THE REPUBLIC OF TURKEY
CUKUROVA UNIVERSITY
INSTITUTE OF SOCIAL SCIENCES
DEPARTMENT OF ECONOMICS

# THREE ESSAYS ON MONETARY POLICY

UFUK CAN

DOCTORAL THESIS

ADANA / 2022

THE REPUBLIC OF TURKEY
CUKUROVA UNIVERSITY
INSTITUTE OF SOCIAL SCIENCES
DEPARTMENT OF ECONOMICS

# THREE ESSAYS ON MONETARY POLICY

UFUK CAN

| | |
|---|---|
| **Supervisor:** | **Prof. Dr. Harun BAL** |
| **Jury Member:** | **Prof. Dr. Neşe ALGAN** |
| **Jury Member:** | **Prof. Dr. Hatice DÜZAKIN** |
| **Jury Member:** | **Prof. Dr. Mehmet BALCILAR** |
| **Jury Member:** | **Prof. Dr. Hakan KAHYAOĞLU** |

**DOCTORAL THESIS**

**ADANA / 2022**

**Çukurova Üniversitesi Sosyal Bilimler Enstitüsü Müdürlüğüne;**

Bu çalışma, jürimiz tarafından İKTİSAT Ana Bilim Dalında DOKTORA TEZİ olarak kabul edilmiştir.

**Başkan:** Prof. Dr. Harun BAL
(Danışman)

**Üye:** Prof. Dr. Neşe ALGAN

**Üye:** Prof. Dr. Hatice DÜZAKIN

**Üye:** Prof. Dr. Mehmet BALCILAR

**Üye:** Prof. Dr. Hakan KAHYAOĞLU

**ONAY**

Yukarıdaki imzaların, adı geçen öğretim elemanlarına ait olduklarını onaylarım.
…/…/2022

Prof. Dr. Serap ÇABUK
Enstitü Müdürü

**NOT:** Bu tezde kullanılan ve başka kaynaktan yapılan bildirişlerin, çizelge, şekil ve fotoğrafların kaynak gösterilmeden kullanımı, 5846 sayılı Fikir ve Sanat Eserleri Kanunu'ndaki hükümlere tabidir.

# ETİK BEYANI

Çukurova Üniversitesi Sosyal Bilimler Enstitüsü Tez Yazım Kurallarına uygun olarak hazırladığım bu tez çalışmasında;

- Tez içinde sunduğum verileri, bilgileri ve dokümanları akademik ve etik kurallar çerçevesinde elde ettiğimi,
- Tüm bilgi, belge, değerlendirme ve sonuçları bilimsel etik ve ahlak kurallarına uygun olarak sunduğumu,
- Tez çalışmasında yararlandığım eserlerin tümüne uygun atıfta bulunarak kaynak gösterdiğimi,
- Kullanılan verilerde ve ortaya çıkan sonuçlarda herhangi bir değişiklik yapmadığımı,
- Bu tezde sunduğum çalışmanın özgün olduğunu,

bildirir, aksi bir durumda aleyhime doğabilecek tüm hak kayıplarını kabullendiğimi beyan ederim. …/…/2022.

Ufuk CAN

## DECLARATION

The thesis is prepared in accordance with the Dissertation Rules of the Institute of Social Sciences of Çukurova University. I do hereby declare that in this thesis-

- The data, information and documents presented are obtained in accordance with academic rules and ethical conduct,
- All information, documents, evaluation and results comply with scientific ethics and morality,
- All sources of information and materials cited are acknowledged with appropriate references,
- No changes have been brought to the data used and the results obtained,

Finally, the thesis is my original work that has not been presented for a degree in any other university and I am fully responsible for any legal issues. …/…/2022.

Ufuk CAN

# ÖZET

## PARA POLİTİKASI ÜZERİNE ÜÇ DENEME

**UFUK CAN**

**Doktora Tezi, İktisat Ana Bilim Dalı**
**Danışman: Prof. Dr. Harun BAL**
**Ocak 2022, 107 sayfa**

Monetarist ve yeni Keynesyen iktisat akımı ile birlikte önemi artan para politikası, iktisat literatüründe yer alan çalışmaların odağını oluşturmaktadır. Bu tezde, para politikası alanında en güncel konular arasında yer alan, merkez bankası bağımsızlığı, parasal aktarım mekanizması ve optimal para politikası geniş bir örneklem ve farklı analiz yöntemleri kullanılarak incelenmektedir.

İkinci bölümde, enflasyon ve merkez bankası bağımsızlığı arasındaki ilişki hem teorik hem de ampirik çerçevede incelenmektedir. Acemoğlu vd. (2008) çalışmasını takip ederek, tam bilgi ve eksik bilgi durumlarını içeren, merkez bankası ve hükümet arasındaki ilişkiyi gösteren teorik model ve politika oyunu inşa edilmektedir. Ayrıca, ampirik bulguları göstermek için, sabit etkili dinamik panel regresyon analizi yapılmaktadır. Dinamik panel analizi bulguları, enflasyon ile merkez bankası bağımsızlığı arasında negatif bir ilişki olduğunu ortaya koymaktadır. Merkez bankası bağımsızlığının enflasyon üzerindeki olumsuz etkisi istatistiksel olarak anlamlıdır ve beklentilerle uyumludur. Tahterevalli ve delegasyon etkileri ayrıştırıldığında ise, tahterevalli etkisi istatistiksel olarak anlamlı ve pozitiftir. Acemoglu vd. (2008) tahterevalli etkisini artan bütçe açığını monetize etmek isteyen hükümetin enflasyonu arttırması olarak açıklamaktadır. Tahterevalli ve delegasyon etkilerinin ayrıştığı model Sikken ve de Haan (1998) ve Lucotte'nin (2009) çalışmalarıyla tutarlı olarak daha düşük bütçe açığının enflasyonun düşmesine katkıda bulunduğunu göstermektedir.

Üçüncü bölüm Türkiye'de enflasyon hedeflemesi rejimi altında parasal aktarım mekanizmasının nasıl ve hangi ölçüde başarılı olduğunu sunmaktadır. İlgili teorik ve uygulamalı literatür dikkatlice gözden geçirildikten sonra, en uygun modeller, çeşitli vektör otoregresif (VAR, SVAR, VARX, SVARX) modeller, küçük ve açık ekonomi varsayımı çerçevesinde Türkiye için geliştirilmektedir. Temel ve genişletilmiş vektör

otoregresif modellerde, likidite göstergesi olan dar kapsamlı para arzı ve politika faiz oranı reel çıktı seviyesinin temel belirleyicileri olmakta; fakat fiyatlar genel seviyesi likidite, çıktı ve nominal döviz kuru tarafından kontrol edilmektedir. Merkez bankası tarafından belirlenen politika faiz oranı ve nominal döviz kuru reel çıktı ve tüketici fiyatları üzerinde anlamlı bir etkiye sahipken, dışsal değişkenler reel çıktı üzerinde küçük olmasına rağmen anlamlı bir etkiye sahiptir fakat tüketici fiyatları üzerinde önemli bir etkiye sahip değildir. Bu sonuçlar TCMB'nin Türkiye'de reel çıktı seviyesini etkileyebildiğini ve parasal aktarımın efektif olduğunu ortaya koymaktadır. Ayrıca, döviz kuru ve faiz oranı kanalı fiyatlar düzeyi üzerinde anlamlı bir etkiye sahipken, varlık fiyatları ve likidite kanalı reel çıktının en önemli belirleyicileridir. Sektörel aktarım mekanizmasına gelince, TCMB'nin politikalarının sektörel çıktı ve fiyatlama mekanizması üzerindeki etkisi istatistiksel ve ekonomik olarak anlamlı bulunmaktadır. Bütün sektörlerde döviz kuru kanalı reel çıktı ve üretici fiyatlarının temel belirleyicisidir, ayrıca inşaat sektöründe faiz oranı kanalı da etkili bulunmaktadır.

Dördüncü bölüm, Türkiye'de optimal para politikasının belirlenmesine odaklanmaktadır. Gali (2015) ve Harrison (2017)'nin çalışmaları takip edilerek, Bayesyen tahminleri içeren yeni Keynesyen dinamik stokastik genel denge (NK-DSGE) modeli oluşturulmaktadır. Tüm şoklar bir arada ele alındığında, döviz kuru sapmalarına ve çıktı açığına sapmalarına cevap veren Kural 8 ve Kural 10, kayıp fonksiyonunu en aza indirgemek için en etkili kurallar olarak görünmektedir. Şoklar tek tek ele alındığında ise, Kural 10 para politikası ve uluslararası faiz şoklarının; yurt içi enflasyon tahmini kuralı olarak adlandırılan Kural 7 ise verimlilik, tercih ve küresel emtia fiyatları şoklarının varlığında kayıp fonksiyonunu en aza indirgemek için en etkili para politikası kurallarıdır. Seçilen değişkenlerin etki tepki fonksiyonlarına bakıldığında, Kural 7, Kural 8 ve Kural 10 şokların yayılma dinamiklerini açıklamak için en uygun kurallardır. Sonsal olasılık dağılımı Kural 7'nin değişkenlerin davranışlarını açıklamak için en iyi para politikası kuralı olduğunu açıkça göstermektedir. Tüm gerekçeler göz önüne alındığında, Türkiye için optimal para politikası olarak Kural 7 akla yatkın görünmekte, ayrıca TCMB, her türlü şoka karşı Kural 8 ve Kural 10 gibi kapsamlı bir dizi para politikası kurallarına da uygulayabileceği değerlendirilmektedir.

