in Turkey is in line with the literature (Alper et al., 2012).

Figure 3.6(b), coupled with Figure 3.6(c), provides a complete picture as to whether the bank lending is procyclical and/or demand-driven. These figures illustrate the impact of GDP and leading indicators on bank loans, respectively. The partial dependence plot for GDP indicates a gradually increasing relationship between the level of economic activity and outstanding bank loans. Therefore, our results might suggest that banks benefit from favorable economic conditions and improve their credit facilities. As noted, GDP is also a proxy for demand conditions in an economy. Thus, the partial dependence plot for GDP provides evidence for the critical role of demand-driven factors on the volume of bank loans. More precisely, a rise in GDP improve the earnings of economic agents, creates investment opportunities, and enable bank to lend more to finance these investments (Imran and Nishat 2013).

Figure 3.6(c) captures the relationship between the leading indicators index and the volume of bank loans. As noted, the leading indicators index is handled to capture the impact of early signals of business cycle fluctuations in an economy on bank lending. The partial dependence plot of this indicator is nearly identical to those of GDP in Figure 3.6(c). Thus, LEAD provides further evidence for the critical role of loan demand and the impact of favorable economic conditions on outstanding loans in Turkey.

It can be inferred from PDPs of GDP and LEAD that increasing economic activity and income levels in any economy provides an opportunity for successful investment projects and encourages businesses to improve their investment projects by calling for more bank loans (Kashyap et al. 1993). Therefore, our findings on economic activity indicators are also in synchronization with a lot of existing studies for various countries (i.e., Hoffman 2001; Calza et al. 2003; Imran and Nishat 2013; Sarath and Van Pham 2014; Kapounek et al. 2017) and for Turkey (i.e., Akinci et al., 2012; Alper et al., 2012; Macit, 2012). It should also be noted that the correlation matrix directed us to handle the fourth lag of GDP and the current values of LEAD in our specification.

Figure 3.6(d), 3.6(e), and 3.6(f) illustrate the relationship between interest rates and outstanding bank loans in Turkey. Among them, Figure 3.6(d) displays the partial dependence plot for the interbank overnight interest rate to demonstrate the impact of monetary policy on bank's lending behavior. As noted, the underlying mechanism that monetary policy changes exert their effects on real economic activity via bank loans is labeled as the bank lending channel (Çavuşoğlu, 2002). The partial dependence plot for the overnight interest rate in the figure above demonstrates the negative relationship between the monetary policy indicator and bank loans. This means that banks offer fewer loans during the monetary contraction period. This finding is likely to provide a signal for an active bank lending channel in Turkey since monetary authorities could affect bank loans via policy rate decisions.

Our findings are consistent with the ones presented in the studies of Aktaş and Taş (2007) and Alper et al. (2012) favoring the bank lending channel and partially in line with Akinci et al. (2012) that proposes a signal for active bank lending channel in the Turkish economy. Besides, these results agree with the findings of other studies, which exhibit a significant negative relationship between the policy rate and bank lending (i.e., Hoffman, 2001; Brissimis et al. 2014; Cantero-Saiz et al. 2014; Brinkmeyer 2014). Unlike existing evidence, our findings provide a nonlinear relationship between the policy rate and bank lending. Furthermore, it might be concluded that policy rate changes have a more significant impact on bank loans.

The partial dependence plot for GVT2Y demonstrates that the outstanding negative relationship between long-term rate measure and bank loans ends up with an equilibrium after GVT2Y exceeds twenty percent. The following rise in the long-term market-rate creates a new equilibrium for the current association. These findings are in favor of Sarath and Van Pham (2014).

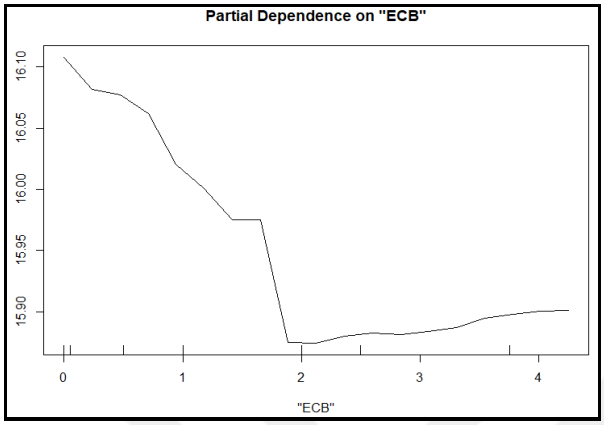
Besides, Figure 3.6(f) provides evidence for the negative relationship between the nine-month Treasury bill rate and bank lending. Thus, it seems that the rise in short-term market rates negatively affects bank lending behavior. Our finding on an outstanding relationship between short-term market rate and bank lending is consistent with the results of Panagopoulos and Spilliotis (1998).

These results are also in line with the illustrated partial dependence plots for LENDINGR, ON, and GVT2Y. The consistency in the relationship between bank lending behavior and various interest rates could be attributed to the pass-through of the central bank policy rate to the various market interest rates. Any change in the policy rate seems to transmit into the bank lending rate and other market rates accurately, which in turn provides the consistency in the relationship between bank loans and interest rates.

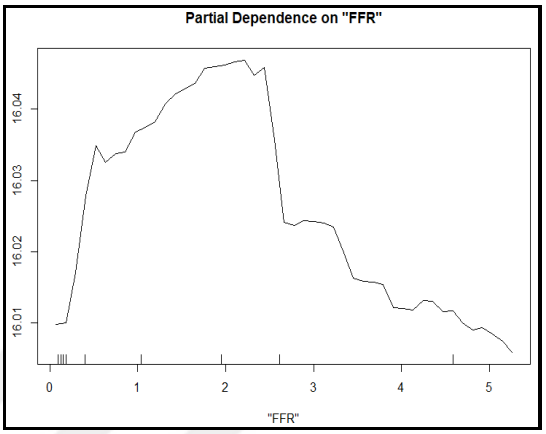
Figure 3.6(g) illustrates the partial dependence plot for the real effective exchange rate and confirms the negative relationship between REER and bank loans. The rise in the REER demonstrates the appreciation of the domestic currency in our specification. Therefore, one can infer that the appreciation of domestic currency decreases bank lending gradually. There are two possible explanations for this result. First, the appreciation of the domestic currency contributes by some valuation effect on the nominal value of bank loans in terms of domestic currency (Imran and Nishat 2013). Another possible explanation for this could be that domestic currency appreciation raises the demand for imports, and economic agents need more bank credit to finance their imports (Shijaku and Kalluci, 2013). These results are in accord with those proposed by Ladime and Osei (2013) and Pham (2015).

Finally, the current study provides the relationship between global factors and outstanding bank loans in Turkey. As a small open economy, Turkey might be affected by global economic conditions. Thus, Figure 3.7 illustrates the partial dependence plots for ECB

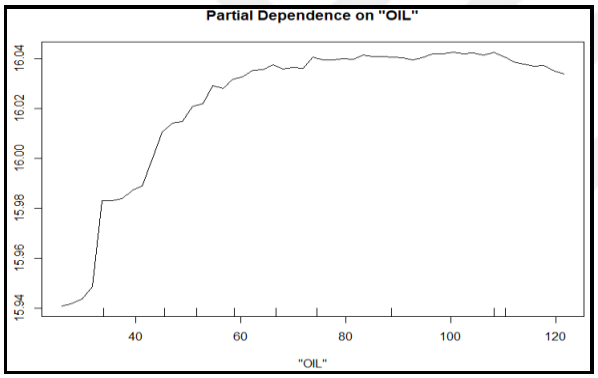
main refinancing rate, Federal Funds Rate, and the oil prices.



a) ECB



b) FFR



c) OIL

Figure 3.7. Partial dependence plots for global factors

Among the global factors, the ECB main refinancing rate matter most for outstanding bank loans. The partial dependence plot in Figure 3.7(a) provides a signal for the nonlinear relationship between ECB and bank lending. It seems that the two percent is a threshold level in which the secularly decreasing relationship turns to a gradually increasing process. The first part of an outstanding relationship supports the idea that the rise in the ECB refinancing rate increases the financing costs of banks in Turkey. Thus, they might cut their lending. The negative relationship between ECB and bank loans is consistent with Ivanovic (2016) arguing the crucial role of borrowing cost of banks on bank lending. However, the gradual rise in bank loans following the ECB refinancing rate increases above the two percent level might be an

indicator of the favorable demand conditions in Euro Area countries. As the biggest trade partner of Turkey, the fruitful economic conditions in Euro Area countries increases their export demand from Turkish firms. Firms, in turn, might increase their demand for bank loans to enlarge their production, and finance their operations.

The partial dependence plot for Federal Funds Rate provides quite different results. Although Figure 3.7(b) demonstrates a nonlinear relationship between FFR and the volume of bank loans, the rise in the FFR up to slightly above the two percent level increases outstanding bank loans in Turkey. The FFR, as an indicator of global liquidity, implies a somewhat nonlinear impact on bank lending in Turkey. It seems that the global liquidity drain associated with the rise in FFR causes bank loans to decline in Turkey after the FFR exceeds the two percent. Besides, the apparent discrepancy between the impact of ECB and FFR on the bank loans in Turkey might be due to the variation in the transmission of the policy rate to the market rates and their ability to affect real economic activity in the Euro Area and the United States.

Finally, Figure 3.7(c) illustrates the relationship between oil prices and bank lending. As noted, oil prices might be an indicator of global economic conditions and could affect bank loans in Turkey by changing firms' production costs, altering cash flows, and influencing investment decisions.

The partial dependence plot for oil prices suggests a steadily increasing relationship between oil prices and bank loans in Turkey. Thus, it is safe to conclude that banks benefit from rising oil prices and increase their lending. These results are likely to be related to demand factors. Since oil price hikes might increase firms' production costs and reduce their cash flows (Kocaarslan and Soytas 2019), firms increase their demand for bank credit.

An alternative explanation for a gradually increasing relationship between oil prices and nominal bank loans in Turkey might be the pass-through of oil prices to the consumer price index. To illustrate, the rise in oil prices causes the domestic price level to increase, which in turn transmits into the nominal valuation of bank loans. The existing literature provides evidence on the pass-through of oil prices to consumer price index in Turkey (i.e., Çatik and Önder, 2011; Çatık and Karaçuka, 2012; Akçelik and Öğünç, 2016).

Overall, the model specification of the current study takes an additional step and provides a comprehensive picture of the drivers of bank lending in Turkey. The current study benefits from the distinct advantages of having machine learning techniques and provide favorable evidence for some nonlinearities on an outstanding relationship between several indicators and the volume of bank lending.

Briefly, findings concerning variable importance and the partial dependence plots indicate that the capital ratio, deposit overhang, and the credit risk are favorable measures influencing bank loans in Turkey. Moreover, these findings suggest that consumer price index, GDP, and the leading indicators index have greater predictive salience on bank lending behavior than global factors.

3.7. Discussion and Conclusion

Banks are the most crucial financial intermediaries regarding their role in financing a firm's and household's investment and consumption expenditures, exacerbating the real economic activity, and affecting the financial stance in any economy. As noted, bank loans are also the most dominant source of financing needs in the Turkish economy. Therefore, it seems critical to investigate the factors affecting bank lending behavior in Turkey. Although many efforts have been made to refine the role of numerous factors on bank lending, and a considerable amount of literature has evolved, there is still an opportunity for new contributions.

This study, therefore, aimed at investigating the relationship between bank loans and a set of bank-specific characteristics, macroeconomic indicators, and global factors in Turkey over the period between 2002Q4 and 2019Q2. The variable specification is based on the studies in the existing literature. This study benefits from the distinct advantages of machine learning techniques (regression tree, boosting, bootstrap aggregating, and random forest predictors) and contributes to the literature in some ways to address the critical role of these variables on bank lending behavior,

First, the methodological specification allows employing a comprehensive set of variables that have a potential contribution to analyze bank lending behavior. Therefore, the study enjoys examining the interaction of various factors with outstanding bank loans in a unique framework. Second, the study methodologically contributes to the literature. The inclusion of various machine learning techniques provides several methodological benefits. As noted, these techniques allow model flexibility and the prior distribution of the variables, provide the functional form best suiting the data, and rank variables regarding their out-of-sample fit measures.

The study finds that the random forest model has the lowest predicting error, and thus it has the best out of sample fit measure. With regards to the random forest model results on variable importance and the illustrated partial dependence plots, numerous bank-specific characteristics seem to be more prominent measures affecting the bank lending behavior. Among the bank-specific characteristics, the capital ratio, reliance on deposit financing, and the credit risk are more salient predictors of bank lending. All these bank-specific characteristics imply a nonlinear association with outstanding bank loans. Therefore, bank loans would enhance with an optimal level of bank capital, deposit financing, and credit risk measure. Besides, balance sheet liquidity, asset structure, and profitability have relatively higher predictive power among bank-specific characteristics and provide somewhat consistent results with existing studies. However, the bank lending rate seems to be silent in predicting bank lending behavior regarding the rank of the variable importance.

The empirical findings for macroeconomic indicators suggest that the consumer price index has a better performance among their counterparts. The CPI seems to demonstrate the valuation effect on nominal bank loans and captures the rise in the loan demand in inflationary periods. Besides, the partial dependence plots for GDP and the leading indicators show the procyclical behavior of bank loans and reflect that improving economic conditions would increase the volume of bank lending. Furthermore, the relationship between the policy rate and the bank loans are in favor of the bank lending channel in Turkey despite the lower predictive performance of the overnight interbank rate. On the other hand, the role of global factors in predicting bank lending behavior in Turkey seems to be less reliable than several bank-specific characteristics and macroeconomic indicators.

In this regard, the findings of the current study might suggest some policy implications for bank managers, regulatory authorities, and policymakers and shape their policy decisions to affect the volume of bank loans in the Turkish economy. In general terms, we might conclude that regarding their importance rank, the higher-ranked indicators are most likely to be more salient policy levers than the lower-ranked measures. Thus, the rank of variable importance enables policymakers to be more confident in designing favorable policies. Notably, the nonlinear nature of the link between capital ratio, deposit overhang, and the credit risk force policymakers to design regarding policies more prudently. The reliable predicting power of bank-specific characteristics on bank lending calls for necessitates the banking authorities to consider their statistical reports properly.

Furthermore, the importance of the economic activity variables suggests that providing more sound economic growth policies would enhance the volume of bank loans. Besides, the relatively critical nature of the monetary policy rate calls for monetary authorities to be more forward-looking in designing policies to provide financial stability. The monetary authority might also promote economic activity since these results provide evidence on an active bank lending channel in Turkey. In global factors case, although the importance of the global factors is somewhat lower than other measures, policymakers should take precautionary measures by tools in their hands when global shocks might create conflicting disorders in the banking sector and macroeconomic environment. Finally, these results might also provide confidence for policymakers about negative policies. Since the current study offers the importance rank of the variables, these results demonstrate the policy levers that might be less effective in shaping bank lending behavior.

The introduction of this study also calls for potential further research. Since this study does not consider the bank size as a bank-specific characteristic in the model specification, further research might aim at investigating the potential heterogeneity in the bank lending behavior and examining the relative predictive performance of these variables in banks with different size groupings.

4. THE FUEL PRICE PASS-THROUGH in a DATA-RICH ENVIRONMENT: THE CASE STUDY of MOTOR FUEL PRICE SUBSIDY SYSTEM in TURKEY

4.1. Introduction

Oil is one of the main inputs for production processes in any modern economy and plays a vital role as a consumption good for households (Chen et al., 2019). Households, for example, consume gasoline in their vehicles for transportation, and businesses consume many petrochemicals as an intermediate product and oil products as a fuel in their production. Therefore, oil price changes are likely to have significant impacts on each country in the world (Sek et al., 2015).

Since 1973, after the first oil price increase, oil prices have risen dramatically, with economists concluding that the rise in oil prices could be the primary source of economic downturns. (Blanchard and Gali, 2007; An et al., 2014). The rise in oil prices has adverse effects on economic activity, price level, trade balance, and a fiscal balance (Jha et al., 2009). Rising oil prices increase the cost of production and proceed to a decline in economic activity (Bhattacharya and Bhattacharyya, 2001). Regarding external balance, the low oil-price elasticity dampens the trade balance in oil-dependent countries (Bhanumurthy et al., 2012).

One widely accepted impact of oil price changes is that the international price developments transmit into the domestic prices. Oil price hikes might create inflationary effects in oil importer countries by directly or indirectly increasing the firms' energy bills (Karimli et al., 2014), by increasing inflation expectations (Conflitti and Luciani, 2017), and by increasing the nominal wages (Blanchard and Gali, 2007). Besides, the degree to which the effect of oil price shocks on any government's fiscal balance depends on its effort to protect domestic prices from oil price hikes (Jha et al., 2009).

When the price of oil increases, transport, and other related costs will rise, which will eventually be passed to consumers, manufacturers face higher production costs, and consumers are affected in the form of higher prices for final goods and services (Salisu et al.,

2017). In a broader context, the direct impact of the increases in oil prices exacerbates inflation by affecting fuel prices. Besides, the indirect pass-through takes place via production costs in industries that use petroleum products as inputs. Concerning this, the rising domestic fuel prices create welfare effects on households in two ways (Del Granado et al., 2010): The direct welfare impact is that households consume fuels with higher prices. The indirect welfare effect is that they face higher prices for other products and services as higher fuel costs increase the cost of production. The welfare impact appears to be related to the share of income devoted to these consumption goods.

However, it is also a common practice for many economies to control domestic fuel prices, absorb the adverse effects of global oil price increases, and not pass on significant oil price rises (Coady et al., 2006). Many governments subsidize fuel prices to absorb the adverse effects of price developments. Governments aim to protect domestic consumers and firms from global oil price fluctuations and absorb the adverse effects of oil price hikes on the household's welfare (Couharde and Mouhoud, 2018). Governments follow a set of subsidy policies either by using government expenditures, selling below the market price, or through tax exemptions (IMF, 2008). The fuel subsidies can be distinguished as consumer subsidies and producer subsidies (Wooders et al., 2019). In this context, consumer subsidies are a practice of charging the private sector lower prices while producer subsidies encourage fuel producers.

There is also no doubt that these measures create a burden for government budget in countries that do not pass on the international oil prices to domestic fuel prices. In a recent study, Coady et al. (2019) estimated that the global fossil fuel subsidies are about 4.7 trillion US dollars in 2015 and are projected to be more than 5 trillion US dollars in 2017. They further argued that, due to fiscal sustainability issues, some countries could not defend the domestic economy from international oil price movements (Kpodar and Abdallah, 2017).

The responses of oil-importing emerging economies to international price hikes differ significantly from that of oil-exporting or developed countries and depend on the degree of their oil dependency (Aydın and Acar, 2011). The oil price-driven macroeconomic fluctuations are expected to be more influential in emerging economies since their financial

system is relatively less stable, and they are more vulnerable to external shocks (Sek et al., 2015). Quantitative analysis of oil price shocks on economic activity, general price level, and budget balance would have important policy implications. The timing and degree of the pass-through of oil price changes are also crucial for predicting inflation and shaping inflation expectations (Conflitti and Luciani, 2017). Policymakers and economic agents should also be aware of the consequences of price shocks, as they adapt their respective policies and investment decisions (Salisu et al., 2017).

Several studies analyzed the impacts of oil price shocks, and it is a common practice to employ small scale or structural vector autoregressive (SVAR) models, Phillips-curve specifications, or general equilibrium models in these studies. A set of these studies concentrated on as to whether oil price shocks create business cycles (i.e., Aydın and Acar, 2011; Bhanumurthy et al., 2012 Mandal et al., 2012), generate inflationary effects (i.e., De Gregorio et al., 2007; Chou and Tseng, 2011; Çatık and Karaçuka, 2012; Akçelik and Öğünç, 2016). There are also numerous studies have analyzed the impact oil subsidies (i.e., Dartanto, 2012; Rentschler, 2016; Boonpramatoe, 2017; Li et al., 2017) in emerging economies.

Turkey, as an emerging economy, has experienced relatively higher growth rates and faced with rising oil demand in recent decades. As is the case for many developing countries, Turkey satisfies its growing oil needs by the large volume of imports (Altinay and Karagol, 2004). In this context, the Turkish economy provides a fruitful environment to examine the impacts of oil price shocks. The oil constitutes approximately 32 percent of the total primary energy consumption in 2018 (BP, 2019). Besides, 87 percent of the total oil product consumption is met by imports (EMRA, 2020). Therefore, the Turkish economy is an oil-dependent country and is very sensitive to international oil price developments. Second, the Turkish government has enacted the motor fuel subsidy system in May 2018 and stabilized the motor fuel prices to limit the adverse effects of the oil price changes on the domestic price level and household welfare. In the current system, motor fuel prices will be regulated and be limited to the base price increase by cutting down the tax corresponding to a rise in prices.

The motor fuel price subsidy system is a novel policy tool in the Turkish economy. The first contribution of the study is to address the impacts of a motor fuel price subsidy program.

To this end, the study first quantifies the pass-through of motor-fuel price changes under the new subsidy regime on a panel of 90 disaggregated price indexes. The study also investigates the direct and indirect impacts of the motor fuel subsidy system on the government budget. Finally, this study explores the effect of the subsidy system on industrial production in various sectors in the Turkish economy. The study gathers monthly data over the 2015:01 to 2019:12 period. The availability of data on the price of motor fuel restricts the data span in the current study.