**Anahtar kelimeler:** Merkez bankası bağımsızlığı, panel veri analizi, parasal aktarım mekanizması, VAR, optimal para politikası, DSGE.

## ABSTRACT


**THREE ESSAYS ON MONETARY POLICY**

**UFUK CAN**

**Ph.D. Thesis, Department of Economics**
**Supervisor: Prof. Dr. Harun BAL**
**January 2022, 107 pages**

Monetary policy, which gained importance with the monetarist and new Keynesian economics, is the focus of the studies in the economic literature. Among the hot topics in this area, central bank independence, monetary transmission mechanism and optimal monetary policy are examined in this dissertation as three independent essays by using a wide range of samples and various analysis methods.

Chapter Two examines the relationship between inflation, budget balance and central bank independence in both theoretical and empirical frameworks. Following the seminal paper by Acemoglu et al. (2008), a theoretical model and a policy game between the central bank and the government that cover the perfect and imperfect information cases are built. In addition, in order to demonstrate the empirical findings, dynamic panel models with fixed effects are also performed. The findings of the dynamic panel analysis reveal that there is a negative relationship between inflation and central bank independence. The negative impact of central bank independence on inflation is statistically significant and is in line with a priori expectations. When the seesaw and delegation effects are distinguished, the seesaw effect is statistically significant and positive. Acemoglu et al. (2008) explain the seesaw effect as an increase in inflation by a government that wants to monetize the growing budget deficit. The model in which the seesaw and delegation effects are distinguished, on the other hand, shows that a lower budget deficit contributes to lower inflation, consistent with the studies of Sikken and de Haan (1998) and Lucotte (2009).

Chapter Three presents how and to what extent the monetary transmission mechanism is successful in Turkey under an inflation-targeting environment. After reviewing carefully the related theoretical and applied literature on monetary theory, the suitable models, i.e., various vector autoregressive (VAR, SVAR, VARX, SVARX) models, are developed for Turkey in the context of a small and open economy. In the baseline and extended vector autoregressive models, the policy interest rate and the narrow monetary base, regarded as a liquidity indicator, are the main drivers of the output level. However, the general price levels are controlled by the changes in real output, liquidity and exchange rate. The policy interest rate, which is implemented by the central bank, and the nominal exchange rate have a significant effect on real output and consumer prices, whereas external variables have a similar, though small, effect, on real output but not on inflation. These results reveal that the CBRT has the ability to influence Turkey's real output level and that monetary transmission is effective. Furthermore, the exchange rate and interest rate channels have a significant effect on the price level. However, the asset price and the liquidity channel are the most important determinants of the real output level. As for the sectoral transmission mechanism, CBRT's policy actions have a statistically and economically significant effect on both the sectoral output level and the sectoral pricing dynamics in Turkey. The exchange rate channel is the key driver of the price level and real output for all sectors, as well as the interest rate channel for the construction sector.

Chapter Four focuses on the determination of the optimal monetary policy in Turkey. Following the papers by Gali (2015) and Harrison (2017), a New Keynesian dynamic stochastic general equilibrium (NK-DSGE) model in which Bayesian estimations are included is constructed. Considering all shocks together, Rule 8 and Rule 10, which respond to the exchange rate and output gap deviations, seem the most effective rules to minimize the loss function. Considering all shocks individually, Rule 10 is the most effective monetary rule to minimize the loss function under monetary policy and international interest rate shocks. However, Rule 7, also called the domestic inflation forecast rule, is the most effective monetary rule to minimize the loss function under productivity, preferences and world price level shocks. As to selected variables' impulse responses, Rule 7, Rule 8 and Rule 10 are suitable for explaining the propagation dynamics of the shocks. The posterior probability clearly illustrates that Rule 7 is the best monetary rule to explain the behavior of the variables. Considering all the grounds, Rule 7 looks plausible for Turkey, as an optimal monetary policy. Moreover, CBRT could implement a comprehensive set of monetary rules, such as Rule 8 and Rule 10, against each kind of shock.

**Keywords:** Central bank independence, panel data analysis, monetary transmission mechanism, VAR, optimal monetary policy, DSGE.

## ACKNOWLEDGEMENT

I am ineffably indebted to my Supervisor Prof. Dr. Harun BAL for his conscientious guidance and encouragement to accomplish this Thesis. I would like to express my sincere gratitude to Prof. Dr. Neşe ALGAN and Prof. Dr. Hatice DÜZAKIN for their advice and for serving as a member of the Thesis Examination Committee. My sincere gratitude goes to Prof. Dr. Mehmet BALCILAR and Prof. Dr. Hakan KAHYAOĞLU for their role as Juries of my dissertation defense. All my teachers, friends, and colleagues deserve special thanks for their ceaseless encouragement throughout this entire process.

I would like to acknowledge the financial support from the Cukurova University Scientific Research Projects (BAP) Coordination Unit (Project Type: Doctorate, Project ID: SDK-2019-11882) during the dissertation period.

I owe a lot to my parents and family members for their gracious support throughout the course of my study. The path was not that easy, and Covid-19 Pandemic made it even harder to finish it on time. Heartiest thanks to my wife Zeynep Gizem CAN for being with me with his generous support throughout this arduous journey. Lots of love to my girl Gizem Arya CAN who was extremely supportive in this process; otherwise the dream would have remained unrealized.

Last but not least; I would like to thank all concerned who help me with technical and administrative issues to make this endeavor a success.

# TABLE OF CONTENTS

## CHAPTER IV

## OPTIMAL MONETARY POLICY



## CHAPTER V

## CONCLUSION

# ABBREVIATIONS

**ADF:** Augmented Dickey-Fuller Unit Root Test

**AR:** Autoregressive Process

**BIST:** Istanbul Stock Exchange

**BPS:** Basis Points

**BRSA:** Banking Regulation and Supervision Agency

**BVAR:** Bayesian Vector Autoregressive Model

**CBI:** Central Bank Independence

**CBRT:** Central Bank of the Republic of Turkey

**CWN:** Cukierman, Webb and Neyapti's CBI Criteria

**DFE:** Dynamic Panel Model with Fixed Effects (DFE)

**DSGE:** Dynamic Stocastic General Equilibrium Model

**FRED:** Federal Reserve Bank of St. Louis

**GMM:** Generalized Method of Moments

**IMF:** International Monetary Fund

**IRFs:** Impulse Response Functions

**KPSS:** Kwiatkowski, Phillips, Schmidt and Shin Stationary Test

**MG:** Mean Group Estimator

**MR:** Monetary Rule

**PC:** Phillips Curve

**PMG:** Pooled Mean Group Estimator

**PPTS:** Percantage Points

**RWMH-MCMC:** Random walk Metropolis-Hastings Monte-Carlo Markov Chains

**SVAR:** Structural Vector Autoregressive Model

**SVARX:** Structural Vector Autoregressive Model with Exogenous Variable

**TURKSTAT:** Turkish Statistical Institute

**VAR:** Vector Autoregressive Model

**VARX:** Vector Autoregressive Model with Exogenous Variable

**W/O:** Blocking-off Methodology

## LIST OF TABLES

**Pages**

# LIST OF FIGURES

# LIST OF APPENDICES

**Pages**

# CHAPTER I

# INTRODUCTION

## 1.1. Background of the Study

Macroeconomic policy consists of two main pillars: monetary and fiscal policies. Monetary policy, which gained importance with the monetarist and new Keynesian economics, is the cornerstone of the studies in the economic literature. Among the hot topics in this area, central bank independence, monetary transmission mechanism and optimal monetary policy are examined by using a wide range of samples and various analysis methods in this dissertation.

The degree to which central bankers are free from government control is known as central bank independence. After the late 1980s, central bank independence became a crucial institutional formula for fighting inflation, sparking a surge of changes at central banks across the world. When governments have discretionary power over monetary instruments, they may put other policy priorities ahead of price stability at any time during their tenure. Politicians can be inclined to use monetary policy to achieve short-term increases in jobs and productivity, i.e., to boost inflation. Therefore, Rogoff (1985) argues that monetary policy should be delegated to autonomous central banks.

Bade and Parkin (1978, 1988) were the first to quantify central bank independence. They were solely based on laws and regulations controlling central banks and their activities. But while Alesina (1988) and Grilli et al. (1991) developed variants of the legal metrics of central bank independence, Cukierman et al. (1992) developed the most commonly cited legislative measure of central bank independence by analyzing central bank laws and statutes in conjunction with survey answers from several central banks to determine their legal independence from political influence.

The monetary transmission mechanism describes which channels and how monetary policy impacts the real economy as a whole. Monetary policy literature discusses a variety of transmission channels. Mishkin (1995) defined the most well-known channels as asset price, credit, exchange rate and interest rate channels. Due to the fact that the central bank follows an inflation-targeting regime by using short-term interest rates as its primary policy instrument, the interest rate channel is the most prominent. However, other channels remain significant and relevant in all countries.

While the greater part of the literature focuses on various monetary transmission channels in developed markets, the monetary transmission mechanism for emerging economies has become a widely debated topic in the last two decades. In addition, numerous studies use VARs or other methods to deduce how Turkey's monetary transmission system operates. Kara et al. (2007), Yilmazkuday (2011) and Can et al. (2020) reveal that Turkey's monetary policy is focused on reducing output volatility and smoothing interest rates via the adjustments in short-term interest rate, and the monetary transmission mechanism is effective.

Optimal monetary policy is a set of monetary policy rules that minimizes well-being, i.e., the loss function. The optimal interest rate, the most important tool in this set, is the rate that maximizes expected utility in intertemporal consumption choice. Monetary policy is close to optimal in developed countries because of the low output gap and inflation deviation. However, it is quite difficult to implement optimal monetary policy in developing countries due to high inflation deviation, exchange rate volatility and output gap. Therefore, an extended Taylor-type monetary policy rule with exchange rate or terms of trade fluctuations is more meaningful.

Dynamic stochastic general equilibrium (DSGE) model is often used in an economy modeled within the framework of New Keynesian economics in order to be able to show the effects of internal and external shocks. Gali (2015) and Harrison (2017) built a New Keynesian DSGE model in a small and open economy under financial frictions. Moreover, the prior knowledge as well as the maximum likelihood function are used to come up with a posterior distribution for the model's parameters, which is the source of the fluctuation in the Bayesian DSGE model. The likelihood function is computed by using the Kalman filter, and the posterior distribution for each rule is drawn by employing the random walk Metropolis-Hastings algorithm to construct Markov chains.

### 1.2. Objectives of the Research

Central bank independence is linked to lower inflation in developed countries; however, there is no generally accepted proof of a negative relationship between them in developing countries (Crowe and Meade, 2007; Klomp and de Haan, 2010). Following the seminal paper by Acemoglu et al. (2008), the seesaw and delegation effects are distinguished by game theory and econometric techniques.

Under an explicit inflation-targeting regime, the general monetary transmission mechanism is effective in Turkey, but there is no empirical study on the sectoral monetary transmission mechanism. Following the exemplary papers by Cushman and Zha (1997) and Can et al. (2020), the effectiveness of the general and sectoral monetary transmission mechanism is revealed by econometric techniques in a more comprehensive framework.

Whether the applied monetary policy rule is optimal, that is, one that minimizes the loss function, is always a matter of debate. Therefore, an optimal set of monetary policies is determined for Turkey by modeling a general equilibrium model within the framework of New Keynesian economics under the joint and individual effects of different internal and external shocks. As far as is known, there are no studies conducted on Turkey in the literature.

### 1.3. Organization of the Study

This thesis consists of five chapters. Following the background and objective of the research in the first chapter, the rest of the paper is structured in the following manner.

Chapter Two presents the relationship between inflation, budget balance and central bank independence. Following a brief introduction in Section 2.1, Section 2.2 presents the theoretical model under both complete and incomplete information cases. Section 2.3 reveals the specification of the data. Section 2.4 gives the empirical evidence for the relationship between inflation, budget balance and central bank independence by constructing panel data analysis, followed by concluding remarks in Section 2.5.

Chapter Three sheds light on the effectiveness of the monetary transmission mechanism in Turkey. Following a brief introduction in Section 3.1, Section 3.2 explains the theoretical framework of the monetary transmission mechanism. Section 3.3 discusses the data and the empirical motivation in detail. Section 3.4 demonstrates the monetary transmission mechanism's efficacy and analyzes the relative significance of various channels and variance decompositions in important macroeconomic indicators, followed by concluding remarks in Section 3.5.

Chapter Four reveals the optimal monetary policy in Turkey. Following a brief introduction in Section 4.1, Section 4.2 lays out the new Keynesian economic framework for a small and open economy, with financial frictions. Section 4.3 explains the calibration process of the parameters. Section 4.4 points out the data, the estimation and the priors for each rule in the model. Section 4.5 summarizes and examines the findings by following the concluding remarks in Section 4.6. Finally, the key findings, policy recommandations and limitations are presented in the last chapter.

# CHAPTER II

# CENTRAL BANK INDEPENDENCE

## 2.1. Introduction

Is the central bank independence vital for keeping inflation under control? The broadly held belief that inflation above a predetermined level is harmful to the real economy is the main driver behind the primary objective of many central banks, which is price stability[1]. High inflation has a disproportionately detrimental effect on developing countries (Burdekin et al., 2004; Bick, 2010; López-Villavicencio and Mignon, 2011; Bittencourt, 2012; Ayres et al., 2014; Ibarra and Trupkin, 2016; Arawatari et al., 2018). As a result, extensive analysis has been conducted in order to identify the organizations and policies that maintain price stability. After the late 1980s, central bank independence became a crucial institutional formula for fighting inflation, sparking a surge of changes at central banks across the world (Goodfriend, 2007). Most countries have given their central banks more autonomy. However, there is no definitive proof of a direct relationship between central bank independence and inflation in developing countries (Cukierman, 1992; Neyapti, 2012; Alpanda and Honig, 2014).

When governments have discretionary power over monetary instruments, they may put other policy priorities ahead of price stability at any time during their tenure. Politicians can be inclined to use monetary policy to achieve short-term increases in jobs and productivity after nominal salaries have been set, i.e., to boost inflation. Kydland and Prescott (1977) were the first to highlight the time inconsistency hypothesis as a possible explanation of the high inflation in the 1970s. Friedman (1962) makes the first reference to central bank independence that we are aware of. Barro and Gordon (1983) emphasize the advantages of imposed commitments over discretion. In addition, Rogoff (1985) argues that monetary policy should be delegated to autonomous central banks. When central bankers are free of political constraints, they may make convincing promises of price stability, which helps to keep inflation stable.

Following these theories, a broad policy consensus developed around the ability

---

[1] Both empirical and theoretical studies by Tobin (1965), Fischer and Modigliani (1978), Logue and Sweeney (1981), Orphanides and Solow (1990), Fischer (1993), Barro (1995), Li and Zou (2002) reveal that high inflation is detrimental to the economy.

of central bank independence to foster inflation stability (Bernhard et al., 2002; Kern et al., 2019). This policy recommendation has been adopted by several countries. There were 266 changes to central bank legislative independence between 1985 and 2012, with 236 of them taking place in developed countries. Garriga (2016) indicates that the majority of these changes (77%) improved the central bank independence. Despite the widespread influence of this policy guidance, the empirical evidence supports that this nexus is still debatable, especially in developing countries.

Central bank independence is linked to lower inflation in developed countries, according to several reports (e.g., Cukierman et al., 1992; Fischer, 1995; Carlstrom and Fuerst, 2009; Bodea and Hicks, 2015a; de Haan et al., 2018; Garriga and Rodriguez, 2020). However, there is no generally accepted proof of a negative relationship between the inflation and central bank independence in developing countries (Cukierman, 1992; Bagheri and Habibi, 1998; Desai et al., 2003; Crowe and Meade, 2007; Klomp and de Haan, 2010). This nexus has been identified in countries with high inflation (Landström, 2011), in developing democracies (Bodea and Hicks, 2015a), in countries with a medium degree of political pressure (Acemoglu et al., 2008), in Latin American countries (Jácome and Vázquez, 2008), in former communist countries (Neyapti, 2001) and in limited countries (Nurbayev, 2018). Despite these mixed signals, central bank independence remains a significant signal for the markets and policymakers in terms of price stability. Moreover, Bodea and Hicks (2015b) state that defending the central bank from political pressures strengthens its reputation and lets developing countries cope with dynamic inconsistency problem.

Following the seminal paper by Acemoglu et al. (2008), a game theoretical model based on a micro-founded model will be proposed. Then, empirical evidence will be given for a theory that indicates that deterioration in fiscal policy, i.e., the seesaw effect, could have negative impacts on inflation and may outweigh benefits from the delegation effect. Acemoglu et al. (2008) built a model in which political constraints and structural consistency are linked to this debate. They conclude that monetary policy adjustments have only minor, if any, consequences in economies with low or high political pressures on executives. They also reveal that monetary policy reform fits well in communities with a medium level of restriction. Furthermore, they describe a phenomenon known as the seesaw effect, which shows how once a policy is reformed, other policies can deteriorate. Again, why would the central bank independence affect inflation negatively? To address this issue, the theory proposed in this paper is that modifying central bank independence has two opposing consequences at the same time. The first one is the delegation effect, which is a direct effect of the central bank independence. This effect may be traced back to Rogoff (1985). As long as the monetary policy is delegated from the fiscal policy authority to an institution that dislikes inflation more than the fiscal authority, i.e. from a government to a conservative central bank, the money supply growth rate slows, the time inconsistency problem becomes less serious, and the direct impact on inflation should be negative. However, what if the government seeks to influence inflation through other policy tools instead of delegating the monetary policy tools to the central bank? This phenomenon is known as the seesaw effect. Other policy aspects can deteriorate as the central bank independence rises.