The second contribution of the study is methodological. Unlike other studies in the pass-through literature the study employs the Factor Augmented Vector Autoregressive (FAVAR) methodology. The FAVAR model is incorporated by Bernanke et al. (2005). This approach has certain advantages over small-scale vector autoregression (VAR) models. First, the FAVAR approach incorporates all the information required from a variety of macroeconomic variables and offers a data-rich environment (Bernanke, Boivin, and Eliasz, 2005). Second, the use of large-scale FAVAR estimates reduces the misspecification issue significantly (Boivin et al., 2009). Third, because the FAVAR models employ a limited number of factors, they solve potential degrees of freedom problems (Bernanke et al., 2005). In what follows, the study can report the disaggregated consumer and producer indexes and displays the responses of economic activity in various sectors in the Turkish economy.

The last contribution is that the current study extends the FAVAR model by adopting an alternative scenario in which the government does not implement the motor fuel price subsidy system. The introduction of an alternative scenario allows assessing the efficiency of the existing subsidy program in the Turkish economy.

The organization of the study is as follows: The second section reviews the literature. The third section describes the motor fuel pricing and the novel subsidy system in Turkey. The fourth section introduces the methodology and the data, and the fifth section describes the methodology. The sixth section presents empirical findings, and the last section concludes the study.

4.2. Literature Review

Since the increase in oil prices in the early 1970s, numerous attempts have been made to examine the effects of oil price shocks both on the developed and the emerging economies. As a result, the literature has grown with many empirical studies investigating the pass-through of oil price fluctuations to the domestic economy and quantifying the fuel price subsidy measures in countries that implementing fiscal tools to defend their domestic economies.

Many studies analyzed the effects of oil price changes in developed and emerging economies. The first group of preliminary studies provided evidence to support the negative correlation between increases in oil prices and growth in output. Bruno and Sachs (1982) focused on the UK economy in an earlier study and found that input prices had a significant impact on real economic activity. Hamilton (1983) argued that most of the fluctuations in economic activity could be traced to the rise in oil prices in the post-OPEC era. Subsequently, Burbidge and Harrison (1984) developed a VAR model and examined the effect of oil price shocks in seven OECD countries during the period 1962 to 1982. They concluded that some portion of the output volatility could be due to oil price shocks in those countries. Following these earlier studies, Mork et al. (1994) and Jimenez-Rodriguez and Sanchez (2005) endorsed some potential asymmetric effects of oil price shocks. These studies suggest that spikes in oil prices have a more significant economic impact than drops in a large sample of countries.

Blanchard and Gali (2007) estimated a structural VAR model to find the dynamic effects of oil price shocks in France, Germany, Italy, Japan, the United Kingdom, and the United States in two sub-periods from 1970 to 1983 and from 1984 to 2005. Their findings indicated that the effect of oil price shocks in these developed countries is declining over time due to the diminishing share of oil in demand, more responsive labor markets, contemporary adverse shocks, an accommodating monetary policy. Cavalcanti and Jalles (2013) used a structural VAR model between 1985 and 2008, and do not provide evidence of a significant impact of oil price shocks on the Brazilian economy's output growth rate. Researchers also concluded that the fluctuations in output could not be attributed to shifts in international oil prices, given the decline in oil imports.

In the US case, a nonlinear FAVAR model was developed by An et al. (2014) to differentiate between the different configurations of oil price shocks. They used quarterly data over the 1959-2006 period. Their findings indicate that output responds positively to innovation in negative oil prices, whereas the response is detrimental to innovation in oil prices. Hence, their results support possible asymmetries on the economic activity's responses to oil price shocks. Aastveit (2014) analyzed the effect of various oil price shocks on numerous macroeconomic indicators in the US economy over the 1974 to 2008 period. They used a FAVAR model and benefitted from many series incorporating the information. Their findings argued that specific demand shocks are somewhat more significant than shocks in supply. They further indicated that positive innovation of the demand-driven oil prices had a significant negative impact on output level. In contrast, the increase in oil prices following oil supply shocks had a slight negative impact on output level.

Herwatz and Plödt (2016) studied the impacts of aggregate demand, oil-specific demand, and oil supply shocks in China, the Euro Area, and the United States by using a similar specification. They studied the period from 1973 to 2014 and used a structural VAR model. They concluded that shocks in oil supply do not have any significant impact on output level while demand shocks lower output levels in those countries. Zhao et al. (2016) followed a dynamic stochastic general equilibrium (DSGE) model and analyzed the impact of four different oil price shocks in the Chinese economy. They found that the oil price shocks driven by political disbursements create short-lived effects on output in China. However, oil price movements driven by demand or supply tend to produce long-lasting impacts on output level.

In a recent study, Mohaddes and Raissi (2018) investigated the impact of US supply-driven oil price shock in a set of 38 countries or regions. They employed a global VAR model over the period 1979-2011. They documented that the negative oil price shock increases the GDP growth in oil-importing economies. More recently, Khan et al. (2019) examined the nonlinear impacts of oil price shocks on economic activity in 13 Asian economies between 1980 and 2014 and employed a nonlinear auto-regressive distributed lag (NARDL) bound testing method. They found that a short-run asymmetry exists between oil prices and economic activity in more developed Asian countries, whereas in sample countries, there is no long-run

asymmetry. Their findings also argued that unanticipated shocks in countries that subsidize fuel prices do not create significant effects on output.

The number of studies concentrating on the impact of oil price shocks on macroeconomic indicators in the Turkish economy is quite limited. The study proposed by Alper and Torul (2008) used the structural VAR model, which covered the period from 1991 to 2007. They included global liquidity conditions in their model specification. While some literature studies argue that the impact of oil prices on any economy is negligible, particularly after the 2000s, their findings suggest that shocks in oil prices have a significant impact on the Turkish economy even after the 2000s. Another study proposed by Aydın and Acar (2011) constructed a multisectoral general equilibrium model for the Turkish economy. They defined their models under scenarios of higher and lower oil prices. Their findings indicated that these scenarios create significant impacts on an overall economy, and the impacts in energy-intensive industries are more severe than other sectors. Çatık and Önder (2013), on the other hand, studied the asymmetric effects of oil price shocks in the Turkish economy. They employed a threshold VAR (TVAR) model and studied the period from 1988 to 2011. They found evidence for the potential threshold level for oil price shocks in the Turkish economy. They concluded that the oil price shocks create a significant impact after the high oil price threshold level.

The set of studies exploring the effect of shocks in oil prices in any economy focuses on the transmission of oil prices into the domestic price level. Of these studies, Bhattacharya and Bhattacharyya (2001) employed a VAR model for the Indian economy and analyzed the 1994-2000 period. Their findings illustrated that the 20-percentage point positive shock to an international oil price would result in a 1.3 percent increase in the prices of other commodities. They also confirmed that the impact of the shock reaches its peak within five to seven months, and it persists for up to two years. Hooker (2002) examined the period between 1962 to 2000 and investigated the potential nonlinearities and structural breaks in the pass-through of oil prices into domestic inflation in the US economy. This study runs a Phillips-curve regression and found that the oil price pass-through has not been significant since 1981. De Gregorio et al. (2007) examined whether the pass-through is constant overtime over the period between 1965 and 2005 in a group of developing and emerging countries. They used both an

augmented Phillips curve layout and a VAR-specification in rolling windows. For most countries, they found evidence that the oil price pass-through decreases over time due to the exchange rate pass-through to domestic prices, accommodation in monetary policy, and conditions of oil demand. They also argued that the domestic price regulations did not cause a decline in the pass-through. Similar specifications employed by the study of Chen (2009) for 19 industrialized countries over 1970-2006. This study indicated that besides domestic currency appreciation and the monetary policy accommodation, the higher degree of trade openness also explains the fall of oil price pass-through over time.

In the US case, Herrera and Pesavento (2009) employed a multivariate VAR model over the period between 1959 and 2006. They pointed out that the response of prices and other macroeconomic indicators have changed after the mid of 1980s. They argued that the practice of implementing active monetary policy tools absorbs the impacts of oil price shocks in the US economy. In another study for the US, Walcarcel and Wohar (2013) also analyzed whether the response of output to oil price shocks is stable over time in the US economy. They employed a time-varying structural VAR model (TVP-SVAR) in a Bayesian setting and investigated the period between 1948 and 2011. Their findings indicated that since the 1980s, there is no significant pass-through to inflation in the US economy.

Alvarez et al. (2011) investigated the oil price pass-through in Spain and the Euro Area. They constructed a DSGE model over the period between 1997 and 2007. The study first implied that the pass-through to inflation is slightly higher in Spain. Besides, both in Spain and the Euro Area, the pass-through is limited despite oil prices explain much of the inflation variation. Employing ARDL bounds testing, rolling regression, and recursive regression analyses Chou and Tseng (2011) investigated the short-term and long-term pass-through of oil prices in Taiwan throughout the 1982-2010 period. Their findings suggested that the short-term impacts of oil prices on domestic inflation are not significant, while oil price changes create long-term significant pass-through effects. Also, rolling and recursive regression analyses propose that the enormous increases in oil prices do not create inflationary effects in Taiwan. They argued that the reason could be the use of alternative energy sources and the decline of oil intensity. The study proposed by Shioji and Uchino (2011) aimed at explaining the factors leading to a decline in oil price pass-through in Japan over the period

between 1980 and 2010. They both used an input-output table and a time-varying VAR (TVP-VAR) methodologies. They found that the reason for the decline in pass-through is the oil price itself during the 1980-2000 period. However, they illustrated that the pass-through of oil prices seems to be accelerated after the 2000s. Sek et al. (2015) compared the oil price pass-through in the countries that have a high oil dependency index and low oil dependency index. They used ARDL bounds testing and a pooled mean group estimator over the period between 1980 and 2010. They found that the direct impact of oil price changes on domestic inflation is higher in countries with a low oil dependency index. In contrast, indirect impacts are more dominant in high dependent countries.

Pass-through of oil prices into domestic inflation in oil-exporting countries is documented by Karimli et al. (2014) for Azerbaijan, Kazakhstan, and Russia over the period 2000-2014. They used a structural VAR model and examined the transmission channels of oil prices to domestic inflation. Their findings indicated that the cost channel and the fiscal channel exacerbates the impact of oil price shocks on domestic inflation. Besides, their findings suggested that the input dependency also amplifies the inflationary impact of oil price shocks. Another study proposed by Salisu et al. (2017) compared the inflationary impacts of oil price shocks in oil-importing and exporting countries. They found that oil price changes have a more significant impact in oil-importing countries, whereas the asymmetric impacts are more in tune in oil-exporting countries.

A group of studies investigated the pass-through of oil prices into gasoline and other motor fuel prices. Atil et al. (2014) examined the asymmetric pass-through of international oil prices to gasoline prices. They specified a NARDL model for the period between 1997 and 2012. They found a significant nonlinearity on the response of gasoline prices to positive and negative oil price shocks. Their findings suggested that oil price drops are more practical to influence gasoline prices in the short run. Berument et al. (2014) examined the impact of oil price and exchange rate shocks on petroleum product prices in five Northern Mediterranean countries, France, Greece, Italy, Spain, and Turkey. The study uses monthly data, and the sample period starts in 2005 and reaches up to 2012 regarding data availability. They employed a mark-up pricing model and found that in the short run, the exchange rate shocks transmit to the petroleum product prices more than the oil price shocks. However, in the long

run, the pass-through of oil prices is relatively higher. Besides, Pal and Mitra (2016) analyzed the asymmetric pass-through of crude oil prices to domestic oil product prices in India. Unlike many other studies investigating the asymmetric pass-through of oil prices, their research decomposes the oil prices in quantiles by multiple thresholds by employing multiple threshold nonlinear autoregressive distributed lag (MTNARDL) model. Their specification suggested that transmission to all kinds of oil products is high. However, the fall of oil prices does not provide a full pass-through to oil products.

The last group of oil price pass-through studies examines the impact of oil price fluctuations in disaggregated price indexes. Gao et al. (2014) investigated the pass-through of oil prices into disaggregate US consumer price indexes. They used a structural VAR model and analyzed the period between 1974 and 2014. As expected, the rise in oil prices creates more inflationary impacts on energy-intensive goods and services. However, the rise in oil prices has a limited impact on the prices of non-energy commodities. In another study, Conflitti and Luciani (2017) employed a dynamic factor model and a VAR specification to analyze the impact of oil price shocks on disaggregated price indexes in the US and the Euro Area. They also decomposed the common and idiosyncratic components of price indexes and investigated their responses to oil price shocks. They found that the pass-through of typical dynamics to core inflation is significant, small but long-lasting, whereas idiosyncratic components do not support pass-through significantly to core inflation. Finally, Sek (2017) examined the oil price pass-through to four domestic price indexes in a linear and nonlinear setting in Malaysia. They employed both linear and nonlinear ARDL bounds testing approaches covering the period between 1980 and 2015. Their study provided evidence for the asymmetric pass-through of oil prices into domestic price indexes. Their findings suggested that the pass-through of oil price changes are more severe in oil-intensive industries, and oil prices transmit into domestic prices via import prices and production costs.

The literature on the impact of oil prices on domestic inflation in the Turkish economy has a relatively large number of studies. Kibritçioğlu and Kibritçioğlu (1999) employed a VAR model and analyzed the period between 1986 and 1998. They found that there is no significant impact of oil price changes on domestic inflation. By using the input-output table of the Turkish economy for the year 1990, Berument and Taşçı (2002) investigated the oil

price pass-through under different specifications. Their findings suggested that when wages, profits, interest rates, and profits are flexible enough to adjust price level changes, the oil price pass-through becomes significant in the Turkish economy. Çatik and Önder (2011) estimated the oil price–augmented Phillips curve model with a Markov regime-switching model, and they documented the pass-through in high and low regimes of oil prices. Their results suggested that the reason for to fall of oil price pass-through in the Turkish economy would be moving from high to low inflation regime. A similar specification was used by Çatık and Karaçuka (2012). They used a Markov regime-switching VAR model and concluded that the direct pass-through of imported oil prices is significant in both low and high inflation regimes.

Dedeoğlu and Kaya (2014) investigated whether oil price pass-through decline over time in the Turkish economy. They employed a VAR model in rolling windows and examined the period between 1990 and 2012. Unlike many other studies, they provided evidence for an increasing pass-through of oil prices. They argued that the relative price increases would be the reason for the rising transmission of oil prices. Their results also indicated that the pass-through to producer prices are two times higher than the pass-through to consumer prices. Finally, Akçelik and Öğünç (2016) analyzed the pass-through of oil prices in a relatively low inflation period, 2004-2014. They used both the Phillips-curve model and VAR specification. Their findings indicated that the pass-through to motor fuel prices is relatively faster, but it accounts for one-third of the fuel prices increases. They also found that the pass-through is two times higher in producer prices than consumer prices.

Several studies investigated the impact of domestic fuel subsidy programs in oil-importing countries. Jha et al. (2009) used a dynamic simulation analysis and provided projections for 32 Asian countries in the case of global oil price shocks. Their projections suggested that countries that regulate or subsidize domestic fuel prices need fiscal consolidation to sustain the steady-state target of the debt burden. Bhanumurthy et al. (2012) constructed a macroeconomic simulation model to analyze the transmission of international oil price fluctuations to the Indian economy. They found that deregulation of the fuel price system and allowing the transmission of oil price changes to domestic prices would create contractionary results in the short-run. At the same time, it encourages output growth in the long-run. By utilizing a Phillips-curve model and the VAR specification, Mandal et al. (2012)

concluded that the effect of the deregulation policy and the subsequent full transition of international oil prices into domestic fuel prices is further inflation and a small output rise.

For Indonesia, Dartanto (2013), by utilizing a computable general equilibrium (CGE) microsimulation model, found that the 25 percent deduction of fuel subsidies increase the incidence of poverty by about 0.25 percent. Also, the rise in the reduction of fuel subsidies increases the incidence of poverty, and it depends on the share of the deduction devoted to government transfers. Plante (2014) constructed a small open economy model and found that the fuel subsidies create crowding-out effect non-oil consumption and reduce the aggregate welfare in both oil-importing and exporting countries. Kpodar and Abdallah (2017) analyzed the role of fuel subsidies on the pass-through of oil prices in 162 countries over the period between 1970 and 2014. Their impulse-response results documented that the pass-through is negatively related to the magnitude of the fuel subsidies. Their study also argued that existing studies underestimate the fiscal costs of subsidies since they use the yearly average price of fuels in their calculations.

Boonpramatoe (2017) aimed at examining the economic impact of fuel subsidy removals in Thailand by using a CGE model. Their results suggested that the transportation sector is expected to experience the highest fall of output following the subsidy removal. Li et al. (2017) used a CGE model to analyze the impact of fuel subsidy reform in Malaysia. Their results are in favor of removing fuel subsidies and concluded that the budget deficit would be much lower if the amount saved is not directed to another expenditure. In one of the more recent studies, Boughanmi and Khan (2019) employed a CGE model and used the survey data in Oman in 2011. Their results argued that removing half of the current fuel subsidies increases income level slightly. However, the impact on household welfare would be negative due to the pass-through of international oil prices to domestic inflation. Finally, Coady et al. (2019) estimated the cost of fuel subsidy programs in 191 countries in 2015. They calculated that subsidies worth 4.7 trillion US dollars and projected to be 5.2 trillion US dollars in 2017.

Overall, quantifying the oil price pass-through on economic activity, general price level, and budget balance, for those countries implementing fuel subsidy programs, would have important policy implications. Therefore, there has been a growing interest in analyzing

the oil price pass-through, especially in emerging economies. As a result, the literature has grown, and existing studies with various methodologies have concluded that spikes in international oil prices increases domestic prices. However, the impact of the subsidy programs on budget balances and output level are albeit with mixed results. In the case of Turkey, the literature calls for studies to investigate the impact of the recently introduced motor fuel subsidy program.

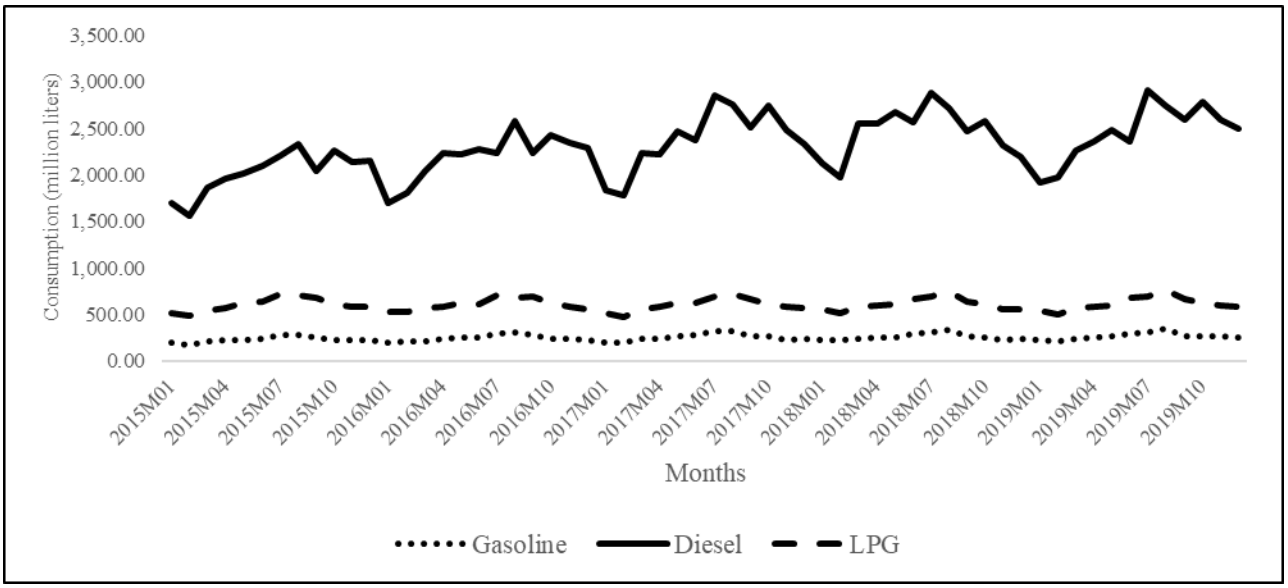
4.3. Oil and Motor Fuel Consumption in Turkey

Total primary energy consumption has been increasing rapidly in the Turkish economy. After 2010, the total primary energy consumption has increased by 42 percent. Oil is the first largest consumed energy source in Turkey since 2015. Oil consumption also has increased by 48 percent during the 2010-2018 period. Although the share of oil in total primary energy consumption is greater than 50 percent in the 1980s, Turkey seems to diversify its energy sources over time. The share of oil in Turkey's total primary energy consumption was 31 percent in 2018. While the total consumption of coal and natural gas is about 27 percent and 26 percent, respectively, the share of total hydroelectric and renewable energy sources is 14 percent in 2018 (British Petroleum Statistical Review, 2019).

Considering that limited domestic sources are unavailable to meet the increasing domestic oil needs, Turkey has been importing massive amounts of oil. The amount of crude oil imports increased by approximately 24 percent since 2015. Turkey imported 31 million tons of crude oil in 2019 (TSI, 2020). Turkey also imports plenty of oil products. In addition to crude oil, Turkey imported 10,8 million tons of gasoline and diesel, and 3,1 million tons of Liquified Petroleum Gas (LPG) in 2019 (EMRA, 2019). Therefore, it is safe to conclude that the Turkish economy might suffer from international oil price developments due to its import dependency.

According to the International Energy Agency (IEA, 2019), total oil consumption was 39 million tons in Turkey in 2017. Of these, 65 percent of the total oil consumption was in the transportation sector, 13 percent was in the industry sector, and 7 percent was in the agriculture and forestry sector. Total motor fuel consumption seems to correspond to the

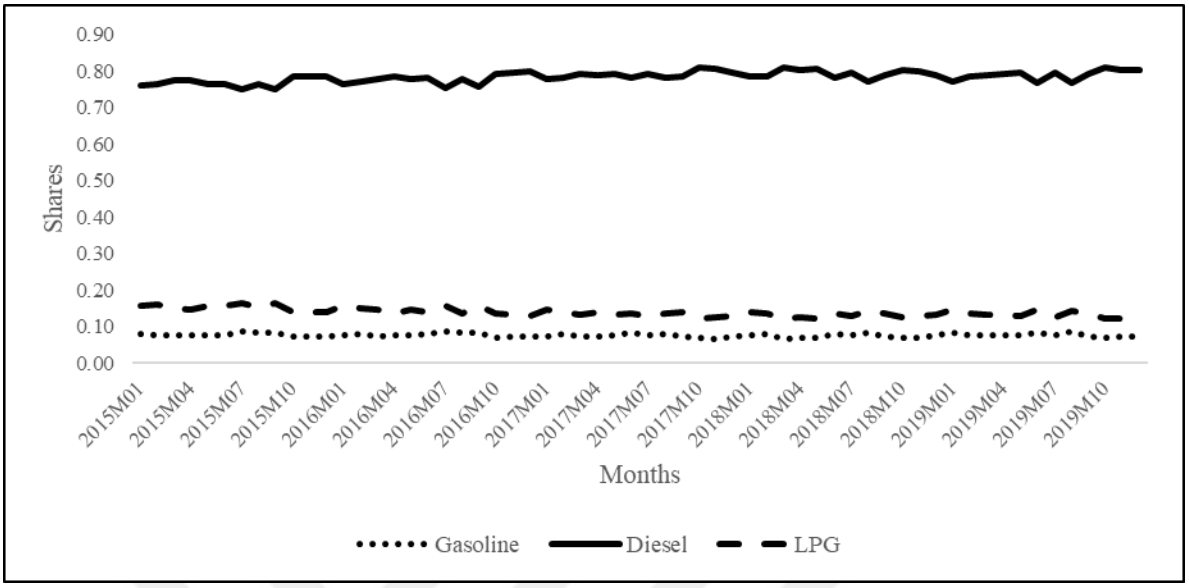
higher share of total crude and oil product imports in Turkey. Motor fuel consumption was 26,7 million tons in 2015 and reached up to 31,4 million tons in 2019. Figure 4.1 demonstrates the monthly gasoline, diesel, and LPG consumption in Turkey over the period between 2015 and 2019. The monthly consumption values are in terms of million liters.



Source: Authors calculation by the data collected from monthly sectoral reports of the Energy Market Regulatory Authority (EMRA).

Figure 4.1. Monthly motor fuel consumption in Turkey (2015-2019)

Diesel is a vital input in both the transportation and agriculture and forestry sector (Boonpramote, 2017) and is the most consumed motor fuel in Turkey. LPG follows the diesel, and the least consumed motor fuel is gasoline in Turkey in this period. The following Figure 4.2 shows the share of motor fuels in total motor fuel consumption.



Source: Authors calculation by the data collected from monthly sectoral reports of the Energy Market Regulatory Authority (EMRA).

Figure 4.2. Shares of motor fuels in Turkey (2015-2019)

In the corresponding period, the proportion of motor fuels does not seem to fluctuate. The most commonly used motor fuel is diesel, which accounts for 80 percent of overall motor fuel consumption. LPG's share is around 13 percent, and the least-used motor fuel, gasoline, is about 7 percent of Turkey's total fuel consumption over 2015-2019.

The more significant share of the transportation sector in oil consumption would raise awareness of the effects of motor fuel consumption and price changes on the Turkish economy. The next section explains the pricing system for motor-fuels in Turkey.

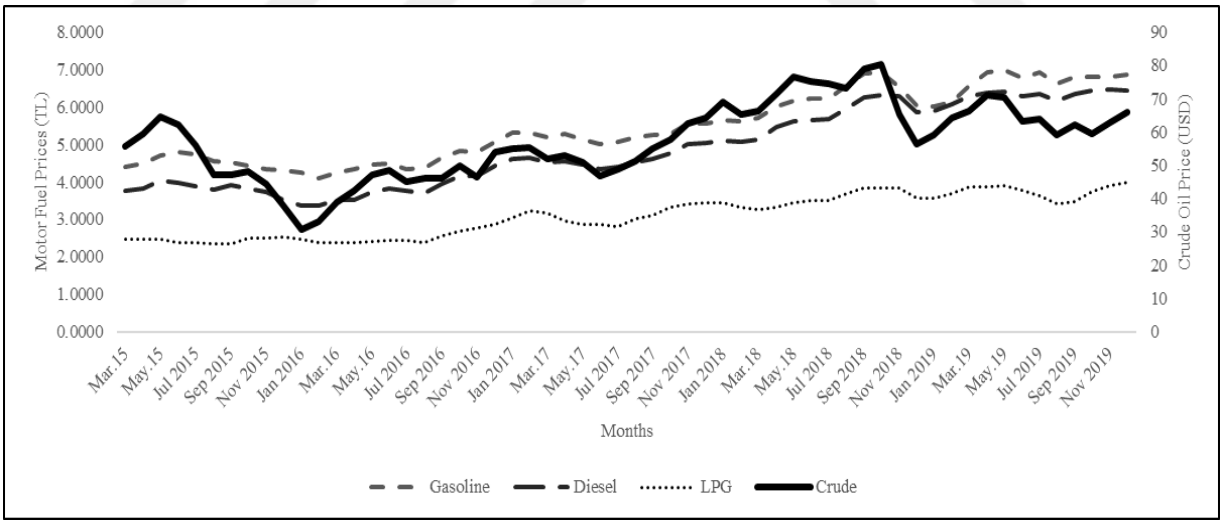
4.4. Motor Fuel Pricing, Taxing and Motor Fuel Price Subsidy System in Turkey

This section of the study first describes the motor fuel pricing in Turkey and then introduces the framework for the novel motor fuel price subsidy program and calculates the direct cost of the program to the government budget.

4.4.1. Motor Fuel Pricing

The ongoing rise in international oil prices has many adverse effects on oil import-dependent countries since it increases the concerns on domestic inflation, reduces output level, and discourages investments, worsens the current account balance (Mandal et al., 2012). International oil prices illustrated sharp declines and spikes during the last decades. Apergis and Payne (2014) explain four oil price regimes the first one of which started in 1990, and the last one is between 2009 and 2013. Baffes et al. (2015) further calls the fall of oil prices from 2011 to 2014 as "the great plunge" and argues that the fall of oil prices in the corresponding period have positive impacts on global economic activity.

In free-market pricing, petroleum product prices are subject to changes when international oil prices fluctuate (Berument et al., 2014) since petroleum products are made up of crude oil (Pal and Mitra, 2015). The following figure demonstrates the international oil price developments and motor fuel price fluctuations in Turkey.



Source: Gasoline, Diesel, and LPG prices are the author's calculation by the data collected from monthly pricing reports of Energy Market Regulatory Authority (EMRA). Crude oil price is the UK Brent price per barrel, taken from Bloomberg.

Figure 4.3. Crude oil price developments and motor fuel prices (2015-2019)

During this period, the UK Brent crude oil price seems to be more volatile than domestic gasoline, diesel, and LPG prices. The reason might be taxes imposed on domestic motor fuel prices. Taxing motor fuel prices is a common practice and the easiest way to increase revenue in several countries, and it is a vital source of government revenue (Kojima, 2016). In this sense, governments in developing countries implement various pricing strategies; some of them fully liberalized the system while a group of them apply a formula-based pricing strategy (Jha et al., 2009).

In Turkey, with the implementation of the Petroleum Market Act in early 2005, an open market structure was introduced. This Act and the pricing system allow distributors to determine their wholesale prices freely. Resellers can enforce price ceilings proposed by fuel distribution companies, or they can decide their retail prices in their marketing areas.

The formula for the fuel pricing is as follows:

$$\begin{aligned} Final\ Consumer\ Price \\ &= (Ex - refinery\ price + wholesaler\ margin \\ &+ EMRA\ revenue\ share + distributor\ and\ dealer\ margin \\ &+ lump\ sum\ SCT)x(1 + VAT) \end{aligned} \tag{4.1}$$

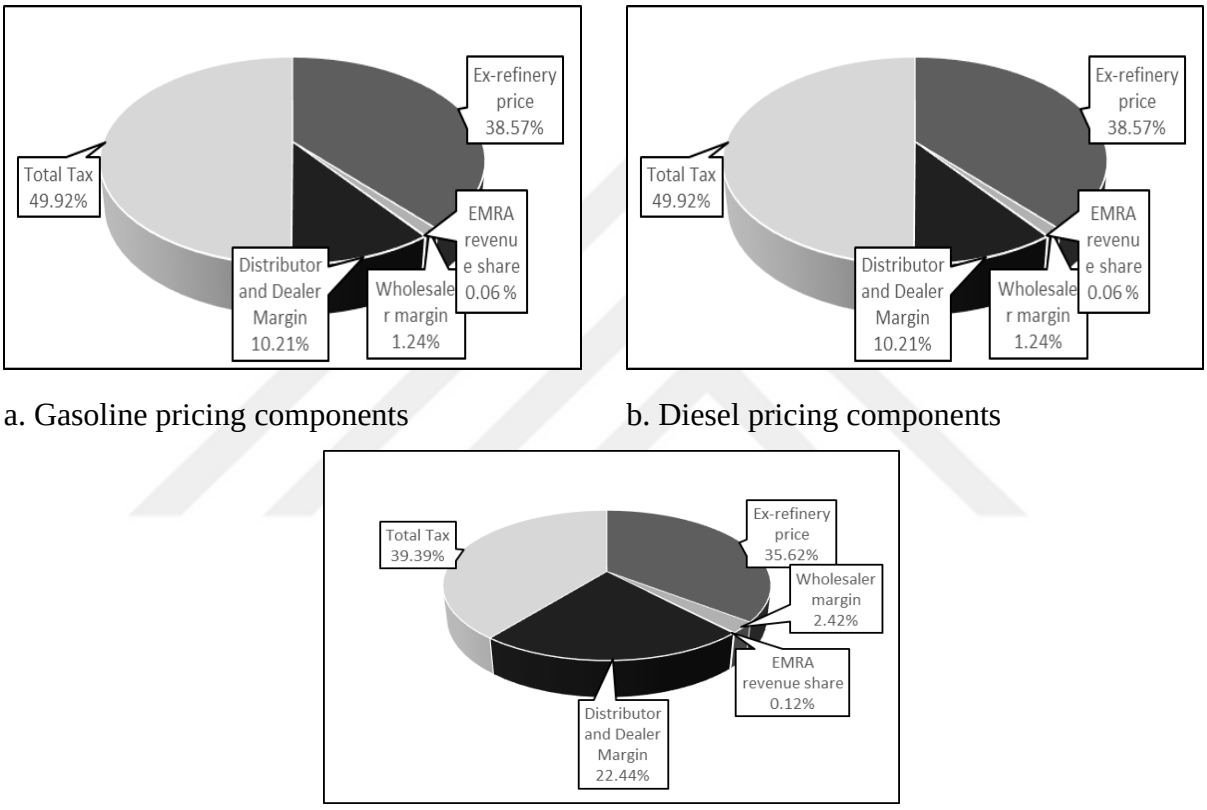
In this formula, SCT is the Special Consumption Tax, and the VAT represents the Value Added Tax. The SCT is the lump-sum tax paid per liter whose tariff adjusts rarely, and the VAT is set at 18 percent. The table below illustrates the pricing formation in December 2019 for each motor fuel.

Table 4.1. Motor fuel price formation

Fuel Type	Ex-refinery price	Wholesaler margin	EMRA revenue share	Distributor and Dealer Margin	SCT	VAT	Fuel Price
Gasoline	2.6440	0.0850	0.0039	0.7000	2.3765	1.0457	6.8550
Diesel	2.9980	0.0280	0.0039	0.7570	1.7387	0.9847	6.4550
LPG	1.4250	0.0970	0.0049	0.8980	0.9620	0.6140	4.0010

Source: EMRA December 2019 pricing report.
Notes: Istanbul (European Side) prices as of December 2019

The ex-refinery price represents the Mediterranean-Italian market CIF price. In addition to the ex-refinery price, the wholesaler margin, the EMRA margin, the distributor and dealer margin, and the lump-sum special consumption tax are added, and the 18 percent VAT is applied to the sum, and the final consumer price emerges. Figure 4.4 shows the shares of each element in price formation.



a. Gasoline pricing components b. Diesel pricing components

c. LPG pricing components

Source: Authors calculation by the data collected from December 2019 monthly pricing report of Energy Market Regulatory Authority (EMRA).

Figure 4.4. Pricing components of motor fuels in December 2019

It seems that the share of taxes in price formation is about 50 percent for gasoline, 42 percent for diesel, and about 40 percent for LPG products in December 2019. The share of taxes in the final consumer price of gasoline and diesel is about 61 percent and 54 percent in European Union countries, respectively. Turkey seems to have relatively lower shares of taxes in motor fuels among European countries.

4.4.2. Motor Fuel Price Subsidy System and Its Direct Fiscal Costs

As noted, countries use various tools to eliminate or absorb the pass-through of oil prices do domestic inflation. To this end, they adopt subsidy programs in their fuel pricing systems. They either decrease the wholesaler or distributor margins or lower taxes imposed on motor fuels (Jha et al., 2009). Fuel subsidy is defined as the government intervention to fuel prices when consumers are about to face an actual price, which is higher than the specific benchmark price (IMF, 2008).

The primary purposes of pricing subsidies in developing countries are to protect the household's real income, stabilize domestic inflation, promote industrial activity, and eliminate the adverse welfare impacts of oil price hikes (Coxhead and Grainger, 2018). However, opponents of the fuel subsidies argue that they create a burden for government budget and is an extra cost for taxpayers. They crowd-out other government expenditures, create market distortions, damages the price signaling mechanisms, leads inefficient allocation of resources and increases environmental pollution (Barany and Grigonyte, 2015).

This study focuses on the impact of the motor fuel subsidy system in Turkey. The Turkish government issued a decree (2018/11818) on May 14, 2018 and enacted a new rule to stabilize motor fuel prices and to avoid the destabilizing impact of international oil price spikes and depreciation of the domestic currency. According to the rule due to global oil price rises and exchange rate adjustments, the recent incremental increases in the ex-refinery price of fuels do not pass through final prices, and the reduction of special consumption tax somewhat offsets those increases. Therefore, the government will face a cost of foregone tax if the ex-refinery price rises following oil price and exchange rate shocks.

The size of the motor fuel subsidy shows the direct cost to the government budget. The most common and the easiest way of measuring the direct cost of a motor fuel subsidy system is the "price-gap" approach (Chelminski, 2018). The direct cost of the subsidy is calculated by multiplying the fuel consumed and the price gap (Couharde and Mouhoud, 2108). The price gap is a measure representing the gap between the free market price (without-subsidy price) and the current transaction price (with-subsidy price). Before demonstrating the direct fiscal

cost of the fuel subsidy program, Table 4.2 first shows the without-subsidy prices and with-subsidy prices of motor fuels and calculates the price-gap for each type of motor fuel.

Table 4.2. With-subsidy and without-subsidy fuel prices

Months	Gasoline (95 Octane)		Gasoline (95 Octane-Other)		Diesel		Diesel (Other)		LPG	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(1)
May 18	6.16	6.26	6.18	6.29	5.61	5.70	5.64	5.74	3.44	3.73
Jun 2018	6.24	6.47	6.26	6.49	5.66	5.87	5.69	5.90	3.51	4.00
Jul 2018	6.24	6.48	6.26	6.50	5.67	5.88	5.70	5.91	3.50	4.06
Aug 2018	6.56	7.06	6.58	7.09	5.96	6.44	5.98	6.47	3.68	4.40
Sep 2018	6.89	7.66	6.91	7.68	6.27	7.21	6.31	7.25	3.85	4.82
Oct 2018	6.92	7.44	6.95	7.47	6.31	7.17	6.36	7.21	3.85	4.83
Nov2018	6.52	6.52	6.55	6.55	6.28	6.54	6.33	6.59	3.85	4.35
Dec 2018	6.04	6.04	6.07	6.07	5.86	5.86	5.91	5.91	3.57	3.82
Jan 2019	6.03	6.03	6.06	6.06	5.89	5.89	5.93	5.93	3.57	3.80
Feb 2019	6.15	6.14	6.18	6.18	6.07	6.07	6.11	6.11	3.69	3.90
Mar 19	6.55	6.55	6.59	6.59	6.30	6.29	6.35	6.34	3.88	4.10
Apr 2019	6.94	7.13	6.98	7.17	6.37	6.52	6.42	6.57	3.88	4.15
May 19	7.00	7.34	7.04	7.38	6.41	6.83	6.45	6.88	3.89	4.25
Jun 2019	6.78	6.82	6.82	6.85	6.30	6.31	6.34	6.35	3.79	4.01
Jul 2019	6.92	6.93	6.95	6.96	6.37	6.37	6.41	6.42	3.61	3.84
Aug2019	6.62	6.62	6.66	6.66	6.17	6.16	6.21	6.21	3.41	3.67
Sep 2019	6.82	6.82	6.86	6.86	6.37	6.41	6.41	6.46	3.47	3.72
Oct 2019	6.80	6.80	6.84	6.84	6.43	6.44	6.48	6.49	3.75	3.71
Nov 2019	6.81	6.81	6.84	6.84	6.48	6.49	6.53	6.54	3.91	3.74
Dec 2019	6.86	6.86	6.89	6.89	6.46	6.52	6.50	6.57	4.00	4.20

Source: EMRA monthly pricing and oil sector reports (May 2018-December 2019). Note: Numbers are per liter TL prices. Note: (1) represents with subsidy price while (2) denotes the without subsidy price.

Given the with- and without-subsidy prices after the adoption of the motor fuel subsidy program in May 2018, the price gap between these two prices is a fiscal cost to the government budget for per liter fuel consumed. In the next step, Table 4.3 demonstrates the direct cost of the motor fuel subsidy program to the government budget in Turkey throughout May 2018 and December 2019.

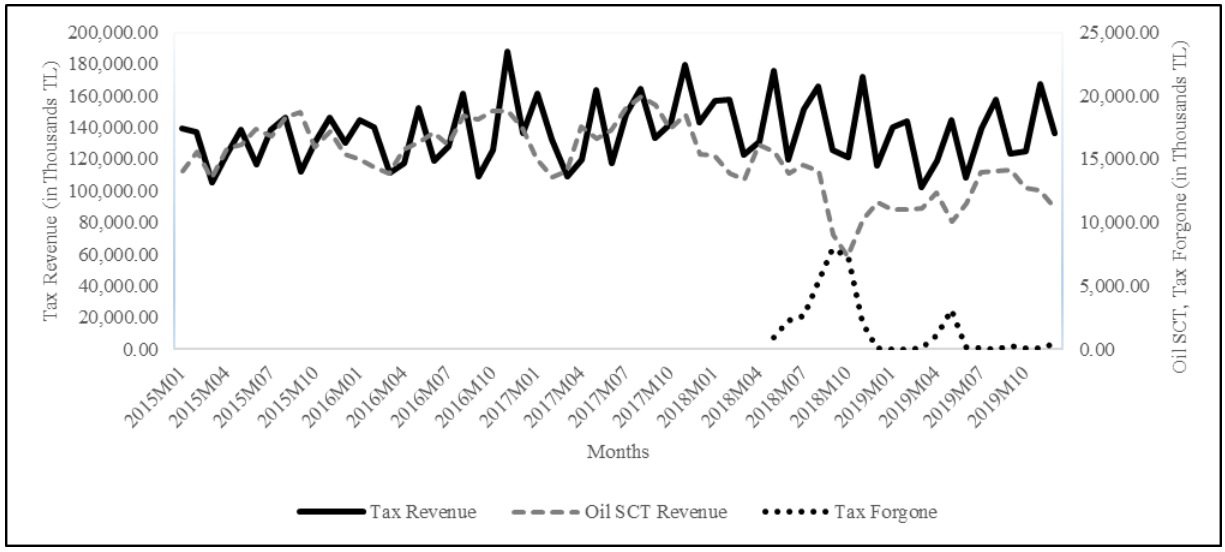
Table 4.3. The direct fiscal cost of the motor fuel subsidy program

Months	Gasoline Cons.	Diesel Cons.	LPG Cons.	Gasoline Tax Forgone (per liter)	Diesel Tax Forgone (per liter)	LPG Tax Forgone (per liter)	Fiscal Cost (Total Tax Forgone)
May 18	0.26	2.67	0.61	0.11	0.10	0.04	0.31
Jun 2018	0.29	2.56	0.67	0.23	0.21	0.29	0.80
Jul 2018	0.31	2.88	0.70	0.24	0.21	0.37	0.94
Aug 2018	0.33	2.72	0.76	0.51	0.49	0.60	1.94
Sep 2018	0.26	2.47	0.64	0.78	0.95	0.92	3.12
Oct 2018	0.25	2.59	0.61	0.52	0.86	0.92	2.91
Nov 2018	0.23	2.32	0.56	0.00	0.26	0.36	0.82
Dec 2018	0.24	2.19	0.56	0.00	0.00	0.02	0.01
Jan 2019	0.23	1.92	0.54	0.00	0.00	0.00	0.00
Feb 2019	0.22	1.97	0.51	0.00	0.00	0.00	0.00
Mart 19	0.25	2.26	0.57	0.00	0.00	0.04	0.02
Apr 2019	0.25	2.35	0.58	0.19	0.15	0.10	0.46
May 19	0.26	2.48	0.60	0.35	0.43	0.21	1.28
Jun 2019	0.29	2.36	0.68	0.03	0.02	0.02	0.07
Jul 2019	0.31	2.91	0.69	0.01	0.01	0.00	0.03
Aug 2019	0.35	2.74	0.77	0.00	0.00	0.00	0.00
Sep 2019	0.26	2.59	0.66	0.00	0.05	0.00	0.12
Oct 2019	0.27	2.79	0.63	0.00	0.01	0.01	0.03
Nov 2019	0.26	2.60	0.60	0.00	0.01	0.01	0.03
Dec 2019	0.25	2.50	0.58	0.00	0.07	0.04	0.19
						Total:	**13.09**

Source: EMRA monthly pricing and oil sector reports (May 2018-December, 2019).
Note: Cons. represents consumption. Consumption values are in billion liters. Tax forgone values are in billion TL. Gasoline consumption and the tax forgone per liter is the average of Gasoline 95 octane and Gasoline 95 octane-other.