For theoretical purposes, two policymakers deal with each other: a fiscal authority (the government) that regulates the government's financial operations and a monetary authority (the conservative central bank) that controls the money supply. Inflation is governed by joint policy decisions taken by policy makers. Furthermore, the government holds the details of the fiscal expansion’s marginal cost. In essence, the model is an adverse selection model with the central bank as the proposer and the government as the responder. As the central bank independence rises, the delegation effect reduces monetary policy’s contribution to inflation, while the seesaw effect exploits fiscal policy to raise inflation (the seesaw effect) at the same time.

The rest of the paper is organized as follows. Section 2.2 presents the theoretical model and solutions under both complete and incomplete information cases. Section 2.3 reveals the specification of the data. Section 2.4 gives the empirical evidence for the relationship between inflation, budget balance and central bank independence by constructing panel data analysis, followed by concluding remarks in Section 2.5.

### 2.2. Theoretical Model

A theoretical model is built following the remarkable paper by Dixit and Lambertini (2003). A staggered price setting mechanism and monopolistic competition are the key features of the model. Due to the monopolistic power of the companies, aggregate output falls short of the optimal level. Both fiscal and monetary policies are available to counteract the monopoly distortion. Staggered price setting allows monetary policy to have a real effect.

The following equations are obtained after solving the micro-founded model developed by Dixit and Lambertini (2003), and the variables are log-linearized around their steady-state values.

$$y = \underline{y} + ax + b(\pi - \pi^e) \tag{1}$$

$$\pi = m + cx \tag{2}$$

where $y$ is the aggregate output, $\underline{y}$ is the natural output level in the case of no corrective fiscal policy, $a$ is the fiscal multiplier parameter, $x$ is the fiscal policy variable, $\pi$ is the realized inflation, $\pi^e$ is the expected inflation, $m$ is monetary policy, $c$ is the inflation coefficient of the fiscal policy variable. Unexpected inflation and expansionary fiscal policy raise the aggregate output, i.e., $a > 0$ and $b > 0$. Unlike the study by Dixit and Lambertini (2003), this work aims to dissociate the delegation and seesaw effect by inspiring the work by Oztunali (2016). Therefore, to reveal the monetary policy's impact on inflation, the monetary policy includes the monetary policy variable's inflation coefficient, $\varphi$, and the monetary policy variable, $z$, i.e., $m = \varphi z$. Expansionary monetary and fiscal policies increase inflation, i.e., $\varphi > 0$ and $c > 0$.

### 2.2.1. The Policy Game

The central bank and the government are the two policymakers in the economy (as the monetary and fiscal authorities). They cannot commit to a strategy until the private sector sets inflation expectations, $\pi^e$, and they choose the monetary and fiscal variables, $z$ and $x$. The government provides the central bank with a certain level of autonomy. This autonomy level is denoted by a fixed cost $F \in [F_{min}, F_{max}]$ where $0 \leq F_{min} \leq F_{max} \leq \infty$. The government must compensate to overrule the decision of the central bank. The payoff function of the government is given by:

$$R^G = -\frac{1}{2}(y - y^n)^2 - \xi x \tag{3}$$

where $y^n$ is the output target of the government, $\xi$ is the constant marginal cost parameter of the fiscal expansion implemented by the government. The payoff function of the central bank is presented by:

$$R^{CB} = -\frac{1}{2}\pi^2 \tag{4}$$

The model is given an informational asymmetry here by suggesting that the government is a random variable with two possible values, i.e., $\xi \in \left[\underline{\xi}, \overline{\xi}\right]$ where $0 \leq \underline{\xi} \leq \overline{\xi} \leq \infty$. As a result, different types of governments can favor fiscal expansion to varying degrees. Nonetheless, it is assumed that the type of government's exact value is private information about the government. The central bank has prior knowledge of the fact that the probability of the type of government $\underline{\xi}$ is $p$ where $0 \leq p \leq 1$.

The policy game takes place as follows: First, inflation expectations, $\pi^e$, are set by the private sector. Second, monetary policy, $z$, which is a function of the fiscal policy variable, $x$, is chosen by the central bank. Third, the type of government is determined by nature. Four, the government chooses either to accept or to reject the monetary policy. If monetary policy is rejected, the government has to pay a fixed cost, $F$, and choose both the fiscal and monetary policy variables, $(x, z)$. Otherwise, if accepted, the government chooses the fiscal policy variable, $x$, and receives $z$. Eventually, aggregate output, $y$, realized inflation, $\pi$, and the payoff functions of the government and the central bank are realized. Figure 1 displays the policy game and the timing.

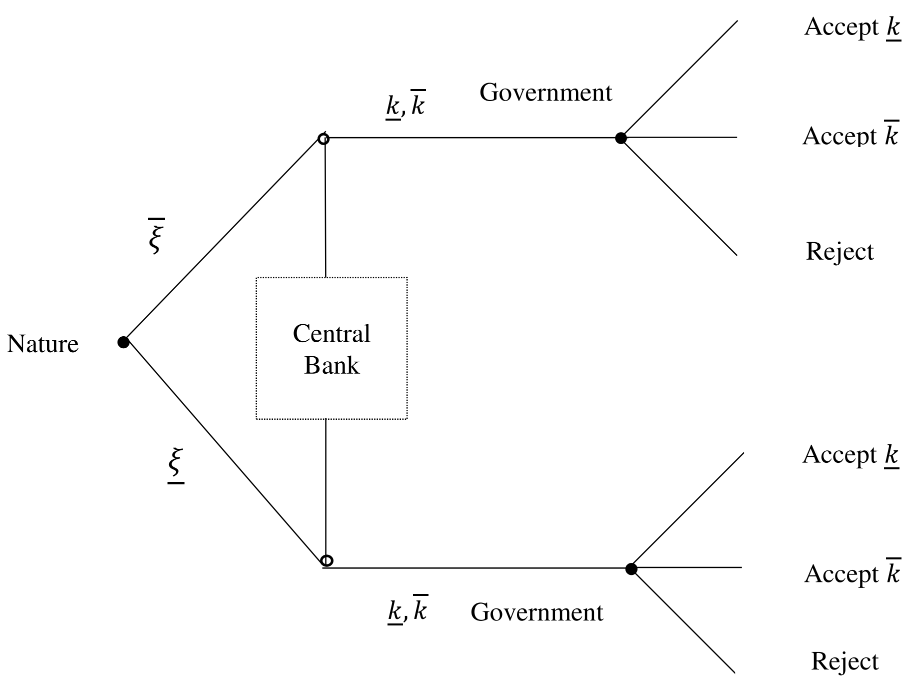



*Figure 1.* Game tree describing the policy game and timing.

Given the monetary policy, $\mu$, chosen by the central bank, the payoff function of the government with type $\xi$ is as follows in the case of accepting the monetary policy.

$$R^G_{Accept}(\xi) \equiv max_x R^G(x, z, \xi) \tag{5}$$

When rejecting the monetary policy, $z$, the government decides a policy $(x_{reject}, z_{reject})$, and its payoff function becomes:

$$R^G_{Reject}(\xi) \equiv max_{\{x_{reject}, z_{reject}\}} R^G(x_{reject}, z_{reject}, \xi) \tag{6}$$

The government accepts the monetary policy if and only if,

$$R^G_{Accept}(\xi) \geq R^G_{Reject}(\xi) - F \tag{7}$$

Given the government's strategy, the objective of the central bank is to decide the monetary policy function, $z$, in order to maximize:

$$E[R^{CB}(x, z, \xi, p)] = R^{CB}\left(x, z, \underline{\xi}\right) p\left(\underline{\xi}\right) + R^{CB}(x, \mu, \overline{\xi}) p(\overline{\xi}) \tag{8}$$

### 2.2.2. The Complete Information Case

The government with type $\xi$ with respect to the marginal cost fiscal expansion is known by the central bank with certainty. Although this is a significant simplification to solve the policy game, it allows clearly distinguishing two different effects of a change in central bank independence, i.e., delegation and seesaw effects. The backward induction method is used to solve the model. The first step is to solve the final stage where the central bank chooses the monetary policy. The government decides whether to reject or accept the monetary policy offered by the central bank. Second, in the case of rejecting the monetary policy offer of the central bank, the government determines the optimal monetary and fiscal policies while paying the fixed cost, $F$, to maximize its payoff.