Table 4.3 shows the direct fiscal cost of the current motor fuel subsidy program in Turkey. It seems that the ex-refinery price does not require any tax exemption, and the with- and without subsidy prices are equal to each other. Therefore, in these months, there is no cost of the program to the budget. On the other hand, in some months, the price gap widens, and the burden of the program increases. The calculation of this study suggests that the total cost of the current motor fuel subsidy system to the government budget is about 13 billion Turkish Lira during May 2018-December 2019 period. The amount of tax exemption was 2.23 billion TL, while the government budget deficit was about 123 billion TL in 2019. Therefore, the direct cost of the subsidy system is around 1.8 percent of the Turkish government budget deficit in 2019.

Special consumption tax revenue from oil and natural gas products consists of about 10 percent of the total tax revenues in the Turkish government budget in 2019. Lastly, the following figure illustrates the developments in total tax revenues, oil, and natural gas product special consumption tax revenues in the Turkish government budget during the subsidy program.



Source: Tax Revenue and Oil SCT revenue series are obtained from the EDDS system of CBRT; the tax forgone measure is the author's calculation from EMRA monthly pricing and oil sector reports (May 2018-December 2019). Note: Tax revenue values are adjusted by CPI (2003=100).

Figure 4.5. Tax revenue, special consumption tax from oil and tax forgone in government budget (price adjusted Values in thousands TL)

Figure 4.5 clearly shows that tax revenues from oil and natural gas products decline following the introduction of the oil subsidy program. However, the real government tax revenues do not exhibit any distinct pattern during this period. The subsidy program creates a direct cost for the government budget. However, one might expect that the introduction of the subsidy program can increase real tax revenues, either by eliminating the oil price pass-through to domestic inflation or by accelerating the economic activity and increasing nominal tax revenues.

4.5. Data and Empirical Methodology

This section of the study first introduces the dataset and then describes the model specification of the study and explains the primary empirical methodology.

4.5.1. Data

This study explores the effect of the motor fuel price subsidy program on the Turkish economy. To this end, the analysis uses a set of 138 information variables. Information variables comprise the spectrum of consumer price indices, producer price indices, industrial production indexes, exchange rate, and public finance. The dataset holds a total of 90 disaggregated series of consumer price index (CPI) and producer price index (PPI), and the output gap of 41 industrial sub-sectors. The output gap series of industrial sub-sectors are derived from the industrial production of these sub-sectors by using the Hodrick–Prescott (HP) filter.

The dataset contains monthly series over the 2015:01 to 2019:12 period. The observable variable is the price of motor fuel generated by weighing the prices of gasoline, diesel, and LPG with their total consumption share. Electronic Data Delivery System (EDDS) provided by the Central Bank of the Republic of Turkey (CBRT) is the main data source for information variables. The motor fuel variable is the calculation of the author by using data obtained during the 2015-2019 period from EMRA's monthly pricing and oil sector reports. Much of these variables (seasonal change, variations, and log-differences) are transformed for study. Descriptions of all the variables, their acronyms, transformations, and data sources were given in Table 7.5 in Appendix C.

4.5.2. Model Specification

The analysis follows the benchmark definition suggested by McCarthy (2007), to analyze the effect of the motor fuel price subsidy program on the Turkish economy in a pass-through framework. The benchmark model of McCarthy (2007) is based on pricing along a distribution chain. We employ a FAVAR model that incorporates a large number of variables into a few numbers of factor variables. Our dataset includes 138 variables in five categories and a motor fuel price variable. The dataset includes a group of variables of consumer price indices, producer price indices, industrial production indexes, exchange rate series, and public finance measures.

The study follows a similar benchmark setup of McCarthy (2007) and Akçelik and Öğünç (2016). It extends their specifications with government revenues to capture the impact of motor fuel price changes on domestic prices, output gap, and the tax revenues and examine the impact of the motor fuel price subsidy system in Tukey. Therefore, the structure of the model specification can be illustrated as follows:

$$\Delta e_t^d = E_{t-1}\left(\Delta e_t^d\right) + e_t^e \tag{4.2}$$

$$\pi_t^f = E_{t-1}\left(\pi_t^f\right) + \alpha_1 e_t^e + e_t^f \tag{4.3}$$

$$\bar{y}_t^o = E_{t-1}(\bar{y}_t^o) + \beta_1 e_t^e + \beta_2 e_t^f + e_t^o \tag{4.4}$$

$$B_t^b = E_{t-1}\left(B_t^b\right) + \gamma_1 e_t^e + \gamma_2 e_t^f + \gamma_3 e_t^o + e_t^b \tag{4.5}$$

$$\pi_t^{pp} = E_{t-1}\left(\pi_t^{pp}\right) + \delta_1 e_t^e + \delta_2 e_t^f + \delta_3 e_t^o + \delta_4 e_t^b + e_t^{pp} \tag{4.6}$$

$$\pi_t^{cp} = E_{t-1}\left(\pi_t^{cp}\right) + \theta_1 e_t^e + \theta_2 e_t^f + \theta_3 e_t^o + \theta_4 e_t^b + \theta_5 e_t^{pp} + e_t^{cp} \tag{4.7}$$

In this model specification, Δe_t^d is the change in the US dollar and Euro exchange rates, π_t^f is the motor fuel price inflation, $\bar{y}_t^o$ is the output-gap, B_t^b is the budget revenues, and $\pi_t^{pp}$and π_t^{cp} are producer price inflation and consumer price inflation, respectively. Besides, e_t^e to e_t^{cp} are the exchange rate, motor fuel price, demand, fiscal policy, producer price, and consumer price shocks, respectively. E_{t-1} stands for the expectation of any variable with given information at the period t-1.

4.5.3. Empirical Methodology

There are some critiques of small-scale or traditional VAR models. First, these models are subject to low-dimensionality, and they employ a limited number of variables due to the degrees of freedom concern (Karagedikli et al., 2005). Second, the standard VAR models are susceptible to ad hoc decisions of variable selections (Fernald et al., 2014). Third, conventional VAR models provide impulse responses for those few variables included in the study (Gupta et al. 2010).

However, this study employs the factor augmented vector autoregressive (FAVAR) methodology in the model specification. The FAVAR approach compounds the standard VAR model with dynamic factor analysis (Bernanke et al., 2005). Since factor analysis transforms many series into a few numbers of factors, the FAVAR methodology exposes from a large dataset all the necessary information (Karagedikli et al., 2009). The FAVAR methodology thus seems to suit well to overcome the problems that standard VAR models face.

The FAVAR model specification in this study handles the general setup of Bernanke et al. (2005) and follows the two-step principal component approach proposed by Stock and Watson (2002). Bernanke et al. (2005)'s benchmark specification uses several non-observable variables and common factors that cannot be observed. In this context, this study proposes that the FAVAR model is characterized by one observable variable, namely the motor fuel price, which is the common component of all variables included in the dataset, and a set of unobserved factors that are extracted from a set of 138 information variables.

To illustrate, suppose that; N is the number of information variables, X_t be an $Nx1$ vector of information variables, M_t is the observable motor fuel price variable, and the F_t is the nx1 vector of unobservable common factors. Such common factors are extracted from the set of information variables and quantify most of the variation in X_t.

The representation of the FAVAR model is as follows (Bernanke et al. 2005):

$$\begin{bmatrix} F_t \\ M_t \end{bmatrix} = D(L) \begin{bmatrix} F_{t-1} \\ M_{t-1} \end{bmatrix} + e_t \qquad (4.8)$$

Here, $D(L)$ is the lag polynomial of order d, $D(.), D_i (i = 1, \dots, d)$, and $D(L) = I - D_1 L -$

$\cdots - D_d L^d$ where L stands for the lag operator, and I is the identity matrix.

However, the estimation of the above equation with standard procedures (i.e., ordinary least squares estimation) generates biased estimations and provides unreliable parameters (Gupta et al., 2010). One possible solution is to employ factor analysis (Stock and Watson, 2002). Here, unobservable factors, F_t, and the motor fuel price, M_t, conveys all necessary information. The notation of the vector of X_t can be displayed as follows:

$$X_t = \wedge^f F_t + \wedge^m M_t + v_t \tag{4.9}$$

where X_t is an *Nx1* vector of observable variables except for the motor fuel price, $\wedge^f$ represents the *NxK* factor loading matrix, the $\wedge^m$ is the *Nx1* coefficient matrix of the observable policy rate variable, and e_t is an *Nx1* vector of error terms with zero mean and idiosyncratic disturbances.

It is also required to determine the slow-moving and fast-moving variables in the model specification. The study follows Bernanke et al. (2005) to determine the set of slow-moving and fast-moving variables. In this context, the slow-moving variables do not respond to innovations in the price of motor fuel at the same time, while the fast-moving variables react contemporaneously. Classifications of the variables are also displayed in Table A.1 in the Appendix.

This study uses a Cholesky identification in which the non-observable variables are ordered before the motor fuel price variable. Factors extracted from the information variables, however, include some variables that respond to changes in motor fuel prices at the same time and violate the presumption of a priori order. Therefore, following Bernanke et al. (2005) and Karagedikli et al. (2013), This study rotates information variables against the motor fuel prices to convert factors that are free of contemporary responses.

4.6. Empirical Results

This section introduces the empirical results of the study. Since the study follows the two-step principal component approach first, the number of factors needs to be decided. Then, in the second step, the study proposes a FAVAR methodology and estimates the pass-through of motor fuel prices into domestic price indexes and evaluates the impact of subsidy system on domestic inflation, output gap, and fiscal measures.

4.6.1. Factor Estimation

The number of factors needs to be determined before proceeding into the impulse-response estimation. This study provides principal component analysis to determine the number of factors for information variables. Table 4.4 reports the number of principal components and the cumulative variance share for each number of factors.

Table 4.4. Determination of the number of factors

Number	Value	Difference	Proportion	Cumulative Value	Cumulative Proportion
1	34.617	11.333	0.250	34.617	0.250
2	23.283	12.706	0.168	57.901	0.419
3	**10.577**	**2.842**	**0.076**	**68.479**	**0.496**
4	7.734	1.472	0.056	76.213	0.552
5	6.262	2.032	0.045	82.475	0.597
6	4.229	0.249	0.030	86.705	0.628
7	3.979	0.657	0.028	90.685	0.657
8	3.322	0.197	0.024	94.007	0.681
9	3.124	0.113	0.022	97.132	0.703
10	3.011	0.142	0.021	100.143	0.725

Note: Principal components are computed using ordinary correlations.

The existing literature suggests that it is a common practice to employ the number of factors, at least explaining around 40 percent of the total variation in information variables (Karagedikli et al. 2013; Potjagailo, 2017). Therefore, the current analysis offers at least two factors which account for 41 percent of the total variation in the dataset. However, the study

selects three factors since it conveys more information and does create problems for the model parsimony. These three factors convey around 50 percent of the total information in the dataset.

Table 4.5 provides information for each factor introduced by the model specification and demonstrates the most highly correlated variables for each latent factor.

Table 4.5. Highly correlated variables with each factor

Series Name	Factor1	Factor2	Factor3
CPI-General	**0.89**		
CPI-Clothing		**0.92**	
CPI-Transport Services		**0.90**	
CPI-Recreation and Culture	**0.90**		
PPI-Computer, electronic and optical products			**0.82**
PPI-Electrical equipment			**0.85**
IP-Intermediate goods			**0.81**
IP-Non-durable consumer goods	**0.92**		
IP-Mining and quarrying	**0.88**		
IP-Manufacture of rubber and plastic products			**0.86**
IP-Manufacture of computer, electronic and optical products	**0.93**		
IP-Repair and installation of machinery and equipment			**0.86**
(USD) US Dollar (Selling)		**0.92**	
(EUR) Euro (Selling)		**0.88**	
Tax Revenues		**0.88**	

Note: Numbers are the correlation coefficients between a variable and the factor.

It seems that the first factor is highly correlated with CPI and some industrial production variables. The second factor appears to be highly correlated with some other disaggregated CPI series, exchange rates, and the tax revenue variables. On the other hand, the third factor is highly correlated with PPI and some other sectoral industrial production variables. Therefore, Table 4.5 illustrates that these factors do not exhibit clear and concise distinction among variables.

Also, Table 4.6 reports the fraction of the explained variance in some selected variables by estimated factors.[4]

Table 4.6. Explained variances of the selected variables by factors

Group-Series Name	Explained Variance (R^2)
CPI-General	0.83
CPI-Food And Non-Alcoholic Beverages	0.39
CPI-Food	0.37
CPI-Housing, Water, Electricity, Gas And Other Fuels	0.38
CPI-Electricity, Gas And Other Fuels	0.26
CPI-Furnishings, Household Equipment, Routine Maintenance Of The House	0.74
CPI-Health	0.40
CPI-Medical Products, Appliances And Equipment	0.18
CPI-Communications	0.30
CPI-Recreational And Cultural Services	0.04
CPI-Education	0.20
CPI-Hotels, Cafes And Restaurants	0.66
PPI-Domestic Producer Price Index	0.91
PPI-Mining and quarrying	0.48
PPI-Crude petroleum and natural gas	0.15
PPI-Manufacturing	0.88
PPI-Food products	0.76
PPI-Basic pharmaceutical products and pharmaceutic preparations	0.12
PPI-Machinery and equipment	0.69
PPI-Electricity, gas, steam and air conditioning	0.46
IP-Total industry	0.91
IP-Durable consumer goods	0.39
IP-Energy	0.46
IP-Manufacturing	0.91
IP-Manufacture of food products	0.55
IP-Manufacture of chemicals and chemical products	0.78
General budget revenues	0.62
Direct Taxes	0.30
Indirect Taxes	0.51
General budget expenditures	0.64

The share of the explained variance for all information variables lies between 1 percent and 91 percent. Three factors have highly explained domestic producer price index, total industrial production, and manufacturing production index series. However, the explained

[4] Explained variance for all variables is available upon request.

variation of some consumer price index series related to services and alcoholic beverages is less than 10 percent. In general, the explanatory power of these three factors seems to be relatively high for information variables. Three factors explain more than 50 percent of the total variation in 68 out of 138 information variables. Therefore, it seems that the dataset contains series that are driven by common factors, and the idiosyncratic elements accelerate the small number of variables.

4.6.2. Impulse Responses

Since this study aims at assessing the impact of the existing motor fuel price subsidy program in the Turkish economy, it extends the FAVAR model by introducing an alternative scenario. The scenario model simulates a variable response if the government does not follow the subsidy program. Thus, the study compares the responses of the baseline FAVAR model with these of an alternative scenario FAVAR model for each price index, output gap, and government revenue variables.

The following sections illustrate the cumulative impulse response results of the set of variables when a specified shock is given to a motor fuel price up to 36 months. Although the VAR specification offers mixed results for optimal lag, we used three lags as optimal, and we used three lags to get rid of the autocorrelation problem.[5]

The following sections provide impulse-response results both for baseline FAVAR model and scenario FAVAR model regarding the pass-through to price indexes, the impact of the motor fuel price shock to fiscal measures, and the output gap in various industrial sectors, respectively. In figures, the thick line reports the responses in the baseline FAVAR model while the dotted line displays the responses of the variables in case of a scenario FAVAR model. In other words, the dotted line represents the response of the selected variable if the government had not adopted a motor fuel subsidy program.

[5] Diagnostic test results are displayed in Appendix C in Tables 7.6, 7.7, and Figure 7.2.

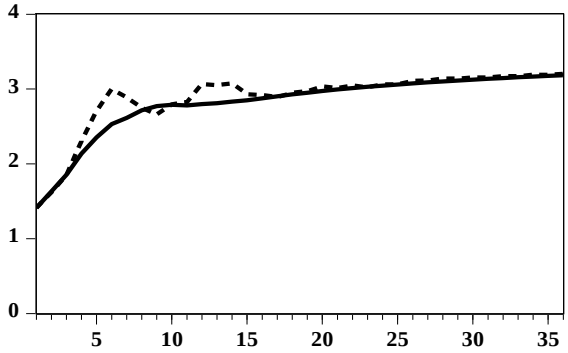
4.6.2.1. Pass-Through to CPI and PPI Indexes

This section of the study concentrates on the pass-through of motor fuel price changes to sub-indexes of consumer price index and producer price index. Figures 4.6 and 4.7 demonstrate the pass-through of consumer price indices, while Figure 4.8 illustrates the producer price indices. The impulse-response graphs in each figure represent the pass-through coefficient. Following Rabanal and Schwartz (2001) and Akçelik and Öğünç (2016), we compute the pass-through coefficient by the given formula:

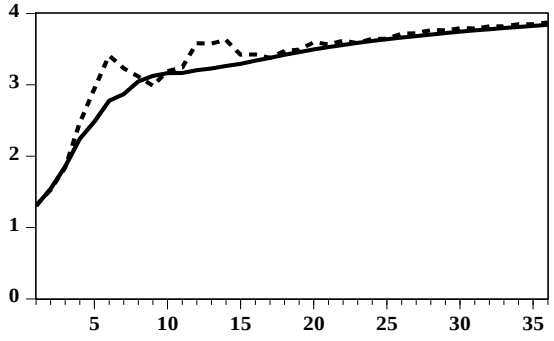
$$PT_{t,t+s} = PT_{t,t+s}/FP_{t,t+s} \tag{4.10}$$

Here, $PT_{t,t+s}$ is the cumulative response of the selected price index to a fuel price shock at horizon s in period t, and the FP is the cumulative response of fuel price itself to a fuel price shock at horizon s in period t.

Also, it is noteworthy that we standardize the motor fuel price shock to a 10 percent increase in motor fuel prices, and the impulse-response graphs for each price index provides the percentage change of each price index in a specified time horizon. Although our dataset includes 56 consumer price indices, we report the responses of main CPI groups and some selected sub-indices.[6] Figure 4.6 shows the response of selected consumer price indices to a 10 percent motor fuel price shock.



a) CPI-General



b) CPI-Food and Non-Alcoholic Beverages

[6] Responses of all CPI series are available upon request.

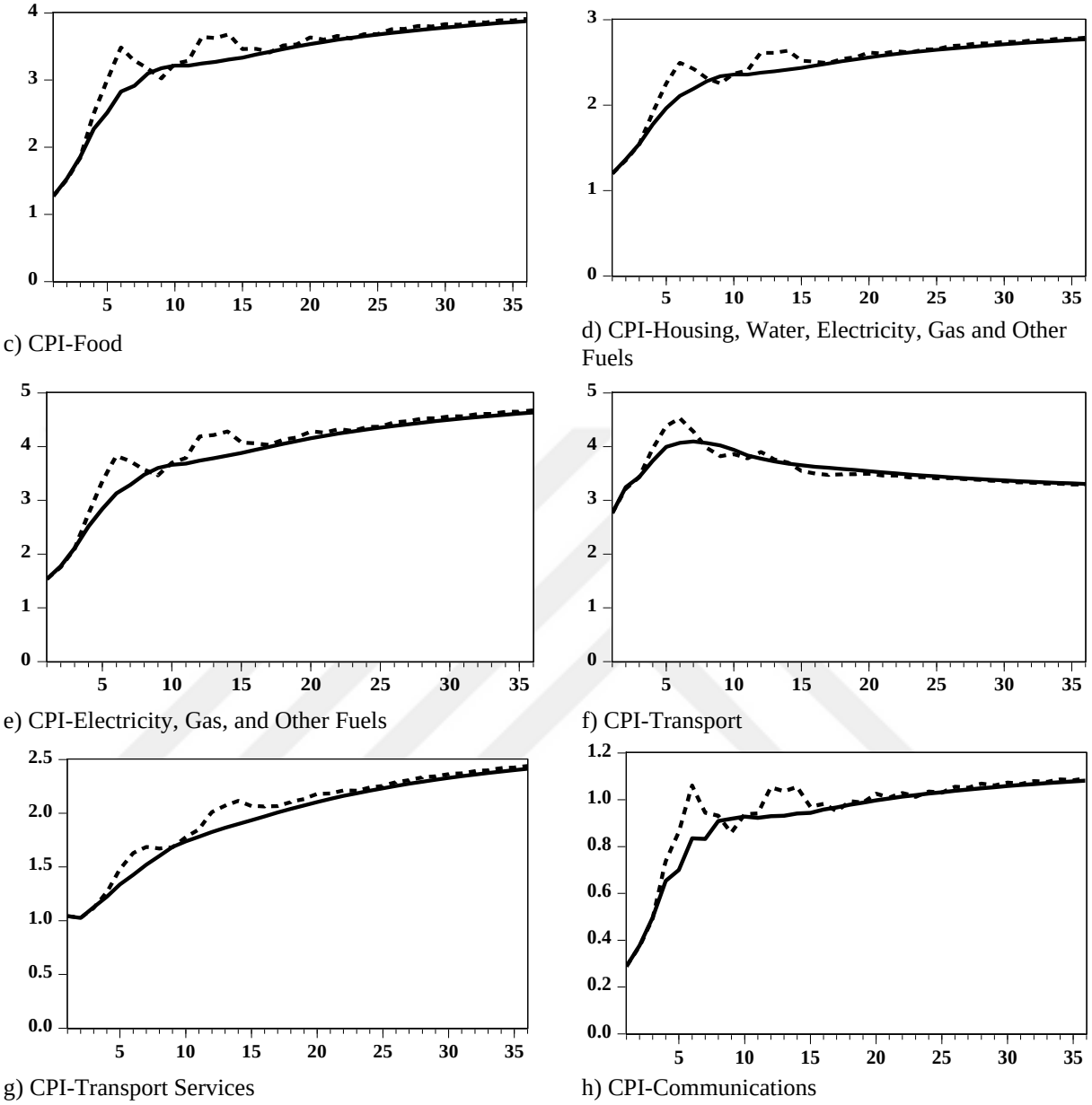


Figure 4.6. The impulse responses of selected consumer price indexes-I

The impulse-response results of the baseline model in Figure 4.6(a) demonstrates that a 10 percent permanent increase in motor fuel prices causes around 3.14 percent increase in overall CPI inflation within 36 months. Therefore, one might conclude that one-third of the impact of the increase in motor fuel prices pass-through to general consumer inflation. It is also worth noting that about 68 percent of the total pass-through has been completed within the first four months, and about 88 percent of the pass-through happens within one year.