When starting the second decision of the game, which determines the optimal monetary and fiscal policies in the case of rejecting the monetary policy offer of the central bank, the government decides $\left(x_{reject}, z_{reject} \in argmax_{\{x_{reject}, z_{reject}\}}\right)$ to satisfy its payoff function with the help of equation (3).

$$R^G_{Reject}(\xi) = -\frac{1}{2}(y - y^n)^2 - \xi x_{reject} - F \tag{9}$$

By combining the equations (1), (2) and (9), the payoff function of the government can be denoted in terms of $z_{reject}, x_{reject}$.

$$R^G_{Reject}(\xi) = -\frac{1}{2}\left[\underline{y} + \lambda x_{reject} + b\left(cx_{reject} + \varphi z_{reject} - \pi^e\right) - y^n\right]^2 - \xi x_{reject} - F \tag{10}$$

Assuming $y^n - \underline{y} + b\pi^e > 0$, which means that the targeted output level is above the realized output if the government does not adopt any corrective policies, and defining $\lambda \equiv y^n - \underline{y} + b\pi^e$, which measures the output gap in the case of no corrective policy. Taking the first order condition of (10) in terms of $\left(x_{reject}, z_{reject}\right)$ yields the equations (11) and (12) in the case of no upper limit in monetary policy.

$$x^*_{reject} = 0 \tag{11}$$

$$z^*_{reject} = \frac{\lambda}{b\varphi} \tag{12}$$

This result is based on very basic intuition. The objective of the government is to minimize the output gap with as little fiscal cost as possible. Fiscal expansion has a positive marginal cost ($\xi > 0$), but monetary expansion has no cost. As a result, with no restrictions on the country's monetary expansion options, the government opts to close the output gap solely through monetary expansion. To avoid this result, an upper limit must be enforced on the monetary policy variable. Suppose that $z \in [z_{min}, z_{max}]$ where $\left(z_{max} < \frac{\lambda}{b\varphi}\right)$. Therefore, the government would no longer be able to eliminate the output gap entirely through monetary expansion alone, and its optimal policy would require a positive level of fiscal expansion as well. The government can choose the highest level of monetary expansion that it is permitted to use and implement fiscal policy to close the remaining output gap. Consequently, the optimal monetary policy is thus and so.

$$z^*_{reject} = z_{max} \tag{13}$$

Given equation (13), there are now two possible optimal fiscal expansion levels in place of equation (12).

$$x'_{reject} = \frac{\lambda - b\varphi z_{max}}{a+bc} \tag{14}$$

$$x''_{reject} = \frac{\lambda - b\varphi z_{max}}{a+bc} - \frac{\xi}{(a+bc)^2} \tag{15}$$

To determine the optimal fiscal policy, consider the payoff function of the government in each case:

$$R^G_{Reject}\left(x'_{reject}, z_{max}, \xi\right) = -\frac{\xi(\lambda - b\varphi z_{max})}{a+bc} - F \tag{16}$$

$$R^G_{Reject}\left(x''_{reject}, z_{max}, \xi\right) = \frac{1}{2}\left[\frac{\xi}{a+bc}\right]^2 - \frac{\xi(\lambda - b\varphi z_{max})}{a+bc} - F \tag{17}$$

Since the first term on the right side of equation (17) is higher than zero, $\frac{1}{2}\left[\frac{\xi}{a+bc}\right]^2 > 0$, the optimal fiscal expansion level is related to the second fiscal policy candidate, equation (17), in the case of rejecting the offer from the central bank. That is to say, the government gets a lower payoff under the second fiscal policy candidate because the realized output level has already exceeded the targeted level. Therefore, the solution to the government's maximization problem becomes the equations (13) and (15) for $\left(x_{reject}, z_{reject}\right)$. The payoff function of the government becomes the equation (17) for $\left(x^*_{reject}, z^*_{reject}, \xi\right)$ in the case of rejecting the monetary policy offer of the central bank.

Given the monetary policy decision of the central bank, if the government accepts the offer from the central bank, the government maximizes the payoff function by choosing the optimal fiscal policy level and not paying any fixed cost. With the help of the equation (3), this choice, $\left(x^*_{accept}\right) \in argmax_{\{x_{accept}\}}$, must be satisfied as follows.

$$R^G_{accept}(\delta) = -\frac{1}{2}(y - y^n)^2 - \xi x_{accept} \tag{18}$$

The payoff function of the government takes a similar form to the equation (10).

$$R_{accept}^{G}\left(x_{accept}, z, \xi\right) = -\frac{1}{2}\left[-\lambda + b\varphi z\left(x_{accept}\right) + (a + bc)x_{accept}\right]^2 - \xi x_{accept} \quad (19)$$

After taking the first order condition of the equation (19) with respect to fiscal policy variables, the optimal fiscal policy is similar to the equation (15)[2].

$$x_{accept}^{*} = \frac{\lambda - b\varphi z}{a+bc} - \frac{\xi}{(a+bc)^2} \quad (20)$$

The payoff function of the government in the case of accepting the offer of the central bank is similar to equation (17).

$$R_{accept}^{G}\left(x_{accept}, z, \xi\right) = \frac{1}{2}\left[\frac{\xi}{a+bc}\right]^2 - \xi\left[\frac{\lambda - b\varphi z}{a+bc}\right] \quad (21)$$

The equations (13), (15) and (17) show the choices and the payoff function of the government in the case of rejecting the offer from the central bank. The equations (20) and (21) indicate the choices and the payoff function of the government in the case of accepting the offer from the central bank. The government decides to accept the offer of the central bank if and only if equation (7), $R_{accept}^{G}\left(x_{accept}, z, \xi\right) \geq R_{reject}^{G}\left(x_{reject}^{*},\ z_{reject}^{*}, \xi\right)$, is satisfied.

$$\frac{1}{2}\left[\frac{\xi}{a+bc}\right]^2 - \xi\left[\frac{\lambda - b\varphi z}{a+bc}\right] = \frac{1}{2}\left[\frac{\xi}{a+bc}\right]^2 - \delta\left[\frac{\lambda - b\varphi z_{max}}{a+bc}\right] - F \quad (22)$$

Rearranging the equation (22) yields:

$$x^{*} = \frac{\lambda - b\varphi z_{max}}{a+bc} - \frac{\xi}{(a+bc)^2} + \frac{F}{\xi} \quad (23)$$

---

[2] The first order condition of the payoff function of the government with respect to the fiscal policy choice includes the derivative of the offer of the central bank with respect to the fiscal policy choice of the government, $\partial z/\partial x$. In Appendix A, it is proven that this derivative is equal to zero. This means that the central bank's offer is actually optimal monetary policy linked to the government's fiscal decision.

$$z^* = z_{max} - \frac{F(a+bc)}{b\varphi\xi} \tag{24}$$

The equation (23) reveals that there is a positive correlation between the central bank independence and the optimal fiscal policy, $\frac{\partial x^*}{\partial F} > 0$, which is associated with the seesaw effect. On the other hand, there is a negative correlation between central bank independence and expansionary monetary policy, $\frac{\partial z^*}{\partial F} < 0$, which is related to the delegation effect. The magnitude of the delegation effect is always higher than that of the seesaw effect because a fiscal expansion has a positive impact on output through the inflation channel both directly and indirectly. That is to say, there is a negative correlation between the central bank independence and inflation in a complete information case.

### 2.2.3. The Incomplete Information Case

The government may lie about its type. If the government lies about its type, the central bank may compel it to engage in fiscal expansion, which corresponds to the opposite type. The government can decide on one of the types: $\xi_i \in \left\{\underline{\xi}, \overline{\xi}\right\}$ where $\underline{\xi} < \overline{\xi}$, that is to say, fiscal expansion is more costly for one type. The government only knows its type; the central bank has no information about the type of government. However, the central bank has a prior probability of the type of government, $Prob\left(\xi_i = \underline{\xi}\right) = p$. Moreover, $z \in [z_{min}, z_{max}]$ with $z_{max} < \frac{\lambda}{b\varphi}$.

Determine first the government's participation decision with $\xi_i \in \left\{\underline{\xi}, \overline{\xi}\right\}$. In the case of rejecting the participation, the payoff function of the government with type $\xi_i$ is similar to the equation (10).

$$R^G_{Reject}(\xi_i) = -\frac{1}{2}\left[\underline{y} + ax_{reject}(\xi_i) + b\left(cx_{reject}(\xi_i) + \varphi z_{reject}(\xi_i) - \pi^e\right) - y^n\right]^2 - \xi_i x_{reject}(\xi_i) - F \tag{25}$$

If possible, the government eliminates output gap when rejecting participation. An upper limit is imposed on $z_i$, in order to not eliminate the output gap with only monetary expansion and at any cost. Therefore, it is assumed that $z \in [z_{min}, z_{max}]$ where $z_{max} < y_n + \pi^e - \underline{y} \equiv \lambda$. Following that, $z_{reject}(\xi_i) = z_{max} \forall \xi_i \in \left\{\underline{\xi}, \overline{\xi}\right\}$. By taking the first order conditions of the equation (25) with respect to $x_i$ and $z_i$, it is similar to the equation (15).

$$x_{reject}(\xi_i) = \frac{\lambda - b\varphi z_{max}}{a+bc} - \frac{\xi_i}{(a+bc)^2} \tag{26}$$

Defining $\Delta x_{reject} \equiv x_{reject}(\overline{\xi}) - x_{reject}\left(\underline{\xi}\right)$, the equation (27) is obtained.

$$y_{reject}(\xi_i) = y_n - \frac{\xi_i}{a+bc} \tag{27}$$

$\overline{\xi} > \underline{\xi}$ implies $y_{reject}(\overline{\xi}) < y_{reject}\left(\underline{\xi}\right)$. In the case of rejecting the participation, the payoff function of the government is defined as follows.

$$R^G_{reject}(\xi_i) = \frac{1}{2}\left[\frac{\xi_i}{(a+bc)}\right]^2 - \frac{\xi_i(\lambda - b\varphi z_{max})}{(a+bc)^2} \tag{28}$$

After determining the payoff function of each government type in the case of rejecting the offer of the central bank, the government's behavior is investigated in the case of accepting the monetary policy offer of the central bank. $R^G(\xi_i, \xi_i)$ is defined as the payoff from truth-telling for the government with type $\xi_i$. $k(\xi_i)$ is specified as the contract offered by the central bank with the expectation that it would be accepted by the government with type $\xi_i$. Each contract has a couple of monetary and fiscal policies. The central bank offers $z(\xi_i)$ to the government with type $\xi_i$ and expects it to spend $x(\xi_i)$. Then $R^G(\xi_i, \xi_i)$ can be written in the following way:

$$R^G(\xi_i, \xi_i) = -\frac{1}{2}\,[-\lambda + (a+bc)x_i + b\varphi z_i]^2 - \xi_i x_i \tag{29}$$

In the complete information case, $\mu_i$ is a constant function, and it is assumed here that $x_i$ is a function of $z_i$. The first order condition of the equation (29) with respect to $x_i$ is similar to the equation (20).

$$x_i = \frac{\lambda - b\varphi z_i}{a+bc} - \frac{\xi_i}{(a+bc)^2} \tag{30}$$

The ability of the central bank to compel truth-telling on the part of the government is being investigated. The equations (31) and (32) are the incentive compatibility constraints for the government types with $\underline{\xi}$ and $\overline{\xi}$.

$$R^G\left(\underline{\xi},\underline{\xi}\right) \geq R^G\left(\overline{\xi},\underline{\xi}\right) \tag{31}$$

$$R^G\left(\overline{\xi},\overline{\xi}\right) \geq R^G\left(\underline{\xi},\overline{\xi}\right) \tag{32}$$

The incentive compatibility constraint for a government with type $\xi_i$ proposes that the payoff from telling the truth should be equal to or higher than the payoff from lying and acting as a type $\xi_j$ where $\xi_i \neq \xi_j$, i.e., $R^G(\xi_i,\xi_i) \geq R^G\left(\xi_i,\xi_j\right)$. The incentive compatibility constraints yield as follows.

$$-\frac{1}{2}\left[-\lambda+\lambda-b\varphi\underline{z}-\frac{\underline{\xi}}{a+bc}+b\varphi\underline{z}\right]^2-\underline{\xi}\underline{x} \geq -\frac{1}{2}\left[-\lambda+\lambda-b\varphi\overline{z}-\frac{\overline{\xi}}{a+bc}+b\varphi\overline{z}\right]^2-\underline{\xi}\overline{x} \tag{33}$$

$$-\frac{1}{2}\left[-\lambda+\lambda-b\varphi\overline{z}-\frac{\overline{\xi}}{a+bc}+b\varphi\overline{z}\right]^2-\overline{\xi}\overline{x} \geq -\frac{1}{2}\left[-\lambda+\lambda-b\varphi z-\frac{\underline{\xi}}{a+bc}+b\varphi\underline{z}\right]^2-\overline{\xi}\underline{x} \tag{34}$$

where $(\overline{x},\overline{z})$ denotes the fiscal and monetary policies in the contract which is offered by the central bank to the government with type $\overline{\xi}$. $\left(\underline{x},\underline{z}\right)$ is associated with the pair of fiscal and monetary policies that are offered by the central bank to the government with type $\underline{\xi}$. The incentive compatibility constraints result in the equations (35) and (36).

$$\frac{\left(\overline{\xi}-\underline{\xi}\right)^2}{2(a+bc)} \geq \underline{\xi}b\varphi\left(\overline{z}-\underline{z}\right) \tag{35}$$

$$\frac{\left(\overline{\xi}-\underline{\xi}\right)^2}{2(a+bc)} \geq \overline{\xi}b\varphi\left(\underline{z}-\overline{z}\right) \tag{36}$$

Given the central bank's monetary policy offer to both government types, their participation constraints are denoted as follows.

$$R^G\left(\underline{\xi},\underline{\xi}\right) \geq R^G_{reject}\left(\underline{\xi}\right) \tag{37}$$

$$R^G\left(\overline{\xi},\overline{\xi}\right) \geq R^G_{reject}\left(\overline{\xi}\right) \tag{38}$$

The participation constraints clearly indicate that the payoff from accepting the offer from the central bank conditional on truth-telling should be equal to or higher than the payoff from rejecting the offer from the central bank for both government types. Using the equations (33)-(38), the participation constraints are presented in detail.

$$-\frac{1}{2}\left[-\frac{\underline{\xi}}{1+c}\right]^2 - \underline{\xi}\underline{x} \geq -\frac{1}{2}\left[-\lambda + \lambda - b\varphi z_{max} - \frac{\overline{\xi}}{a+bc} + b\varphi z_{max}\right]^2 - \underline{\xi}\underline{x}_{reject} \tag{39}$$

$$-\frac{1}{2}\left[-\frac{\overline{\xi}}{1+c}\right]^2 - \overline{\xi}\overline{x} \geq -\frac{1}{2}\left[-\lambda + \lambda - b\varphi z_{max} - \frac{\underline{\xi}}{a+bc} + b\varphi z_{max}\right]^2 - \overline{\xi}\overline{x}_{reject} \tag{40}$$

Rearranging the equations (39) and (40) yields as follows.

$$\underline{z} \geq z_{max} - \frac{F(a+bc)}{\underline{\xi}b\varphi} \tag{41}$$

$$\overline{z} \geq z_{max} - \frac{F(a+bc)}{\overline{\xi}b\varphi} \tag{42}$$

Up until now, the conditions are necessary to guarantee the participation of the government and accept only the contract corresponds to its own type. Given the behavior of the government, the optimal monetary policy problem of the central bank is now being scrutinized. The central bank's maximization problem is specified as follows.

$$\max_{\underline{z},\overline{z}} E\left[R^{CB}\left(\underline{z},\overline{z},\underline{\xi},\overline{\xi},p\right)\right] = pR^{CB}\left(\underline{z},\underline{\xi}\right) + (1-p)R^{CB}\left(\overline{z},\overline{\xi}\right)$$

subject to $\quad \dfrac{\left(\overline{\xi}-\underline{\xi}\right)^2}{2(a+bc)} \geq \underline{\xi}b\varphi\left(\overline{z}-\underline{z}\right)$

$$\frac{\left(\overline{\xi}-\underline{\xi}\right)^2}{2(a+bc)} \geq \overline{\xi}b\varphi\left(\underline{z}-\overline{z}\right)$$

$$\underline{z} \geq z_{max} - \frac{F(a+bc)}{\underline{\xi} b\varphi}$$

$$\overline{z} \geq z_{max} - \frac{F(a+bc)}{\overline{\xi} b\varphi}$$

$$0 \leq \underline{z} \leq \overline{z} \leq z_{max}$$

$$R^{CB}(z_i, \xi_i) = -\frac{1}{2}\pi(z_i, \xi_i)^2 = -\frac{1}{2}\left[\frac{c\lambda}{a+bc} + \frac{c\xi_i}{(a+bc)^2} + \frac{a\varphi z_i}{a+bc}\right]^2 \tag{43}$$

To begin solving this problem, consider the central bank's payoff function, which is specified in the last row of the preceding problem. It is negatively related to both $\underline{z}$ and $\overline{z}$. Considering the optimal behavior of the government, monetary expansion contributes to higher inflation. As a result, the central bank will provide as little monetary expansion as possible to each type of government.