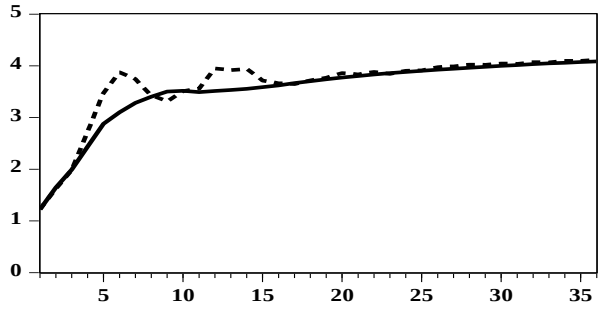
The reaction of consumer inflation for food and non-alcoholic beverages is somewhat higher than the response of general consumer inflation. Figure 4.6(b) illustrates that the impact of the 10 percent permanent increase in motor fuel prices causes about a 4 percent rise in prices of food-related price indexes within 36 months. However, the speed of pass-through in food-related indexes is slightly lower than those of overall prices. The response of the consumer prices for housing, water, electricity, gas, and other fuels is slightly less than the overall CPI. The magnitude of the response indicates that a 10 percent permanent price hike in motor fuels translates into about a 2.7 percent increase in the prices of housing, water, electricity, gas, and other fuels. However, the cumulative pass-through coefficient increases when we concentrate on the sub-index of consumer prices for electricity, gas, and other fuels and exclude the housing component of the main index. As expected, due to the positive correlation among fuels, the pass-through to the prices of electricity, gas, and other fuels is higher than their counterparts. Although the immediate impact of the pass-through is not substantially higher, the effect of the motor fuel price rise creates a more long-lasting impact on electricity, gas, and other fuel prices.

The most immediate impact of the motor fuel price hikes takes place in transport prices. The permanent rise in motor fuel prices reaches its peak within seven months. The 10 percent rise in motor fuel prices causes a price hike, which is slightly higher than 4 percent within seven months, and the accumulated impact tends to decline hereafter. However, as can be seen in Figure 6(g) the pass-through to transport service prices is quite slow and somewhat lower. The accumulated impact of the 10 percent permanent motor fuel price hike is about 2.7 percent in the three years, and 75 percent of the total impact occurs within a year. The magnitude and the speed of the response of transport services are entirely consistent with the results Akçelik and Öğünç (2016). The plausible explanation for this finding might be that the elements of the transport services price index include some regulated and subsidized services (i.e., subway ticket, municipality bus ticket), and these prices do not respond quickly to fuel price changes. Lastly, the pass-through of consumer inflation for communications is relatively lower and quite weak (Figure 6(h)). The permanent 10 percent rise in motor fuel prices leads communications prices to increase by 1 percent at the end of the three years. The probable

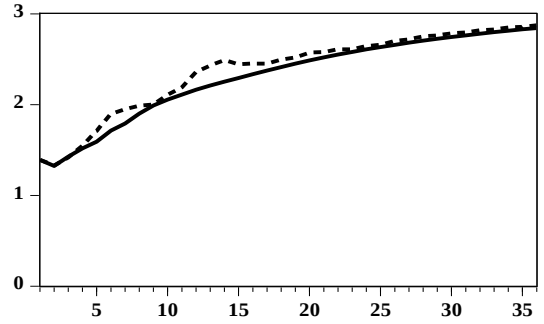
explanation might be the pricing structure and the regulated nature of the communications sector in Turkey.

As noted, dotted lines in each figure illustrate the responses of domestic prices in scenario FAVAR model and show what would happen to pass-through to domestic prices if the government had not adopted the motor fuel price subsidy program. It appears that the pass-through of motor fuel price rise would be higher in all consumer price indexes if the government had not implemented the subsidy program and allowed the transmission of international price rises into domestic fuel prices. Figures show clearly the significant impact, especially within one and a half years, of the subsidy program on domestic prices. The fuel price subsidy program also seems to mitigate the speed of the pass-through to domestic prices. For instance, if the government had not adopted the motor fuel price subsidy system, the accumulated pass-through of motor fuel prices to the general consumer price index would be much higher (3.20 percent). Also, around 95 percent of the accumulated impact would take place within a year.

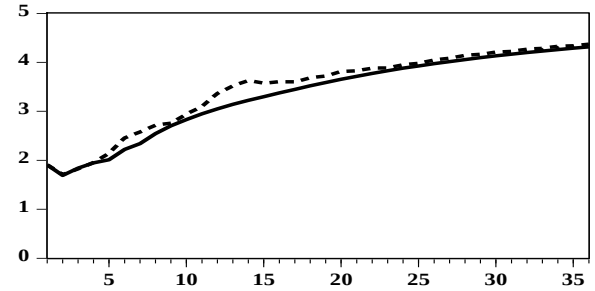
Figure 7 also plots the impulse responses of other main consumer price index groups and demonstrates the pass-through of motor fuel prices.

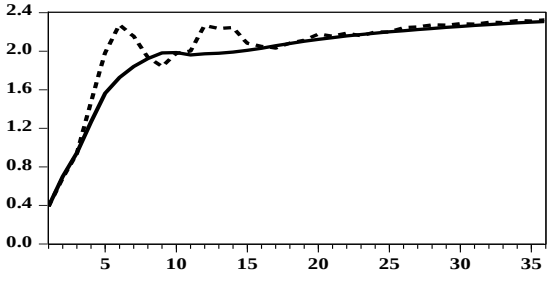


a) CPI- Furnishings, Household Equipment, Routine Maintenance of The House

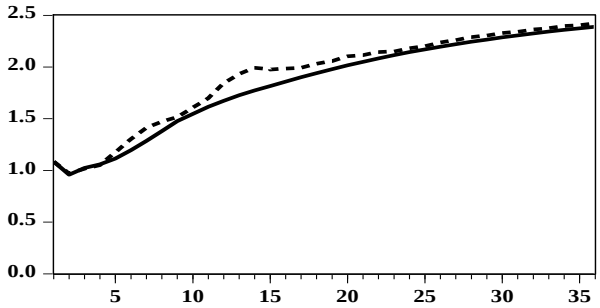


b) CPI-Health

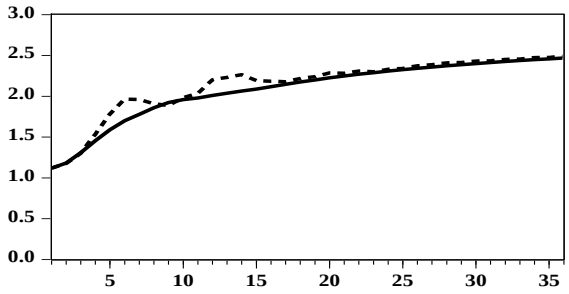




c) CPI- Medical Products, Appliances, and Equipment



d) CPI-Recreation and Culture



e) CPI-Education

f) CPI-Hotels, Cafes, and Restaurants

Figure 4.7. The impulse responses of selected consumer price indexes-II

The baseline model responses of the remaining main consumer price index categories in Figure 4.7 demonstrates that an increase in motor fuel price causes higher accumulated price hikes in price indexes of furnishings, household equipment, routine maintenance of the house (4.7a), and medical products, appliances and equipment (4.7c) than overall domestic prices (4.6a). The 10 percent permanent increase in motor fuel prices will lead to around 4 percent rise in the former price index while the pass-through is about 4.3 percent in the latter price index. The response of the remaining price indexes (consumer prices for health, education, and hotels, cafes, restaurants) is lower than that of the overall price index and is around 2.5 percent.

The impact of the motor fuel price subsidy program is also significant in these price indexes. The pass-through of motor fuel price increases would have been rather high if the government had not adopted the subsidy system. It is also the case that the fuel price subsidy program alleviates the pace of the pass-through to domestic prices for those price indices. Furthermore, the absence of the subsidy program would cause the impact of the fuel price hikes to be more long-lasting in the domestic economy.

Therefore, this study provides a piece of evidence that the inflationary effect of motor fuel price changes is higher for petroleum product-related consumer prices. Our findings also suggest that the pass-through impact for less petroleum intensive indexes is less severe and short-lived. These findings are in line with those of Goa et al. (2014), who argue that since the demand is more inelastic for energy-related industries, the rise in oil prices may decrease the

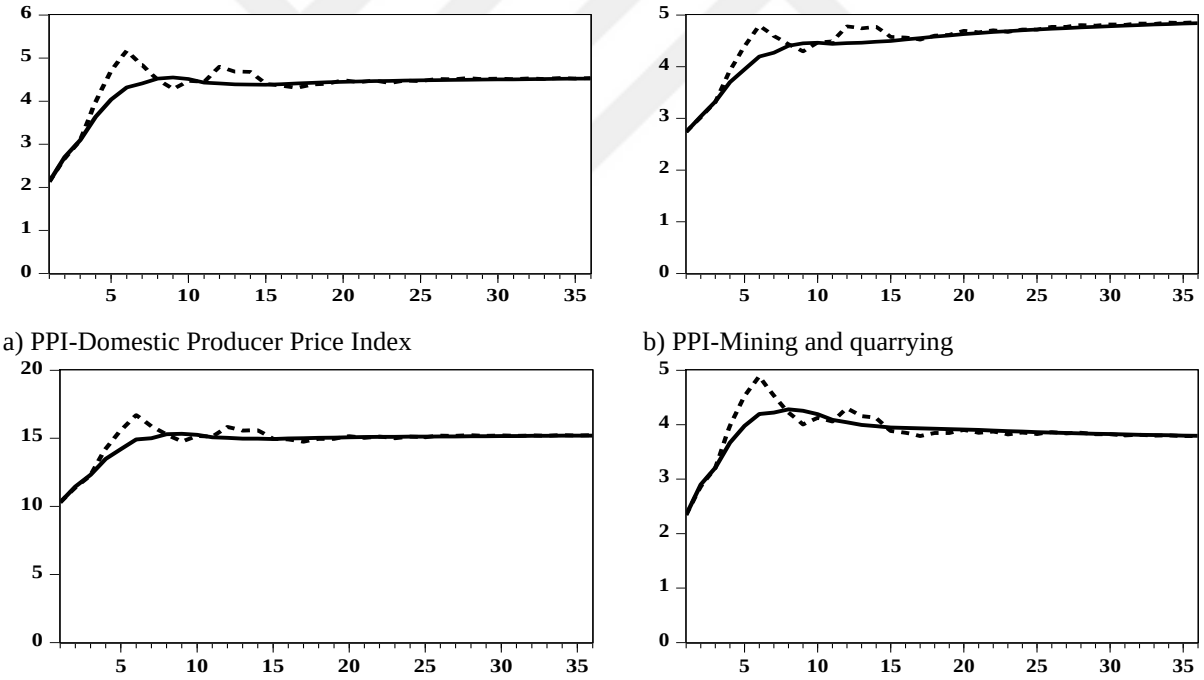
demand for less-energy related goods and services and the pass-through to various price indexes will be heterogeneous. Pass-through of the motor fuel prices to consumer price inflation, which is the indirect effect of the oil price changes, occurs through the increase in the cost of producing goods and services that use petroleum products as input. The strength of the shock depends on the market competition, cyclical fluctuations, and the nature of the shock (Alvarez et al., 2011). Another probable explanation for the heterogeneity across indices might be due to the second-round effects. Berument and Taşçı (2002) found in their study that the pass-through of oil prices to domestic inflation significantly depends on the behaviors of wages, profits, and interest rates in Turkey. Therefore, the response of these measures might create heterogeneity across consumer price indexes.

Compared to Çatık and Karaçuka (2012), our findings suggest that the pass-through of petroleum products increased overtime in the Turkish economy. They discover that the 10 percent rise in petroleum product prices increases the consumer price index of 1.79 percent in the low inflation environment. However, we find that the pass-through of motor fuel price increases is around 3 percent, which is substantially higher than the estimation made by Çatık and Karaçuka (2012). One explanation might be the rise in the share of income devoted to the consumption of gasoline and other motor fuels (Alvarez et al., 2011). Indeed, the weights by main expenditure groups of consumer price index data demonstrate that the share of transportation rises about three percentage points in the consumer price index calculation of TSI (TSI, 2020). When we compare our findings with Akçelik and Öğünç (2016) who analyzed the 2004-2014 period for Turkey, our results also exhibit that the pass-through increased overtime. Therefore, these findings are consistent with Dedeoğlu and Kaya (2014), whose study argued that the main reason for increasing pass-through overtime is the oil prices itself. Therefore, they concluded that during low oil price periods, pass-through increases since oil becomes less critical for the cost structure.

Overall, our findings allow us to conclude that the subsidy program is effective in absorbing the adverse effects of international price shocks to domestic inflation. Therefore, the elimination of the pass-through to domestic prices may create positive welfare effects for consumers (Del Granado et al., 2010). First, households face lower motor fuel prices directly, and their real income increases. Second, the fall of the pass-through also decreases the

inflationary impacts of motor fuels on other goods and services. Therefore, the real income of households would be relatively higher (Coady et al., 2015). Finally, the slowdown in inflation rates due to a fall in the pass-through of domestic prices might facilitate the work of the central bank since the monetary authority is delegated to ensure price stability (Salisu et al., 2017). Therefore, one might conclude that the adoption of the subsidy program might help CBRT to cut rates during this period and allow CBRT to encourage economic activity by expansionary monetary policy in Turkey.

After examining the consumer price indexes, our analysis also investigates the pass-through of selected producer price indexes. It evaluates the effectiveness of the subsidy program to eliminate the transmission of international oil prices on domestic producer prices. Figure 4.8 plots the impulse responses of selected PPIs. [7]



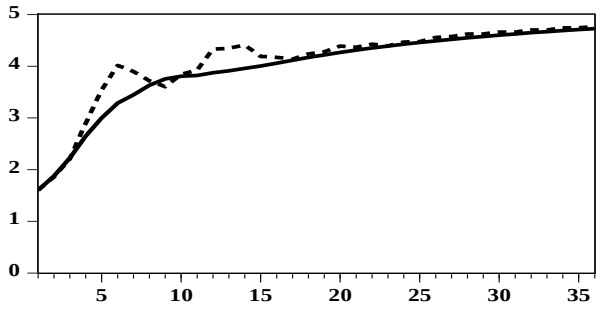
a) PPI-Domestic Producer Price Index

b) PPI-Mining and quarrying

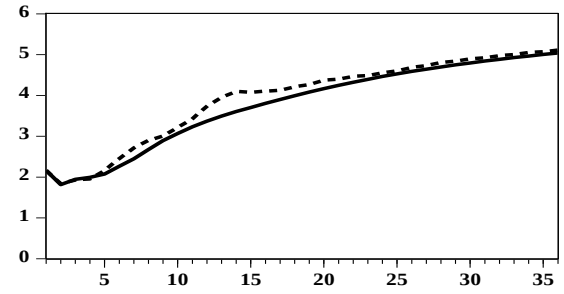
c) PPI-Crude petroleum and natural gas

d) PPI-Manufacturing

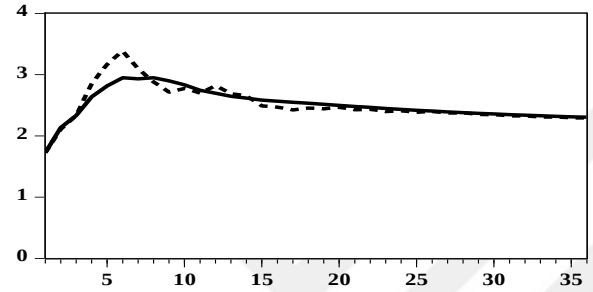
[7] Responses of all PPI series are available upon request.



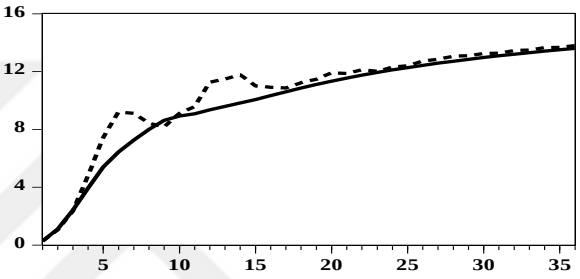
e) PPI-Food products



f) PPI-Basic pharmaceutical products and pharmaceutic preparations



g) PPI-Machinery and equipment



h) PPI-Electricity, gas, steam and air conditioning

Figure 4.8. The impulse responses of selected producer price indexes

The impulse-response results of the baseline model in Figure 4.8 illustrates that the response of various producer price indexes to a motor fuel price increase is heterogeneous. Figure 4.8(a) shows that the 10 percent permanent increase in motor fuel prices leads to around a 4.5 percent rise in domestic producer price index within 36 months. The pass-through impact on domestic producer prices also appears to take place rapidly. Around 90 percent of the total accumulated pass-through occurs in the first five months, and it reaches up to its peak level in the ninth month after the shock. The response of the manufacturing producer price index is quite similar to the producer price index. The 10 percent permanent rise in motor fuel prices causes the manufacturing price index to reach its peak level as 4.28 percent within eight months period. The quite similar responses are not surprising since the weight of manufacturing is about 90 percent in the producer price index.

Although the response of the producer prices in mining and quarrying is slightly less rapid than the producer price index, the accumulated pass-through is somewhat higher. It takes a half year for the pass-through of 86 percent of the total accumulated response. The total accumulated pass-through impact within 36 months is quite similar for producer prices in food

products (4.8e), and basic pharmaceutical products and pharmaceutic preparations (4.8f). A rise in motor fuel prices of 10 percent has an impact of 4.72 percent and 5.03 percent for those indexes, respectively. However, the response is more rapid in food products. 70 percent of the total pass-through occurs within half of the year in food products while it takes more than a year in basic pharmaceutical products and pharmaceutic preparations to reach 70 percent.

As is the case in producer prices, the transmission of motor fuel prices seems to be higher for the petroleum product-related producer prices. The impact of the 10 percent increase in motor fuel prices leads to 15.32 percent rise in producer prices of crude petroleum and natural gas, and 13.60 percent rise in producer prices of electricity, gas, steam and air conditioning. 90 percent of the total pass-through takes place within four months in electricity, gas, steam, and air conditioning prices. Therefore, it seems that the magnitude and the speed of the price adjustment are quite higher in petroleum product-related price indexes, and the rapid response might demonstrate that the direct impact is somewhat higher for these price indexes.

The motor fuel price subsidy program appears to be effective in absorbing the adverse effects of international oil price shocks on domestic producer prices. In the absence of the subsidy program, the pass-through to domestic producer prices reaches up to 4.8 percent. For all sub-indexes, the impulse response results demonstrate that the pass-through would be higher if the government had not adopted the subsidy system. Besides, the presence of the subsidy program curtails the long-lasting impact of the motor fuel price increases.

The pass-through from motor fuel prices to producer prices is quite higher than the pass-through to consumer prices. While Akçelik and Öğünç (2016) and Dedeoğlu and Kaya (2014) found the impact in producer prices to be twice as high, our results show that the gap between producer and consumer prices is higher than their findings in absolute terms. Akçelik and Öğünç (2016) argue that imposed taxes on retail prices stabilize the impact of oil price changes and the impact of oil prices exert its impact more on the producer prices. By citing Jongwanich and Park (2011), Dedeoğlu and Kaya (2014) argue that the gap between producer and consumer prices depend on the behavior of monetary authority. Since central banks adopt

inflation targeting and are mandated to set targets on consumer prices, their policy actions generally aim to eliminate the inflationary effects of oil price changes on consumer prices. Besides, the rise in motor fuel prices quickly passes through to producer prices. Akçelik and Öğünç (2016) argue that consumer prices respond to oil price shocks immediately due to the impact of import prices. Furthermore, Dedeoğlu and Kaya (2014) suggest that rising competition and the low inflationary period also causes the fall of transmission from producer prices to consumer prices.

4.6.2.2. Impact of Fuel Price Shock on Fiscal Measures

As noted, the fiscal channel is the one through which global oil price changes exert its impact on the macroeconomic indicators. The fiscal channel indicates the cost to the government when the government absorbs the share of the oil price changes and eliminates the part of the pass-through impact into the domestic economy (Bhanumurthy et al., 2012). Government subsidies that are used to eliminate the adverse effects of the price shocks do have fiscal costs and provide important implications for government budget (IMF, 2008).

After the introduction of the motor fuel price subsidy program in May 2018, the rise in international oil prices and depreciation of domestic currency created some burdens for the Turkish government budget due to the tax exemptions in motor fuel prices. As calculated, the direct cost of the subsidy program, which is the amount of tax forgone is about 13 billion Turkish Lira during May 2018 and December 2019. However, this section of the study aims at investigating the impact of the motor fuel price shocks on various fiscal measures and discussing the sustainability of the program. To this end, Figure 4.9 reports the response of tax revenues to a positive innovation to motor fuel prices.

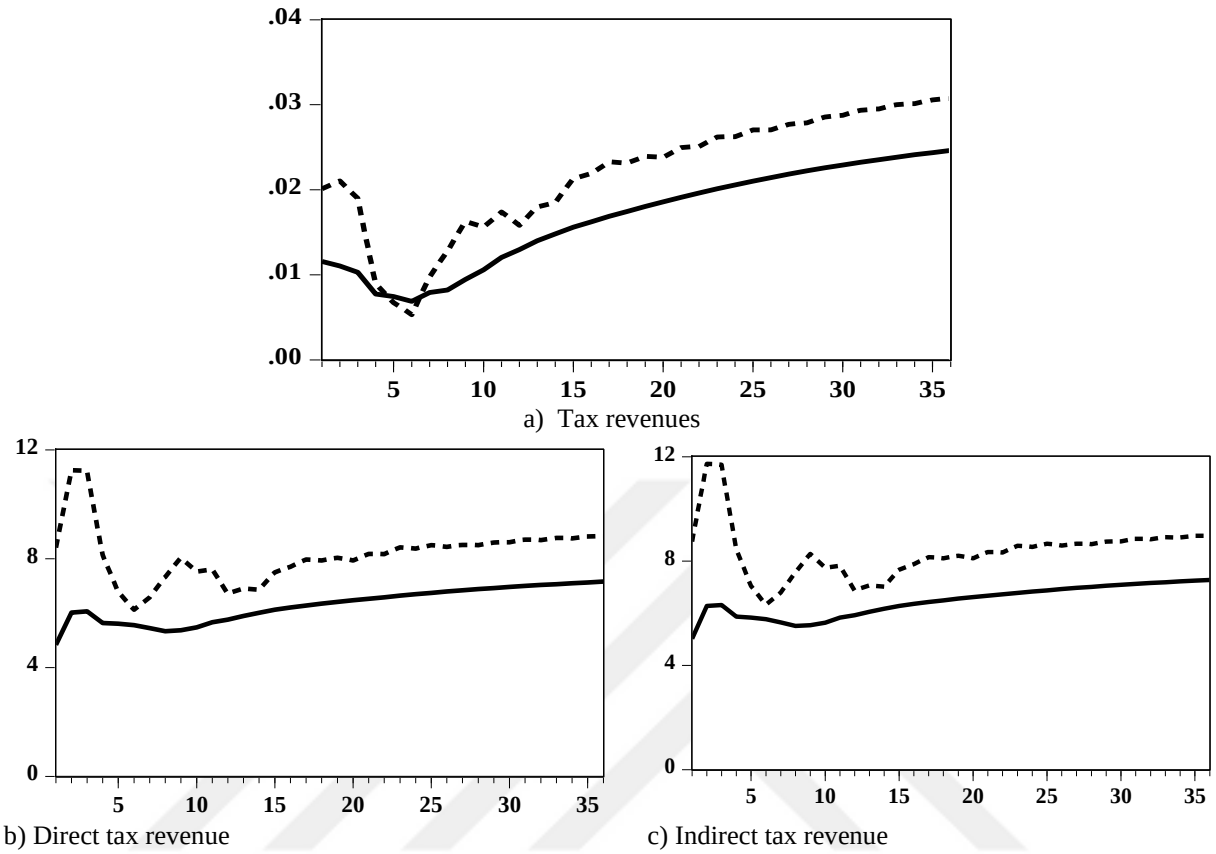


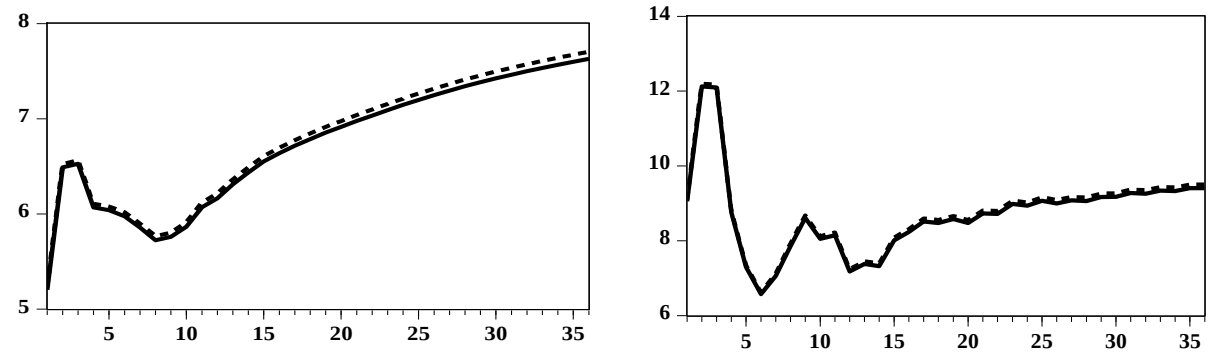
Figure 4.9. The impulse responses of tax revenues

The baseline model results in Figure 4.9 illustrate that government tax revenues respond positively to a positive motor fuel price shock. The positive response of government revenues to a motor fuel price hike is not surprising since Figure 4.1 reports the increasing trend in gasoline, diesel, and LPG consumption regardless of the rise in oil prices.

In Figure 4.9(a), the cumulative response of total tax revenues follows a U-shaped pattern within one year. That means the cumulative response decreases from the shock after half a year. However, after the first six months, the response of tax revenues steadily increases, and the impact of the shock does not seem to be fully completed during the three years. The responses of direct and indirect tax revenues are quite stable, and they follow nearly identical patterns. It seems that around 85 percent of the total impact of the motor fuel price shock is complete within three months for both direct and indirect tax revenues.

The scenario model results illustrate the burden of the subsidy program to the government budget. Since the dotted lines represent the response of the tax revenue if there is no tax exemption on motor fuels, the gap between dotted and the dashed lines might indicate the cost of the subsidy program. As expected, tax revenues in the government budget would be higher if the government had not adopted the subsidy program. Therefore, one can conclude that the subsidy program creates a cost for the budget eventually. Furthermore, the figure demonstrates that the response of the tax revenues under the subsidy program is quite higher in the first few months after the fuel price shock. Therefore, the cost of the subsidy system to the government budget seems to be much higher within the first few months following motor fuel price shock.

To discuss the impact of the subsidy program on government budget balance, Figure 4.10 reports the responses over general budget revenues and expenditures under baseline and scenario models. Keep in mind that in Figure 4.10 (a) and (b), the dashed lines represent the response of general budget revenue, and the dotted line shows the response of expenditures.



a) Revenue vs. Expenditures in the baseline model b) Revenue vs. Expenditures in the scenario model

Figure 4.10. The impulse responses of general budget revenues and expenditures

Figure 4.10 (a) plots the responses of general budget revenues and expenditures to a motor fuel price rise in the baseline model. The responses of revenues and expenditures exhibit a slightly different pattern. The very first response of the budget measures is positive within three months, while the accumulated positive response declines during 3 and 8 months after the price shock. The accumulated response of both revenues and expenditures steadily increases after the eighth month. Figure 4.10 (a) shows that the response of expenditures to a

motor fuel price shock is slightly higher than the response of revenues.

On the other hand, Figure 4.10 (b) reports the responses of budget revenues and expenditures in the scenario model. The gap between dashed and the dotted lines would have represented the impact of motor fuel price shock to a budget deficit if the government had not implemented the subsidy system. The responses of revenues and expenditures appear to be virtually identical within the three years after the fuel price shock.

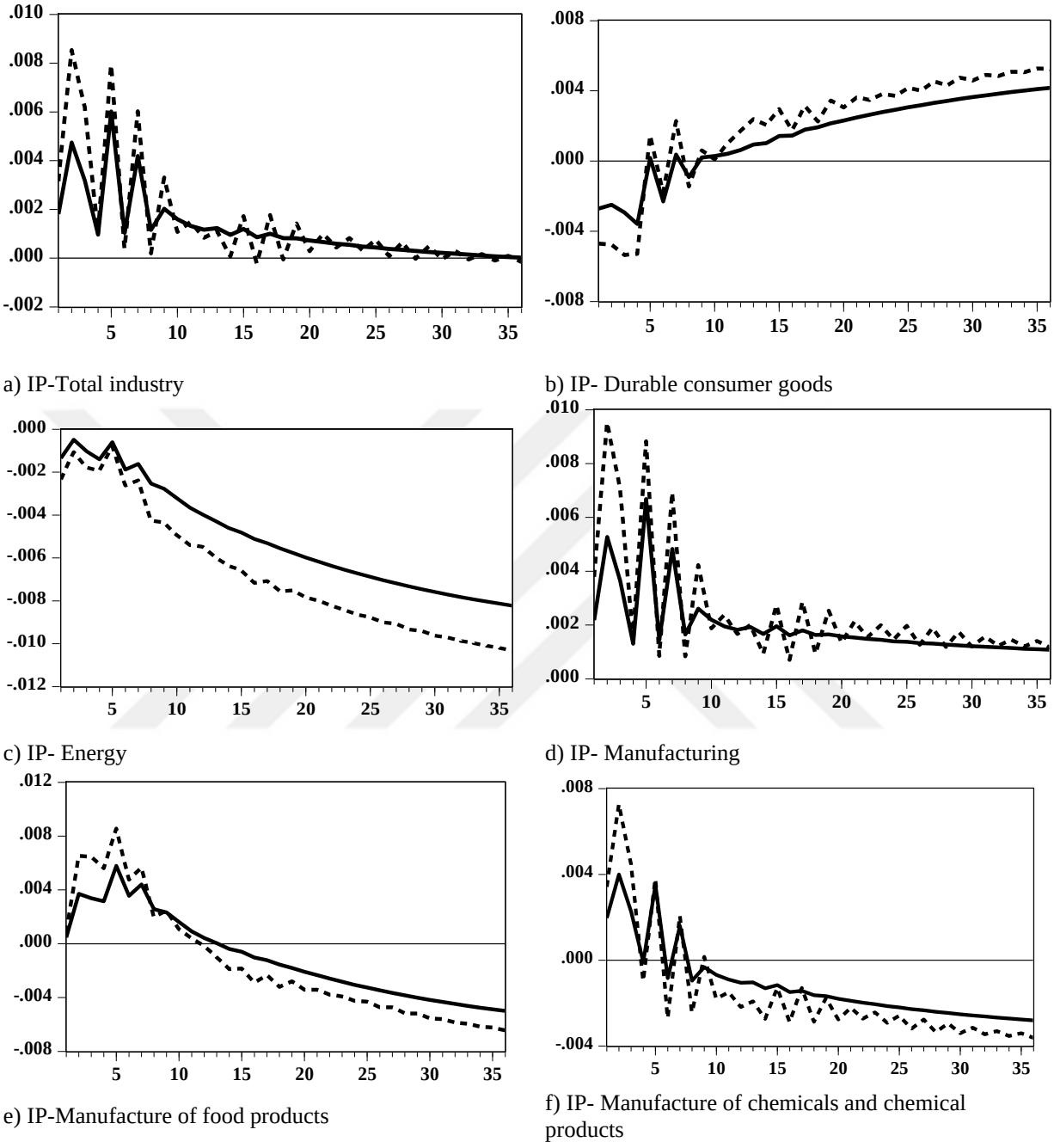
The comparison of the impact of the fuel price shock in Figure 4.10 (a) and (b) at this moment demonstrates the burden of the motor fuel price subsidy program on the government budget. When we compare the responses of budget revenues and expenditures in Figure 4.10 (a) and (b), it is safe to conclude that the introduction of the subsidy program creates a small budget deficit and a little burden to the government budget. The comparison of the baseline and scenario models illustrate that the motor fuel subsidy program does not incorporate risks to budget deficit dynamics. Thus, the main implication of these results might be that the subsidy program does not create fiscal sustainability challenges for the Turkish economy.

4.6.2.3. Impact of Fuel Price Shock on Output Gap

Many economists have reached a consensus that the oil price hikes have contractionary effects on economic activity. Furthermore, governments tend to get benefits from the fuel subsidies, not just by eliminating the pass-through of oil prices to domestic inflation, but also by promoting the industrial activity (Coxhead and Grainger, 2018).

Figure 4.11 illustrates how the output gap in selected industrial sectors behaves in response to a motor fuel price increase and demonstrates the response of these sectors in the absence of the motor fuel price subsidy program.[8] As explained, the output gap series is constructed by using the Hodrick–Prescott (HP) filter for industrial production index series in various sectors.

[8] Responses of all output gap series are available upon request.



a) IP-Total industry

b) IP- Durable consumer goods

c) IP- Energy

d) IP- Manufacturing

e) IP-Manufacture of food products

f) IP- Manufacture of chemicals and chemical products

Figure 4.11. The impulse responses of the output gap in selected industrial sectors

Before proceeding into discussing the impact of the motor fuel price hikes on an output gap in the various industrial sector, it is noteworthy that the responses of the output gap series are not significant in the baseline model except for the energy sector. The response of the energy sector is significant after 15 months following the fuel price shock.

The baseline model results suggest that the response of the output gap varies substantially across sectors. The accumulated response is positive in durable consumer goods and manufacturing sectors. At the same time, the energy, manufacture of food products, and the manufacture of chemicals and chemical products are negative within the three years. The accumulated response of the total industry gap seems to be muted at the end of the three years. The rising positive output gap as a response to fuel price rises seems to be quite controversial since the general conclusion of the traditional oil price-output nexus studies conclude that the impact of oil price on output is negative.

However, the rising output gap means the rise in actual output level relative to potential output, which is in line with the findings of Mandal et al. (2012). Their study also revealed an increasing output gap in response to a positive shock to oil prices in India. They argued by referring to Bahattacharya and Bahattacharyya (2001) that this is the case for the period when domestic oil prices are administered, and prices rise only in the favorable macroeconomic environment. Aastevit (2014) and Herwatz and Plöt (2016) also illustrated that the impact of positive oil price shock might be expansionary if the rise in oil prices is due to rising global demand conditions.

On the other hand, the increase in motor fuel prices causes a persistent and significant (15 months after the shock) negative impact on the output gap in the energy sector. In the manufacture of the food sector and the manufacture of chemicals and chemical products sector response of output, the gap is positive initially, and the accumulated impact becomes negative with a delay. Therefore, baseline model results are entirely consistent with the traditional conclusion of the negative link between oil prices and output level.

Although the impulse response results do not exhibit substantial changes in the scenario model, the response of the output gap provides more significant results in the scenario model. The impact of the fuel price increase is significant in the three years in the energy sector. Responses of remaining sectors are also significant at most up to six months. However, in energy, manufacture of food, and manufacture of chemicals and chemical products sectors, the adoption of the motor fuel price system acts as a buffer and partly eliminates the fall of output gap following the positive fuel price shock. Therefore, it is safe to

conclude that the impact of the subsidy system on economic activity is not entirely practical since output gaps in these sectors do not respond significantly.

4.7. Conclusion

Scholars have paid much attention to analyze the impact of international oil price shocks since the first oil spike at the beginning of the 1970s. Several pieces of research conclude that oil price hikes are primary sources of economic fluctuations. Several studies also provide evidence for the inflationary effects of oil price changes. Increasing oil prices accelerate inflation as industries that use petroleum products as an input face a rising cost of production. Eventually, increasing production costs will be passed on to consumers, and they will also pay higher prices.

However, many governments follow a common policy tool and subsidize fuel prices to eliminate the adverse effects of oil price changes on the domestic economy. Governments either sell fuel products lower than the free market price or reduces taxes imposed on these products. In May 2018, the Turkish government also enacted a decree to stabilize the prices of motor fuels and eradicate the destabilizing effects of international oil price spikes and domestic currency depreciation. Therefore, the Turkish economy provides an ideal laboratory environment to investigate the effectiveness of subsidy programs. This study aimed at analyzing the impact of a motor fuel shock on domestic prices, fiscal balance, and the output gap in Turkey during 2015:01-2019:12.

The study uses the Factor-Augmented Vector Autoregression (FAVAR) approach to address those issues. The FAVAR method is a well-designed and functional tool for examining the efficacy of fuel price developments in which a large number of information variables are condensed into a few factors. This approach thus significantly reduces the misspecification issues and eliminates the degrees of freedom problems. This research also adopts a scenario analysis and adds to the literature as a case study aimed at addressing the impacts of a novel subsidy program.

Results of the study for consumer price indexes provide a piece of evidence for the heterogeneous response of consumer price sub-indexes. Findings indicate that motor fuel prices create more inflationary effects for the petroleum product-related consumer prices, and the pass-through in less petroleum intensive indexes is found to be less severe and short-lived. Besides, the subsidy system is found to alleviate the pass-through to domestic consumer prices. For producer prices, the pass-through from motor fuel prices is found to be greater than the one for consumer prices. The introduction of the subsidy program also diminishes the persistence of the motor fuel price shocks on domestic producer prices. Overall, these results provide a piece of evidence favoring the role of subsidy program in absorbing the adverse effects of international price shocks to domestic inflation.

In the fiscal balance case, the introduction of the subsidy system appears to create a small budget deficit and a little burden to the government budget. However, when we compare the baseline and scenario models, we might conclude that the motor fuel subsidy program does not incorporate risks to budget deficit dynamics. In other words, the subsidy program does not create a challenging tradeoff between fiscal sustainability and price stability. Finally, the partially significant impact of the subsidy program on output gap measures in various industrial sectors proposes that the subsidy system is not entirely effective on economic activity.

These results provide some policy implications for policymakers. First, since the Turkish economy is high-energy and particularly oil-dependent economy, energy-efficient policies need to be implemented to reduce the import dependency and to eliminate the potential vulnerability to international oil price shocks. Second, the manufacturing production structure needs to be designed in a way to reduce oil dependency in the production sector. Increasing the share of renewable energy in production should also be an effective tool to reduce oil dependency and to lower the impact of oil-related costs in industrial activity. Third, scholars reached a consensus on the role of accommodative monetary policy to decrease the pass-through of oil prices into domestic inflation. Therefore, the more active monetary policy in response to the oil price changes might eliminate the adverse spillover effects on the domestic economy.

Fourth, since the pass-through to producer prices are relatively higher than the transmission to producer prices, policymakers should take some measures to mitigate the production and working capital costs of the producers. Thus, policymakers will avoid a downturn in economic activity and an increase in unemployment. Finally, although the novel subsidy program does not create a high burden on fiscal sustainability, policymakers should oversee the cost of the program to react to protect the fiscal balance. It is also noteworthy that the fiscal and monetary policy tools should be adopted accordingly to provide the stability in the economy.

This study concentrated on the first round (direct and indirect) impact of the fuel price changes. It investigated the impact of fuel subsidy programs on domestic prices, fiscal balance, and the output gap. However, the second-round effects (pass-through of prices to inflation expectations) and the distributional impacts of the subsidy system on households with different income groups are beyond the scope of the current study. Therefore, further research might focus on these issues.

5. CONCLUSION

This thesis study is composed of three separate applied macroeconomics studies. The first study focuses on the effectiveness of negative interest rate policy in a way it exerts its effects on the various indicators in the Swedish economy. The second study enjoys the benefits of machine learning techniques and examines the drivers of bank lending in Turkey. Finally, the third study analyzes the benefits and costs of the novel motor fuel price subsidy system in Turkey. The conclusion part of this thesis briefly summarizes the findings and the significant policy implications of these studies.

The baseline and scenario FAVAR model results in the first study show that expansionary monetary policy shock effectively transmits into bank lending rates which in turn leads to an increase in the amount of bank lending. Therefore, the principal finding of the first study is that the bank lending channel is effective in Sweden. Since the pass-through to bank lending rates is more straightforward in the scenario model, negative interest rates tend to be transmitted to lending rates more firmly. The pass-through of policy rate into market rates is also pronounced in negative interest rate policy times. Furthermore, the depreciation of Swedish Krona seems to boost exports and strengthen the trade balance in case of the negative interest rate policy.

Finally, the implementation of the expansionary monetary policy in both baseline and scenario settings shows that economic activity increases with a delay. Therefore, one concludes that monetary policy adjustments have had an influence on economic activity across various channels, and the implementation of the NIRP has not diminished the effectiveness of monetary policy in Sweden. These findings provide some useful insights for policymakers that they might take some precautionary measures and support the effectiveness of negative interest rate policy.

The second study compares the predictive performance of the various machine learning techniques in discovering the drivers of bank lending in Turkey. The random forest model seems to provide a more accurate measure and has the best out of sample fit. The random forest results demonstrate the nonlinear relationship between bank-specific, macroeconomic

and global indicators on outstanding bank loans. The results of the study also confirmed that the consumer price index has a better performance in predicting bank lending among their counterparts. Also, GDP and leading indicators explain the procyclical nature of bank loans and indicate that improving economic conditions will raise bank lending volumes. Besides, since the policy rate increases bank lending, the bank lending channel seems to be effective in the Turkish economy. Finally, the role of global factors in the Turkish deposit bank's lending behavior appears to be less reliable than several bank-specific features and macroeconomic indicators. The significant policy implication of the second study is that the ranking of variables regarding their importance on predicting bank lending behavior might be more salient policy levers than other alternatives.