The intervals in which monetary policy is calculated for each type of government by using the incentive compatibility and participation constraints, i.e., from the second to sixth row of the equation (43).

$$\underbrace{z_{max} - \frac{F(a+bc)}{\underline{\xi} b\varphi}}_{Q} \leq \underline{z} \leq \underbrace{\frac{\left(\overline{\xi}-\underline{\xi}\right)^2}{2\overline{\xi} b\varphi(a+bc)} + \overline{z}}_{R} \tag{44}$$

$$\underbrace{z_{max} - \frac{F(a+bc)}{\overline{\xi} b\varphi}}_{P} \leq \overline{z} \leq \underbrace{\frac{\left(\overline{\xi}-\underline{\xi}\right)^2}{2\underline{\xi} b\varphi(a+bc)} + \underline{z}}_{S} \tag{45}$$

Since $\overline{\xi} > \underline{\xi}$, it is arrived to $P > Q$ and $T > S$. $Q$ and $P$ are the fixed cost's decreasing functions. Assume $F \in [F_{min}, F_{max}]$, and $Q(F_{min}) \leq R$. The latter provides that a monetary policy always satisfies the government with type $\underline{\xi}$'s incentive compatibility and participation constraints. The central bank wants to offer the smallest possible monetary expansion that satisfies each government's participation and incentive compatibility. Since a smaller monetary policy, such as $\underline{z} = Q$ can satisfy the government with type $\underline{\xi}$'s participation constraint, and $\underline{z}$ limits $\overline{z}$ from above, the central bank would indeed set $\underline{z}^* = Q(F)$. By subtracting $Q$ from $P$ and adding and subtracting $Q(F)$ from both sides, the government with type $\overline{\xi}$'s incentive and participation constraints is rewritten as follows.

$$\frac{F(a+bc)}{b\varphi}\left[\frac{\overline{\xi}-\underline{\xi}}{\overline{\xi}\underline{\xi}}\right] + Q(F) \leq \overline{z} \leq S + Q(F) \tag{46}$$

Now it is assumed that $P(F_{min}) - Q(F_{min}) < S$. After that, if $F_{max}$ is large enough, it can be concluded that $\exists\tilde{F}$ such that $P(\tilde{F}) - Q(\tilde{F}) = S$ by using the mean value theorem. At $F = \tilde{F}$, it is arrived to the equation (47).

$$\tilde{F} = \frac{(\overline{\xi}-\underline{\xi})\overline{\xi}}{2(a+bc)^2} \tag{47}$$

Therefore:

$$P(F)\begin{cases} \leq Q(F) + S \; if \; F \in [F_{min}, \tilde{F}] \\ \geq Q(F) + S \; if \; F \in [\tilde{F}, F_{max}] \end{cases} \tag{48}$$

Since the fixed cost, $F$, have to be in the range $[F_{min}, \tilde{F}]$, the central bank can offer a monetary policy that can both satisfy the government with type $\overline{\xi}$'s incentive compatibility and participation. When $(\overline{\xi} - \underline{\xi})$ is regarded as the extent of informational asymmetry between the central bank and the government, the range of institutional quality is actually endogenously related to this. Under the condition that $F > \tilde{F}$, which means the central bank is more independent than the critical degree that is endogenously determined by the informational asymmetry, then it will not be able to act independently in practice. In this case with probability $(1-p)$, the central bank will encounter the government type $\overline{\xi}$ for which there does not exist a monetary policy that satisfies this government type's incentive and participation constraints. The government $\overline{\xi}$ will decline the contract related to its type as $F > \tilde{F}$ makes the monetary policy $\overline{z}$ too low to ensure participation.

On the other hand, it is assumed that $P - Q = S$, i.e. $F = \tilde{F}$. By using $\underline{z}^* = Q$, the government type $\overline{\xi}$'s incentive and participation constraints results in the equation (49).

$$Q + S \leq \overline{z}^* \leq S + Q \tag{49}$$

Therefore, $\overline{z}^* = Q + S$. The optimal solution to the maximization problem of the central bank is the pair of monetary policies, as revealed by the equations (50) and (51).

$$\underline{z}^* = z_{max} - \frac{\tilde{F}(a+bc)}{\underline{\xi} b\varphi} \tag{50}$$

$$\overline{z}^* = \frac{\left(\overline{\xi} - \underline{\xi}\right)^2}{2\underline{\xi} b\varphi(a+bc)} + z_{max} - \frac{\tilde{F}(a+bc)}{\underline{\xi} b\varphi} \tag{51}$$

The equations (50) and (51) indicate that the informational asymmetry brings about a positive information rent to the government at a high marginal fiscal cost.

$$\underbrace{\overline{z}^*\left(\tilde{F}\right) - \overline{z}_{complete}\left(\tilde{F}\right)}_{I} = \frac{\left(\overline{\xi} - \underline{\xi}\right)}{\underline{\xi}}\left[\frac{\left(\overline{\xi} - \underline{\xi}\right)}{2(a+bc)} - \frac{\tilde{F}(a+bc)}{\underline{\xi} b\varphi}\right] \tag{52}$$

where $I$ is information rent. According to equation (52), the government with a high fiscal cost's information rent is negatively related to the fixed cost of circumventing the central bank and positively related to the magnitude of informational asymmetry. Au contraire, in the case of $\underline{z}^*\left(\tilde{F}\right) = z_{complete}\left(\tilde{F}\right)$, the government with a low marginal fiscal cost does not benefit from informational asymmetry, i.e., the information rent is zero.

Due to the informational asymmetry, the fiscal expansion of the government with type $\overline{\xi}$ is different from the complete information level.

$$\overline{x}^* - \overline{x}_{complete} = -\frac{b\varphi\left(\overline{z}^* - \overline{z}_{complete}\right)}{a+bc} \tag{53}$$

The equation (53) points out that the fiscal expansion's deviation from the complete information level is different compared to the monetary expansion's deviation due to the term $\frac{b\varphi}{a+bc}$.

Now the relationship between the expected inflation and the degree of central bank independence is revealed. In cases of $F = F_{min}$ and $F = \tilde{F}$, the expected inflation can be written as follows.

$$\mathbb{E}\pi(F_{min}) = p\left[c\underline{x}^*(F_{min}) + \varphi\underline{z}^*(F_{min})\right] + (1-p)\left[c\overline{x}^*(F_{min}) + \varphi\overline{z}^*(F_{min})\right] \tag{54}$$

$$\mathbb{E}\pi(\tilde{F}) = p\left[c\underline{x}^*(\tilde{F}) + \varphi\underline{z}^*(\tilde{F})\right] + (1-p)\left[c\overline{x}^*(\tilde{F}) + \varphi\overline{z}^*(\tilde{F})\right] \tag{55}$$

The seesaw and delegation effects are illustrated by subtracting the expressions above from each other.

$$\mathbb{E}\pi(F_{min}) - \mathbb{E}\pi(\tilde{F}) = \underbrace{c\left\{p\left[\underline{x}^*(F_{min}) + \underline{x}^*(\tilde{F})\right] + (1-p)\left[\overline{x}^*(F_{min}) - \overline{x}^*(\tilde{F})\right]\right\}}_{SE}$$
$$\underbrace{\sigma\left\{p\left[\underline{\mu}^*(F_{min}) + \theta\underline{\mu}^*(\tilde{F})\right] + (1-p)\left[\overline{\mu}^*(F_{min}) - \overline{\mu}^*(\tilde{F})\right]\right\}}_{DE} \tag{56}$$

where $SE$ is the seesaw effect, $DE$ is the delegation effect. The seesaw effect can be rewritten in the following manner:

$$SE = cp\left\{\frac{\lambda - b\varphi\underline{z}^*(F_{min})}{a+bc} - \frac{\underline{\xi}}{(a+bc)^2} - \left[\frac{\lambda - b\varphi\underline{z}^*(\tilde{F})}{a+bc} - \frac{\underline{\xi}}{(a+bc)^2}\right]\right\} + c(1-p)\left\{\frac{\lambda - b\varphi\overline{z}^*(F_{min})}{a+bc} - \frac{\overline{\xi}}{(a+bc)^2} - \left[\frac{\lambda - b\varphi\overline{z}^*(\tilde{F})}{a+bc} - \frac{\overline{\xi}}{(a+bc)^2}\right]\right\} \tag{57}$$

Therefore:

$$SE = -\frac{bc}{a+bc}DE \tag{58}$$

These results reveal that $|SE| < |DE|$ no matter how the informational asymmetry's magnitude relates to the magnitudes of both $SE$ and $DE$. In case $a = 0$, that is the fiscal policy has not a direct effect on output, but its indirect effect via creating inflation takes place. The delegation and seesaw effects always dominate each other, and therefore, there is no correlation between expected inflation and institutional quality in the case of this special situation. In other cases, i.e. $a \neq 0$, the seesaw effect is dominated by the delegation effect, and higher institutional quality brings about lower expected inflation.

In particular, information asymmetry has influenced the specific level of fixed cost, $\tilde{F}$. If the hypothetical fixed cost level $\tilde{F}$ is less than this practice level $F$, the central bank cannot enforce the government with type $\overline{\delta}$'s both incentive compatibility and participation constraints. If and only if $(F < \tilde{F})$ where $\tilde{F}$ is positively related to $(\overline{\xi} - \underline{\xi})$ ensures that the central bank acts independently. That is to say, the central bank enforces both governments to participate and accept the offer associated with their own type. In the case of $F \in (\tilde{F}, F_{max})$, both government types will accept the contract offered by the central bank targeted at the type with low fiscal cost. The government will lie about its type with high marginal fiscal cost. Thus, the expected inflation will not relate to the fixed cost level in practice, and both the seesaw and the delegation effects will be zero, i.e., the relationship between inflation and central bank independence will be zero.