The third study provides a comprehensive picture of the impact of the introduction of the motor fuel price subsidy system in the Turkish economy. Through incorporating the scenario model, the analysis explores the effect of the new subsidy system. The scenario model would show the impulse responses of selected variables unless the government were inclined to follow the subsidy program. Empirical results from the third study suggest heterogeneity in the transmission of fuel prices to numerous consumer price indexes. The study confirms that the fuel price changes create relatively higher inflationary impacts in petroleum-related sectors and indicate that the pass-through impact is more long-lasting in these sectors.

Besides, the pass-through is noticed to be higher in producer price indices than the consumer prices. On the other hand, the scenario model results demonstrate that the subsidy program decreases the pass-through to domestic prices and is a useful tool to eliminate the inflationary impacts of oil price changes. Besides, the fiscal burden of the subsidy program seems not to create a challenge for the government to sustain budget deficit and have a little burden on the government budget. Finally, the impact of the motor fuel price shock in both baseline and scenario models have partially significant effects on output gap measures in various industrial sectors.

The advancements in measurement methods, developments in data collection methods and the introduction of the new empirical methodologies allow major evolutions to take place

in applied macroeconomics. The literature also calls for further studies that improve the understanding of the dynamic nature of the macroeconomics and various macroeconomic indicators.

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7. APPENDICES

7.1. Appendix A

Table 7.1. Description of Variables

Group	Acronyms	Series Name	Unit	SA	S/F	Source	Transform.
Economic Activity	IPI	Industrial production index (2015=100, SA)	Index	Y	S	Statistics Sweden	5
Economic Activity	MPI	Manufacturing prodcution index (2015=100, SA)	Index	Y	S	Statistics Sweden	5
Economic Activity		Industrial Production: mines and quarries (2015=100, SA)	Index	Y	S	Statistics Sweden	5
Economic Activity		Industrial Production: intermediate goods industry (2015=100, SA)	Index	Y	S	Statistics Sweden	5
Economic Activity		Industrial Production: capital goods industry (2015=100, SA)	Index	Y	S	Statistics Sweden	5
Economic Activity		Industrial Production: non-durable consumer goods industry (2015=100, SA)	Index	Y	S	Statistics Sweden	5
Economic Activity		Industrial Production: food, beverage, tobacco industry (2015=100, SA)	Index	Y	S	Statistics Sweden	5
Economic Activity		Industrial Production: chemicals industry (2015=100, SA)	Index	Y	S	Statistics Sweden	5
Economic Activity		Industrial Production: basic metals industry (2015=100, SA)	Index	Y	S	Statistics Sweden	5
Economic Activity	IPI Engineering	Industrial Production: engineering industry (2015=100, SA)	Index	Y	S	Statistics Sweden	5
Economic Activity		Industrial Production: electrical equipment industry (2015=100, SA)	Index	Y	S	Statistics Sweden	5
Economic Activity		Industrial Production: furniture industry (2015=100, SA)	Index	Y	S	Statistics Sweden	5
Economic Activity		Industrial Production: electricity, gas, powerplant industry (2015=100, SA)	Index	Y	S	Statistics Sweden	5

Group	Acronyms	Series Name	Unit	SA	S/F	Source	Transform.
Economic Activity		Retail Sale Index (2015=100, SA)	Index	Y	S	Statistics Sweden	5
Economic Activity		Retail Sale Index: Durables (2015=100, SA)	Index	Y	S	Statistics Sweden	5
Economic Activity	TURN	Turnover in Industry: Domestic market (2015=100, SA)	Index	Y	F	Statistics Sweden	5
Economic Activity		Turnover in Industry: Domestic market: Intermediate Goods (2015=100, SA)	Index	Y	F	Statistics Sweden	5
Economic Activity	TURN_Capital Goods	Turnover in Industry: Domestic market: Capital Goods (2015=100, SA)	Index	Y	F	Statistics Sweden	5
Economic Activity	TURN_Manufacturing	Turnover in Industry: Domestic market: Manufacturing Industry (2015=100, SA)	Index	Y	F	Statistics Sweden	5
Economic Activity		Turnover in Industry: Domestic market: Non-durable consumer goods Industry (2015=100, SA)	Index	Y	F	Statistics Sweden	5
Economic Activity		Orders in Industry: Domestic Market (2015=100, SA)	Index	Y	F	Statistics Sweden	5
Economic Activity		Orders in Industry: Domestic market: Manufacturing Industry (2015=100, SA)	Index	Y	F	Statistics Sweden	5
Consumption	CONS	Household Consumption (Fixed prices, SA)	Index	Y	S	Statistics Sweden	5
Consumption		Household Consumption: transport and retail sales and service of motor vehicles (Fixed prices, SA)	Index	Y	S	Statistics Sweden	5
Consumption		Household Consumption: furniture, furnishings, household equipment and consumables (Fixed prices, SA)	Index	Y	S	Statistics Sweden	5
Employment		Employment (15-74 years)	1000s	Y	S	Thomson Reuters	5
Employment		Hours Worked: Accommodation	Millions Hour	Y	S	Thomson Reuters	1

Group	Acronyms	Series Name	Unit	SA	S/F	Source	Transform.
Employment		Hours Worked: Agriculture, Forestry, Fishing	Millions Hour	Y	S	Thomson Reuters	1
Employment		Hours Worked: Construction	Millions Hour	Y	S	Thomson Reuters	1
Employment		Hours Worked: Education	Millions Hour	Y	S	Thomson Reuters	1
Employment		Hours Worked: Manufacturing Industry	Millions Hour	Y	S	Thomson Reuters	1
Employment		Hours Worked: Total, Domestic	Millions Hour	Y	S	Thomson Reuters	1
Employment		Hours Worked: Wholesale and Retail Trade	Millions Hour	Y	S	Thomson Reuters	1
Employment		Unemployment	Thousands Person	Y	S	Thomson Reuters	5
Employment		Unemployment: 16-64 years	Thousands Person	Y	S	Thomson Reuters	5
Employment		Unemployment: 20-24 years	Thousands Person	Y	S	Thomson Reuters	5
Employment		Unemployment: 55-64 year	Thousands Person	Y	S	Thomson Reuters	5
Employment	UNEMP	Unemployment Rate: 15-74 years	Percentage	Y	S	Thomson Reuters	2
Employment		Number of persons not in the labor force aged 15-74 (1000s)	1000s	Y	S	Statistics Sweden	5
Employment		Number of persons not in the labor force aged 16-64 (1000s)	1000s	Y	S	Statistics Sweden	5
Price Indexes		Consumer Price Index (CPI): Food and non-alcoholic beverages, 1980=100	Index	Y	S	Statistics Sweden	5
Price Indexes		Consumer Price Index (CPI): Alcoholic beverages and tobacco, 1980=100	Index	Y	S	Statistics Sweden	5
Price Indexes		Consumer Price Index (CPI): Clothing and footwear, 1980=100	Index	Y	S	Statistics Sweden	5
Price Indexes		Consumer Price Index (CPI): Housing, water, electricity, gas and other fuels, 1980=100	Index	Y	S	Statistics Sweden	5
Price Indexes		Consumer Price Index (CPI): Furnishings and household goods, 1980=100	Index	Y	S	Statistics Sweden	5

Group	Acronyms	Series Name	Unit	SA	S/F	Source	Transform.
Price Indexes		Consumer Price Index (CPI): Health, 1980=100	Index	Y	S	Statistics Sweden	5
Price Indexes		Consumer Price Index (CPI): Transport, 1980=100	Index	Y	S	Statistics Sweden	5
Price Indexes		Consumer Price Index (CPI): Communication, 1980=100	Index	Y	S	Statistics Sweden	5
Price Indexes		Consumer Price Index (CPI): Recreation and culture, 1980=100	Index	Y	S	Statistics Sweden	5
Price Indexes		Consumer Price Index (CPI): Restaurants and hotels, 1980=100	Index	Y	S	Statistics Sweden	5
Price Indexes		Consumer Price Index (CPI): Miscellaneous goods and services, 1980=100	Index	Y	S	Statistics Sweden	5
Price Indexes	CPI	Consumer Price Index (CPI), Total, Shadow Index numbers, 1980=100	Index	Y	S	Statistics Sweden	5
Price Indexes		Consumer Prices, by Commodity, Special Indexes, Underlying Inflation CPIF Excluding Energy, (1987=100)	Index	Y	S	Thomson Reuters	5
Price Indexes		Consumer Prices, Domestic Production (RB), (1980=100)	Index	Y	S	Thomson Reuters	5
Price Indexes		Consumer Prices, Goods and Services, Import (RB). (1980=100)	Index	Y	S	Thomson Reuters	5
Price Indexes		Consumer Prices, by Commodity, Services (RB). (1980=100)	Index	Y	S	Thomson Reuters	5
Price Indexes		Import Prices, by Industry, Consumer Goods, Total. (2015=100)	Index	Y	S	Thomson Reuters	5
Price Indexes		Import Prices, by Industry, Consumer Goods, Durable. (2015=100)	Index	Y	S	Thomson Reuters	5
Price Indexes		Sweden, Export Prices, Consumer Goods. (2015=100)	Index	Y	S	Thomson Reuters	5
Price Indexes		Export Prices, Consumer Goods, Durable. (2015=100)	Index	Y	S	Thomson Reuters	5
Price Indexes		Core Consumer Price Index, Index, 2010 = 100.	Index	Y	S	Thomson Reuters	5

Group	Acronyms	Series Name	Unit	SA	S/F	Source	Transform.
		(2010=100)					
Price Indexes	PPI	Producer Price Index (PPI), Total, 2015=100	Index	Y	S	Statistics Sweden	5
Price Indexes		Producer Price Index (PPI), Products Of Agrıculture, Forestry, And Fıshıng, 2015=100	Index	Y	S	Statistics Sweden	5
Price Indexes		Producer Price Index (PPI), Manufactured Products, 2015=100	Index	Y	S	Statistics Sweden	5
Price Indexes		Producer Price Index (PPI), Electrıcıty, Gas, Steam And Aır Condıtıonıng, 2015=100	Index	Y	S	Statistics Sweden	5
Price Indexes		Producer Price Index (PPI), Water Supply; Sewerage, Waste Management, and Remedıatıon Servıces, 2015=100	Index	Y	S	Statistics Sweden	5
Price Indexes		Producer Price Index, Domestic Market, Consumer Goods (Except Food, Beverages, and Tobacco), Current Prices, Index, 2015 = 100	Index	Y	S	Thomson Reuters	5
Price Indexes		Producer Price Index, Domestic Market, Non-Durable Consumer Goods, Current Prices, Index, 2015 = 100	Index	Y	S	Thomson Reuters	5
Exchange Rates		AUD Australian, dollar	SEK	N	F	Sveriges Riksbank	5
Exchange Rates		CAD Canada, dollar	SEK	N	F	Sveriges Riksbank	5
Exchange Rates		CHF Switzerland, francs	SEK	N	F	Sveriges Riksbank	5
Exchange Rates		CNY China, yuan renminbi	SEK	N	F	Sveriges Riksbank	5
Exchange Rates	DKK	DKK Denmark, krone	SEK	N	F	Sveriges Riksbank	5
Exchange Rates	EUR	EUR Euroland, euro	SEK	N	F	Sveriges Riksbank	5
Exchange Rates		GBP Great Britain, pound	SEK	N	F	Sveriges Riksbank	5
Exchange Rates		ISK Iceland, kronor	SEK	N	F	Sveriges Riksbank	5
Exchange Rates	JPY	JPY Japan, yen	SEK	N	F	Sveriges Riksbank	5
Exchange Rates		KRW South Korea, won	SEK	N	F	Sveriges	5

Group	Acronyms	Series Name	Unit	SA	S/F	Source	Transform.
						Riksbank	
Exchange Rates		NOK Norway, krone	SEK	N	F	Sveriges Riksbank	5
Exchange Rates		PLN Poland, zloty	SEK	N	F	Sveriges Riksbank	5
Exchange Rates		RUB Russia, rouble	SEK	N	F	Sveriges Riksbank	5
Exchange Rates		TRY Turkey, the new lira	SEK	N	F	Sveriges Riksbank	5
Exchange Rates	USD	USD US, dollar	SEK	N	F	Sveriges Riksbank	5
Exchange Rates	REER	Swedish TCW index	Index	N	F	Sveriges Riksbank	5
Stock Prices		OMX Stockholm 30 (OMXS30) - Price Index	Index	N	F	Thomson Reuters	5
Stock Prices	OMXS	OMX Stockholm (OMXS) - Price Index	Index	N	F	Thomson Reuters	5
Stock Prices		NASDAQ OMX Stockholm Aerospace and Defence	Index	N	F	Thomson Reuters	5
Stock Prices		NASDAQ OMX Stockholm Auto and Parts	Index	N	F	Thomson Reuters	5
Stock Prices		NASDAQ OMX Stockholm Banks	Index	N	F	Thomson Reuters	5
Stock Prices		NASDAQ OMX Stockholm Financial Services	Index	N	F	Thomson Reuters	5
Stock Prices		NASDAQ OMX Stockholm Industrials	Index	N	F	Thomson Reuters	5
Stock Prices		NASDAQ OMX Stockholm Real Estate	Index	N	F	Thomson Reuters	5
Stock Prices		NASDAQ OMX Stockholm Retail	Index	N	F	Thomson Reuters	5
Foreign Trade	IMP	Total imports	SEK million	Y	S	Statistics Sweden	5
Foreign Trade	EXP	Total exports	SEK million	Y	S	Statistics Sweden	5
Foreign Trade	NX	Net Trade of goods	SEK million	N	S	Statistics Sweden	2
Foreign Trade		Imports: Crude materials, inedible, except fuels	SEK thousand	Y	S	Statistics Sweden	5
Foreign Trade		Imports: Mineral fuels, lubricant. and related materials	SEK thousand	Y	S	Statistics Sweden	5
Foreign Trade		Imports: Manufactured goods.	SEK thousand	Y	S	Statistics Sweden	5

Group	Acronyms	Series Name	Unit	SA	S/F	Source	Transform.
Foreign Trade		Imports: Machinery and transport equipment	SEK thousand	Y	S	Statistics Sweden	5
Foreign Trade		Imports: Miscellaneous manufactured articles	SEK thousand	Y	S	Statistics Sweden	5
Foreign Trade		Exports: Crude materials, inedible, except fuels	SEK thousand	Y	S	Statistics Sweden	5
Foreign Trade		Exports: Mineral fuels, lubricant. and related materials	SEK thousand	Y	S	Statistics Sweden	5
Foreign Trade		Exports: Manufactured goods.	SEK thousand	Y	S	Statistics Sweden	5
Foreign Trade		Exports: Machinery and transport equipment	SEK thousand	Y	S	Statistics Sweden	5
Foreign Trade		Exports: Miscellaneous manufactured articles	SEK thousand	Y	S	Statistics Sweden	5
Monetary Aggregates		Money Supply (M1)	Millions SEK	N	S	Thomson Reuters	5
Monetary Aggregates		Money Supply (M3)	Millions SEK	N	S	Thomson Reuters	5
Monetary Aggregates		Monetary Base	Millions SEK	N	S	Thomson Reuters	5
Confidence Indicators	CONS_Conf	Consumer Confidence Indicator	Index	Y	S	Thomson Reuters	5
Confidence Indicators	IND_Conf	Total Industry Confidence Indicator	Index	Y	S	Thomson Reuters	5
Interest Rates	Policy_Rate	Policy Rate-Bank of Sweden	Percentage	N	F	Sveriges Riksbank	1
Interest Rates	STIBOR_1M	STIBOR: 1-Month	Percentage	N	F	Sveriges Riksbank	1
Interest Rates		STIBOR: 3-Month	Percentage	N	F	Sveriges Riksbank	1
Interest Rates	Treasury_1M	Swedish Treasury Bills: 1-Month	Percentage	N	F	Sveriges Riksbank	1
Interest Rates		Swedish Treasury Bills: 3-Month	Percentage	N	F	Sveriges Riksbank	1
Interest Rates		Swedish Government Bonds: 2Y	Percentage	N	F	Sveriges Riksbank	1
Interest Rates		Swedish Government Bonds: 5Y	Percentage	N	F	Sveriges Riksbank	1
Interest Rates	GVB_10Y	Swedish Government Bonds: 10Y	Percentage	N	F	Sveriges Riksbank	1
Interest Rates	MB_2Y	Mortgage Bonds: 2Y	Percentage	N	F	Sveriges Riksbank	1
Interest Rates		Mortgage Bonds: 5Y	Percentage	N	F	Sveriges Riksbank	1
Interest Rates	BLRates_NF_5Y	Bank Lending Rates: Nonfinancial Corporations. New and Renegotiated Agreements. One to five	Percentage	N	F	Sveriges Riksbank	1

Group	Acronyms	Series Name	Unit	SA	S/F	Source	Transform.
		years (1-5 years)					
Interest Rates		Bank Lending Rates: Nonfinancial Corporations. New and Renegotiated Agreements. Over five years	Percentage	N	F	Sveriges Riksbank	1
Interest Rates	BLRates_NF	Bank Lending Rates: Nonfinancial Corporations. New and Renegotiated Agreements. All Accounts	Percentage	N	F	Sveriges Riksbank	1
Interest Rates	BLRates_H_5Y	Bank Lending Rates: Households. New and Renegotiated Agreements. One to five years (1-5 years)	Percentage	N	F	Sveriges Riksbank	1
Interest Rates		Bank Lending Rates: Households. New and Renegotiated Agreements. Over five years	Percentage	N	F	Sveriges Riksbank	1
Interest Rates	BLRates_H	Bank Lending Rates: Households. New and Renegotiated Agreements. All Accounts	Percentage	N	F	Sveriges Riksbank	1
Interest Rates		Banks' Deposit Rates. Nonfinancial Corporations. Outstanding Agreements. All Accounts.	Percentage	N	F	Sveriges Riksbank	1
Interest Rates	BDRates_NF	Banks' Deposit Rates. Nonfinancial Corporations. New and Renegotiated Agreements. All Accounts.	Percentage	N	F	Sveriges Riksbank	1
Interest Rates		Banks' Deposit Rates. Households. Outstanding Agreements. All Accounts.	Percentage	N	F	Sveriges Riksbank	1
Interest Rates	BDRates_H	Banks' Deposit Rates. Households. New and Renegotiated Agreements. All Accounts.	Percentage	N	F	Sveriges Riksbank	1

Group	Acronyms	Series Name	Unit	SA	S/F	Source	Transform.
Interest Rates	SPREAD	Interest Rate Spread (1to5-year lending to nonfinancial firms minus Swedish Govt Bonds Rate 5Y)	Percentage	N	F	Sveriges Riksbank	1
Interest Rates	NIM_NF	Net Interest Margin: Nonfinancial firms (ser124-ser129)	Percentage	N	F	Sveriges Riksbank	1
Interest Rates	NIM_H	Net Interest Margin: Households (ser127-ser131)	Percentage	N	F	Sveriges Riksbank	1
Banking Sector	Assets	Total assets (Current Prices)	SEK million	N	F	Statistics Sweden	5
Banking Sector		Cash and credit balances at central Banks (Current Prices)	SEK million	N	F	Statistics Sweden	5
Banking Sector		Lending, Total (Current Prices)	SEK million	N	F	Statistics Sweden	5
Banking Sector	Lending_NF	Lending, Swe, Non-financial Corporations (Current Prices)	SEK million	N	F	Statistics Sweden	5
Banking Sector		Lending, Swe, Households (Current Prices)	SEK million	N	F	Statistics Sweden	5
Banking Sector		Tangible Assets (Current Prices)	SEK million	N	F	Statistics Sweden	5
Banking Sector		Total liabilities and Equity (Current Prices)	SEK million	N	F	Statistics Sweden	5
Banking Sector		Deposits, Total (Current Prices)	SEK million	N	F	Statistics Sweden	5
Banking Sector	Deposits_NF	Deposits, Swe, Non-financial Corporations (Current Prices)	SEK million	N	F	Statistics Sweden	5
Banking Sector	Deposits_H	Deposits, Swe, Households (Current Prices)	SEK million	N	F	Statistics Sweden	5
Banking Sector	Debt_Securities	Debt securities issued (Current Prices)	SEK million	N	F	Statistics Sweden	5
Banking Sector	MM_Papers	Money market papers, Issued (Current Prices)	SEK million	N	F	Statistics Sweden	5
Banking Sector		Bonds, Issued, Total (Current Prices)	SEK million	N	F	Statistics Sweden	5
Banking Sector		Deposits/Total Assets	%	N	F	Statistics Sweden	2
Banking Sector		Issued Securities/Total Assets	%	N	F	Statistics Sweden	2
Central Bank		Marginal Lending Facility	SEK million	N	F	Thomson Reuters	2
Central Bank		Central Bank: Capital and Reserves	SEK million	N	F	Thomson Reuters	5

Group	Acronyms	Series Name	Unit	SA	S/F	Source	Transform.
External Variables		Crude Oil - Brent Free On-Board US Dollar / Barrel, USD	US Dollar	N		Thomson Reuters	5
External Variables		Federal Funds Rate	Percent	N		Thomson Reuters	1
External Variables		ECB Policy Rate	Percent	N		Thomson Reuters	1

Notes: SA stands for seasonal adjustment. Y indicates Yes, and N is for No. S and F represent slow-moving or fast-moving. In Transformation column: 1: no transformation, 2: first difference, 5: log differenced.

Table 7.2. Lag selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1409.97	NA	2412.593	27.65333	28.36528	27.94176
1	-1139.56	483.6335	34.31898	23.39528	**25.35315***	24.18847
2	-1060.07	131.4538	**19.46376***	**22.80905***	26.01284	**24.10700***
3	-1016.23	**66.60420***	22.42775	22.90827	27.35797	24.71097
4	-980.117	50.00302	31.03706	23.15609	28.8517	25.46355
5	-935.937	55.22474	38.58451	23.24879	30.19031	26.061
6	-884.916	56.90866	44.87189	23.20991	31.39735	26.52689
7	-828.318	55.50896	51.16193	23.06381	32.49717	26.88554
8	-779.214	41.54933	75.90549	23.06181	33.74109	27.3883

Note: * indicates lag order selected by the criterion.

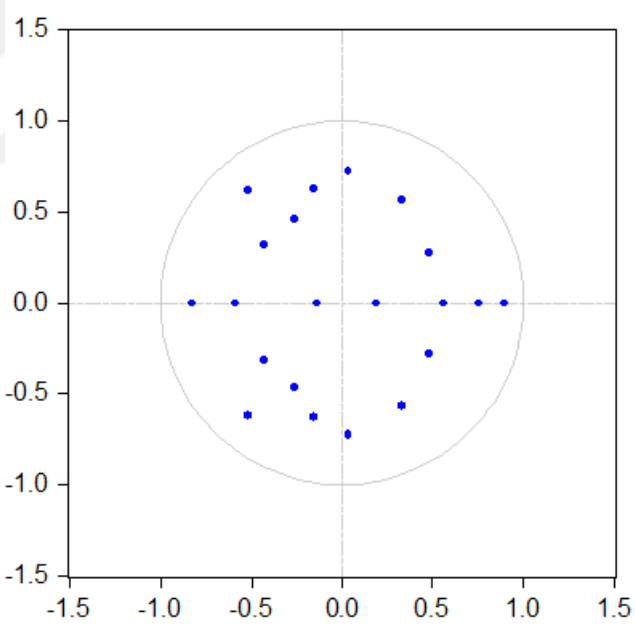


Figure 7.1. AR Roots Graph

7.2. Appendix B

Table 7.3. List of sample banks

Bank	Establishment Year	Total Assets (mln TL)	Total Loans (mln TL)
Türkiye Cumhuriyeti Ziraat Bankası A.Ş.	1863	610,360	420,940
Türkiye İş Bankası A.Ş.	1924	432,780	273,215
Türkiye Halk Bankası A.Ş.	1938	428,974	286,819
Yapı ve Kredi Bankası A.Ş.	1944	384,656	238,254
Türkiye Garanti Bankası A.Ş.	1946	383,651	240,001
Türkiye Vakıflar Bankası T.A.O.	1954	380,525	262,423
Akbank T.A.Ş.	1948	344,764	196,786
QNB Finansbank A.Ş.	1987	171,203	108,440
Denizbank A.Ş.	1997	147,726	98,783
Türk Ekonomi Bankası A.Ş.	1927	101,549	68,757
ING Bank A.Ş.	1984	57,736	34,702
HSBC Bank A.Ş.	1990	33,046	17,343
Şekerbank T.A.Ş.	1953	30,923	21,912
Alternatifbank A.Ş.	1991	28,664	17,871
Fibabanka A.Ş.	1984	20,397	14,767
ICBC Turkey Bank A.Ş.	1986	16,186	8,515
Anadolubank A.Ş.	1996	15,960	11,888
Turkland Bank A.Ş.	1991	3,641	2,330
Turkish Bank A.Ş.	1981	1,273	933

Note: Total assets and total loans are in June 2019.

Table 7.4. Variable definitions and data sources

Group	Variable Title	Acronym	Unit	Description	Source
Dependent Variable	Total Loans	Ln(Loans)	TL	The Natural Logarithm of Nominal loans	BAT
Bank Specific Characteristics	Credit Risk	LLPTA	Ratio	The ratio of loan loss provisions to total assets	BAT
	Liquidity Ratio	LIQR	Ratio	The ratio of the sum of cash, reserves at CBRT and government securities to total assets	BAT
	Liquidity	GVTTA	Ratio	The ratio of government securities to total assets	BAT
	Asset Structure	FATA	Ratio	The ratio of fixed assets to total assets	BAT
	Deposit Funding Ratio	DFR	Ratio	The ratio of total deposits to total assets	BAT
	Deposit Overhang	DEPOVER	Ratio	The ratio of total loans to total deposits minus one	BAT
	Capital Ratio	CAPR	Ratio	The ratio of total capital to total assets	BAT
	Profitability	ROA	Ratio	The ratio of profit before tax over total assets	BAT
	Lending Rate	LENDINGR	Ratio	The ratio of net interest income over gross loans	BAT
Macroeconomic Indicators	Gross Domestic Product	Ln(GDP)	Thousand TL	The Natural Logarithm of Gross Domestic Product	EDDS by CBRT
	Leading Indicators Index	LEAD	Index	Composite leading indicators for Turkey	EDDS by CBRT
	Consumer Price Index	CPI	Index	Consumer price index (2003=100)	Thomson Reuters
	Policy Rate	ON	%	The interbank overnight rate	Thomson Reuters
	Reel Effective Exchange Rate	REER	Index	The real effective exchange rate	Thomson Reuters
	Long-Term Market Rate	GVT2Y	%	Turkish Government Bond Yield (2-Year)	Thomson Reuters
	Short-Term Market Rate	GVT9M	%	Turkish Government Treasury Bill Yield 9-Month)	Thomson Reuters

Global Factors	Federal Funds Rate	FFR	%	US Federal Funds Rate	Thomson Reuters
	ECB Main Refinancing Rate	ECB	%	ECB Main Refinancing Rate	Thomson Reuters
	Oil Price	OIL	US Dollar	WD Crude Oil Price, FOB, Spot	Thomson Reuters

7.3. Appendix C

Table 7.5. Description of variables

Group	Unit	Description	SA	Slow/ Fast	Transform.
CPI	Index	0.GENERAL-Level(2003=100)	Y	S	2
CPI	Index	01.FOOD AND NON-ALCOHOLIC BEVERAGES-Level(2003=100)	Y	S	2
CPI	Index	011.FOOD-Level(2003=100)	Y	S	2
CPI	Index	012.NON-ALCOHOLIC BEVERAGES-Level(2003=100)	Y	S	2
CPI	Index	02.ALCOHOLIC BEVERAGES AND TOBACCO-Level(2003=100)	Y	S	2
CPI	Index	021.ALCOHOLIC BEVERAGES-Level(2003=100)	Y	S	2
CPI	Index	022.TOBACCO-Level(2003=100)	Y	S	2
CPI	Index	03.CLOTHING AND FOOTWEAR-Level(2003=100)	Y	S	1
CPI	Index	031.CLOTHING-Level(2003=100)	Y	S	1
CPI	Index	032.FOOTWEAR-Level(2003=100)	Y	S	2
CPI	Index	04.HOUSING, WATER, ELECTRICITY, GAS AND OTHER FUELS-Level(2003=100)	Y	S	2
CPI	Index	041.ACTUAL RENTALS FOR HOUSING-Level(2003=100)	Y	S	2
CPI	Index	043.MAINTENANCE AND REPAIR OF THE DWELLING-Level(2003=100)	Y	S	2
CPI	Index	044.WATER SUPPLY AND MISCELLANEOUS SERVICES RELATING TO THE DWELLING-Level(2003=100)	Y	S	2
CPI	Index	045.ELECTRICITY, GAS AND OTHER FUELS-Level(2003=100)	Y	S	2
CPI	Index	05.FURNISHINGS, HOUSEHOLD EQUIPMENT, ROUTINE MAINTENANCE OF THE HOUSE-Level(2003=100)	Y	S	2
CPI	Index	051.FURNITURE AND FURNISHINGS, CARPETS AND OTHER FLOOR COVERINGS-Level(2003=100)	Y	S	2
CPI	Index	052.HOUSEHOLD TEXTILES-Level(2003=100)	Y	S	2
CPI	Index	053.HOUSEHOLD APPLIANCES-Level(2003=100)	Y	S	2
CPI	Index	054.GLASSWARE, TABLEWARE AND HOUSEHOLD UTENSILS-Level(2003=100)	Y	S	2
CPI	Index	055.TOOLS AND EQUIPMENT FOR HOUSE AND GARDEN-Level(2003=100)	Y	S	2
CPI	Index	056.GOODS AND SERVICES FOR ROUTINE HOUSEHOLD MAINTENANCE-Level(2003=100)	Y	S	2
CPI	Index	06.HEALTH-Level(2003=100)	Y	S	2
CPI	Index	061.MEDICAL PRODUCTS, APPLIANCES AND EQUIPMENT-Level(2003=100)	Y	S	2

CPI	Index	062.OUTPATIENT SERVICES-Level(2003=100)	Y	S	2
CPI	Index	063.HOSPITAL SERVICES-Level(2003=100)	Y	S	2
CPI	Index	07.TRANSPORT-Level(2003=100)	Y	S	2
CPI	Index	071.PURCHASE OF VEHICLES-Level(2003=100)	Y	S	2
CPI	Index	072.OPERATION OF PERSONAL TRANSPORT EQUIPMENT-Level(2003=100)	Y	S	2
CPI	Index	073.TRANSPORT SERVICES-Level(2003=100)	Y	S	2
CPI	Index	08.COMMUNICATIONS-Level(2003=100)	Y	S	2
CPI	Index	081.POSTAL SERVICES-Level(2003=100)	Y	S	2
CPI	Index	082.TELEPHONE AND TELEFAX EQUIPMENT-Level(2003=100)	Y	S	2
CPI	Index	083.TELEPHONE AND TELEFAX SERVICES-Level(2003=100)	Y	S	2
CPI	Index	09.RECREATION and CULTUR-Level(2003=100)	Y	S	2
CPI	Index	091.AUDIO-VISUAL, PHOTOGRAPHIC AND INFORMATION PROCESSING EQUIPMENT-Level(2003=100)	Y	S	2
CPI	Index	092.OTHER MAJOR DURABLES FOR RECREATION AND CULTURE-Level(2003=100)	Y	S	2
CPI	Index	093.OTHER RECREATIONAL ITEMS AND EQUIPMENT, GARDENS AND PETS-Level(2003=100)	Y	S	2
CPI	Index	094.RECREATIONAL AND CULTURAL SERVICES-Level(2003=100)	Y	S	2
CPI	Index	095.NEWSPAPERS, BOOKS AND STATIONERY-Level(2003=100)	Y	S	2
CPI	Index	096.PACKAGE HOLIDAYS-Level(2003=100)	Y	S	2
CPI	Index	10.EDUCATION-Level(2003=100)	Y	S	2
CPI	Index	101.PRE-PRIMARY AND PRIMARY EDUCATION-Level(2003=100)	Y	S	2
CPI	Index	102.SECONDARY EDUCATION-Level(2003=100)	Y	S	1
CPI	Index	104.TERTIARY EDUCATION-Level(2003=100)	Y	S	1
CPI	Index	105.EDUCATION NOT DEFINABLE BY LEVEL-Level(2003=100)	Y	S	2
CPI	Index	11.HOTELS, CAFES AND RESTAURANTS-Level(2003=100)	Y	S	2
CPI	Index	111.CATERING SERVICES-Level(2003=100)	Y	S	2
CPI	Index	112.ACCOMMODATION SERVICES-Level(2003=100)	Y	S	2
CPI	Index	12.MISCELLANEOUS GOODS AND SERVICES-Level(2003=100)	Y	S	2
CPI	Index	121.PERSONAL CARE-Level(2003=100)	Y	S	2
CPI	Index	123.PERSONAL EFFECTS N.E.C.-Level(2003=100)	Y	S	2
CPI	Index	124.SOCIAL PROTECTION-Level(2003=100)	Y	S	2
CPI	Index	125.INSURANCE-Level(2003=100)	Y	S	2

CPI	Index	126.FINANCIAL SERVICES N.E.C.-Level(2003=100)	Y	S	1
CPI	Index	127.OTHER SERVICES N.E.C.-Level(2003=100)	Y	S	2
PPI	Index	1.Domestic Producer Price Index (2003=100)	Y	S	2
PPI	Index	2.Mining and quarrying (2003=100)	Y	S	2
PPI	Index	2.1.Coal and lignite (2003=100)	Y	S	2
PPI	Index	2.2.Crude petroleum and natural gas (2003=100)	Y	S	2
PPI	Index	2.3.Metal ores (2003=100)	Y	S	2
PPI	Index	2.4.Other mining and quarrying products (2003=100)	Y	S	2
PPI	Index	3.Manufacturing (2003=100)	Y	S	2
PPI	Index	3.1.Food products (2003=100)	Y	S	2
PPI	Index	3.2.Beverages (2003=100)	Y	S	2
PPI	Index	3.3.Tobacco products (2003=100)	Y	S	2
PPI	Index	3.4.Textiles (2003=100)	Y	S	2
PPI	Index	3.5.Wearing apparel (2003=100)	Y	S	2
PPI	Index	3.6.Leather and related products (2003=100)	Y	S	2
PPI	Index	3.7.Wood and products of wood and cork, except furniture (2003=100)	Y	S	2
PPI	Index	3.8.Paper and paper products (2003=100)	Y	S	2
PPI	Index	3.9.Printing and recording services (2003=100)	Y	S	2
PPI	Index	3.10.Coke and refined petroleum products (2003=100)	Y	S	2
PPI	Index	3.11.Chemicals and chemical products (2003=100)	Y	S	2
PPI	Index	3.12.Basic pharmaceutical products and pharmaceutic preparations (2003=100)	Y	S	2
PPI	Index	3.13.Rubber and plastic products (2003=100)	Y	S	2
PPI	Index	3.14.Other non-metallic mineral products (2003=100)	Y	S	2
PPI	Index	3.15.Basic metals (2003=100)	Y	S	2
PPI	Index	3.16.Fabricated metal products, except machinery and equipment (2003=100)	Y	S	2
PPI	Index	3.17.Computer, electronic and optical products (2003=100)	Y	S	2
PPI	Index	3.18.Electrical equipment (2003=100)	Y	S	2
PPI	Index	3.19.Machinery and equipment n.e.c. (2003=100)	Y	S	2
PPI	Index	3.20.Motor vehicles, trailers and semi-trailers (2003=100)	Y	S	2
PPI	Index	3.21.Other transport equipment (2003=100)	Y	S	2
PPI	Index	3.22.Furniture (2003=100)	Y	S	2

PPI	Index	3.23.Other manufactured goods (2003=100)	Y	S	2
PPI	Index	4.Electricity, gas, steam and air conditioning (2003=100)	Y	S	2
PPI	Index	4.1.Electricity, gas, steam and air conditioning (2003=100)	Y	S	2
PPI	Index	5.Water supply sewerage, waste management and remediation (2003=100)	Y	S	2
PPI	Index	5.1Water water treatment and supply services (2003=100)	Y	S	2
Industrial Production	Index	Total industry (2015=100)	Y	S	2
Industrial Production	Index	IG -Intermediate goods (2015=100)	Y	S	2
Industrial Production	Index	DCG-Durable consumer goods (2015=100)	Y	S	1
Industrial Production	Index	NDCG-Non-durable consumer goods (2015=100)	Y	S	1
Industrial Production	Index	NRG-Energy (2015=100)	Y	S	1
Industrial Production	Index	CG-Capital goods (2015=100)	Y	S	2
Industrial Production	Index	LT-Low technology (2015=100)	Y	S	1
Industrial Production	Index	MLT-Medium low technology (2015=100)	Y	S	2
Industrial Production	Index	MHT-Medium high technology (2015=100)	Y	S	2
Industrial Production	Index	HT-High technology (2015=100)	Y	S	1
Industrial Production	Index	B-Mining and quarrying (2015=100)	Y	S	1
Industrial Production	Index	05-Mining of coal and lignite (2015=100)	Y	S	1
Industrial Production	Index	06-Extraction of crude petroleum and natural gas (2015=100)	Y	S	1
Industrial Production	Index	07-Mining of metal ores (2015=100)	Y	S	1
Industrial Production	Index	08-Other mining and quarrying (2015=100)	Y	S	2
Industrial Production	Index	C-Manufacturing (2015=100)	Y	S	2
Industrial Production	Index	10-Manufacture of food products (2015=100)	Y	S	1
Industrial Production	Index	11-Manufacture of beverages (2015=100)	Y	S	1
Industrial Production	Index	12-Manufacture of tobacco products (2015=100)	Y	S	2
Industrial Production	Index	13-Manufacture of textiles (2015=100)	Y	S	1
Industrial Production	Index	14-Manufacture of wearing apparel (2015=100)	Y	S	1
Industrial Production	Index	15-Manufacture of leather and related products (2015=100)	Y	S	1
Industrial Production	Index	16-Manufacture of wood and of products of wood and cork (except furniture) (2015=100)	Y	S	2

Industrial Production	Index	17-Manufacture of paper and paper products (2015=100)	Y	S	1
Industrial Production	Index	18-Printing and reproduction of recorded media (2015=100)	Y	S	1
Industrial Production	Index	19-Manufacture of coke and refined petroleum products (2015=100)	Y	S	1
Industrial Production	Index	20-Manufacture of chemicals and chemical products (2015=100)	Y	S	2
Industrial Production	Index	21-Manufacture of basic pharmaceutical products and pharmaceutical preparations (2015=100)	Y	S	1
Industrial Production	Index	22-Manufacture of rubber and plastic products (2015=100)	Y	S	2
Industrial Production	Index	23-Manufacture of other non-metallic mineral products (2015=100)	Y	S	2
Industrial Production	Index	24-Manufacture of basic metals (2015=100)	Y	S	2
Industrial Production	Index	25-Manufacture of fabricated metal products (except machinery and equipment) (2015=100)	Y	S	1
Industrial Production	Index	26-Manufacture of computer, electronic and optical products (2015=100)	Y	S	1
Industrial Production	Index	27-Manufacture of electrical equipment (2015=100)	Y	S	1
Industrial Production	Index	28-Manufacture of machinery and equipment n.e.c. (2015=100)	Y	S	2
Industrial Production	Index	29-Manufacture of motor vehicles, trailers and semi-trailers (2015=100)	Y	S	2
Industrial Production	Index	30-Manufacture of other transport equipment (2015=100)	Y	S	1
Industrial Production	Index	31-Manufacture of furniture (2015=100)	Y	S	1
Industrial Production	Index	32-Other manufacturing (2015=100)	Y	S	1
Industrial Production	Index	33-Repair and installation of machinery and equipment (2015=100)	Y	S	1
Industrial Production	Index	D-Electricity, gas, steam and air conditioning supply (2015=100)	Y	S	1
Exchange Rate	TRY	(USD) US Dollar (Selling)	N	F	2
Exchange Rate	TRY	(EUR) Euro (Selling)	N	F	2
Public Finance	Thousand TRY	1.GENERAL BUDGET REVENUES	N	F	1
Public Finance	Thousand TRY	1A. Tax Revenues	N	F	2
Public Finance	Thousand TRY	1A1.Direct Taxes	N	S	1
Public Finance	Thousand TRY	1A2.Indirect Taxes	N	F	1
Public Finance	Thousand TRY	2.GENERAL BUDGET EXPENDITURES	N	F	1

Motor Fuel Price	TRY	Motor Fuel Price (The Weighted Price of Motor Fuels Gasoline, Diesel and LPG)	N	2

Notes: SA stands for seasonal adjustment. Y indicates Yes, and N is for No.
S and F represent whether a variable is classified as slow-moving or fast-moving.
In Transformation column: 1: log, 2: log difference.

Table 7.6. Lag selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-335.88	NA	7.22	13.33	13.48	13.39
1	-273.59	112.38	1.18	11.51	**12.27***	11.80
2	-251.48	36.41	0.94	11.27	12.64	**11.79***
3	-231.63	29.58	0.83	11.12	13.09	11.88
4	-209.65	**29.30***	**0.69***	10.89	13.46	11.87
5	-199.71	11.70	0.98	11.13	14.31	12.34
6	-184.03	15.99	1.17	11.14	14.93	12.59
7	-156.80	23.49	0.96	10.70	15.09	12.38
8	-131.27	18.02	0.96	**10.32***	15.32	12.24

Note: * indicates lag order selected by the criterion.

Table 7.7. LM autocorrelation test results

Lags	LM-Stat	Prob.
1	24.26	0.08
2	15.45	0.49
3	22.17	0.14
4	19.02	0.27
5	16.35	0.43
6	15.01	0.53
7	22.24	0.14
8	17.53	0.35

Note: The null of no serial correlation cannot be rejected for all lags at the 5% level.

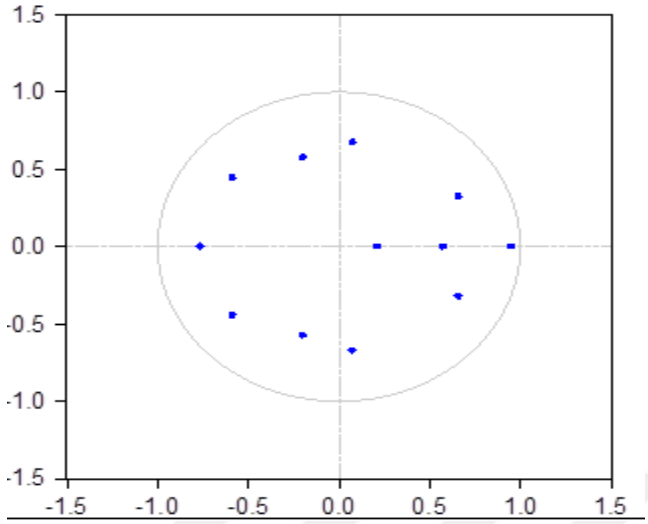


Figure 7.2. AR roots graph

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Incentive Program (2020)

- Anadolu University, Faculty of Economics and Administrative Sciences, Highest Degree Graduate Student, 2010.

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