### 2.3. The Data

A panel data set of central bank independence, inflation, and public deficits as a percentage of GDP for 35 countries, covering the years from 2000 to 2012, is compiled to examine the interaction of monetary and fiscal policies and their joint effects on inflation[3]. The annual inflation rate is calculated by using the annual variation in the consumer price index as documented by International Monetary Fund (IMF). The structural budget balance data is a good indicator for displaying the public deficit[4]. As for central bank independence, many different methods have been employed in the literature to assess it. However, each method has its own set of limitations[5].

Most empirical studies, such as Alesina et al. (1989), Grilli et al. (1991) and Cukierman (1992), use the central bank independence as a dependent or independent variable, based on central bank statutes, i.e., de jure CBI. On the other hand, some scholars use the central bank independence related to the questionnaires, i.e., de facto CBI (Cukierman et al., 1992; Almeida et al., 1996; Blinder, 2000), or to the central bankers' turnover rate (Cukierman and Webb, 1995; de Haan and Siermann, 1996). However, due

---

[3] The selected countries are strictly committed to inflation targeting, both legally and institutionally. In addition, these countries are stated as medium and strong in terms of codings based on executive constraints and the rule of law by Acemoglu et al. (2008).

[4] The structural budget balance is a cyclically adjusted general government balance that is adjusted for non-structural factors beyond the economic cycle. Fedelino et al. (2009) provide comprehensive information on this notion.

[5] The comprehensive theoretical and practical frameworks for the central bank independence index are provided by Mangano (1998), Acemoglu et al. (2008), Garriga (2016) and Garriga and Rodriguez (2020).

to limited coverage of the questionnaires, cross-sectional comparability, and within-country heterogeneity are the important problematics, so this method may not be reliable. Based on Cukierman, Webb and Neyapti (CWN)'s criteria, the current state of the art of the de jure central bank independence index, which is documented by Garriga and Rodriguez (2020), is used in this study[6]. They developed the aforementioned central bank independence index in three aspects. First, it covers broader country and years (290% larger) than the original dataset of Cukierman et al. (1992). Second, even if there is no information on a change in the particular aspects of central bank independence, the authors include factors that account for the presence of central bank reforms and their direction. The aforementioned factors can provide information on the direction of reforms for further studies. Finally, they identify a number of reforms that have been overlooked in previous datasets, including the reforms that restrict CBI, a possibility that has never been addressed in the literature.

Figure 2 reveals the joint interactions between inflation, budget balance and central bank independence. As clearly seen in Figure 2, there is a negative relationship between inflation and central bank independence. Moreover, there is a slightly negative relationship between budget balance and central bank independence, but it is not clear.

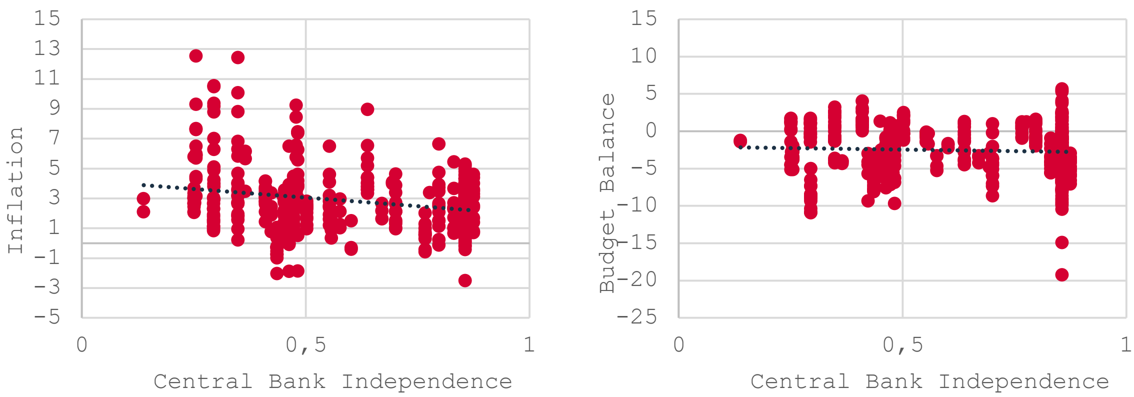



*Figure 2.* Relationship between inflation, budget balance and central bank independence.

[6] CWN's criteria consist of 16 dimensions linked to four components of the CBI, which are the characteristics of the CEO, policy formulation, the objective of the central bank and its limitations on lending to the public sector. These dimensions and components have a weight and finally they are combined into a single weighted index, i.e., the central bank independence index, which ranges from 0 (lowest) to 1 (highest). Because CWN's criteria are flexible, easily understandable and replicable, they have been widely used as the current state of the art of measurement of de jure CBI (Acemoglu et al., 2008).

## 2.4. Empirical Findings

Following the seminal paper by Rogoff (1985), many researchers have put forward that there is a negative relationship between inflation and central bank independence (e.g., Alesina and Summers, 1993; Loungani and Sheets, 1997; Cukierman et al., 2002). However, this relationship has been questioned by several exemplary studies (i.e. Banaian et al., 1998; Hillmann, 1999; de Haan and Kooi, 2000)[7]. Recently, Acemoglu et al. (2008) revealed that the central bank independence has differential effects on inflation that depend on the institutional quality of the countries in question.

To test the inflation and the central bank independence nexus, the following panel data regression is estimated by following the inspirational paper by Garriga and Rodriguez (2020).

$$\pi_{it} = \theta\pi_{i,t-1} + \beta_1 CBI_{it} + \eta_{it} + \zeta_{it} + \tau_{it} + u_{it} \tag{59}$$

where $\pi_{it}$ is the inflation, $\pi_{it-1}$ is the lagged inflation, $CBI_{it}$ is the central bank independence index, $\theta$ and $\beta_1$ are the coefficients of the variables, $\eta_{it}$ is the constant term, $\zeta_{it}$ is the country dummy, $\tau_{it}$ is the period dummy and $u_{it}$ is the error term in country $i$ in year $t$, respectively. To check the fixed effects, country and period dummies are included[8].

As explained in the introduction and theoretical model sections, the direct effect of the central bank independence on inflation, which is negative, is delegation effect; on the other hand, the effect of the deterioration of the fiscal policy on inflation, which is positive, is seesaw effect. Before distinguishing between these effects, it must be checked whether the budget balance really worsens when the central bank independence goes up. Therefore, the following panel data regression is running:

$$BB_{it} = \wp BB_{it-1} + \beta_2 CBI_{it} + \varphi_{it} + \gamma_{it} + \omega_{it} + \varepsilon_{it} \tag{60}$$

where $BB_{it}$ is the budget balance, $CBI_{it}$ is the central bank independence index, $\wp$ and

---

[7] For a more detailed discussion, see Hefeker and Hayo (2008).

[8] The main purpose of this regression analysis is to reveal the relationship between the central bank independence and inflation. Therefore, the exogeneity and no serial correlation assumptions do not strictly hold.

$\beta_2$ are the coefficients of the variables, $\varphi_{it}$ is the constant term, $\gamma_{it}$ is the country dummy, $\omega_{it}$ is the period dummy and $\varepsilon_{it}$ is the error term in country $i$ in year $t$, respectively. To check the fixed effects, country and period dummies are included.

To distinguish the delegation and seesaw effects, the coefficient of the central bank independence index in equation (59) is written in the following functional form:

$$\beta_1 = \beta_3 + \beta_4 BB_{it} \tag{61}$$

The equation (61) implies that the effect of the central bank independence on inflation hinges on the budget balance. Therefore, the panel regression equation is as follows.

$$\pi_{it} = \theta\pi_{it-1} + \beta_3 CBI_{it} + \beta_4 CBI_{it} BB_{it} + \eta_{it} + \zeta_{it} + \tau_{it} + u_{it} \tag{62}$$

where $\beta_3$ and $\beta_4$ represent the delegation and seesaw effects, which are expected to be negative. When the budget balance deteriorates, the central bank independence and inflation go up. The findings of the equations (59), (60) and (62) are revealed in Table 1.

Table 1
*Dynamic panel models with fixed effects for the relationship between inflation, budget balance and central bank independence*

| Dep. Var.: $\pi$ | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| Constant | 4.005 (0.599) | -2.918 (0.997) | 3.990 (0.595) |
| $\beta_1$ | -1.980 (0.940) | | |
| $\beta_2$ | | 0.549 (1.564) | |
| $\beta_3$ | | | -1.689 (0.839) |
| $\beta_4$ | | | 0.010 (0.039) |
| $R^2$ | 0.40 | 0.16 | 0.41 |
| $N$ | 455 | 455 | 455 |

***Notes.*** All regressions include country and year-fixed effects. The numbers in parentheses represent the standard errors. Model 1, Model 2 and Model 3 denote the equations (59), (60) and (62), respectively.

Table 1 reveals that the coefficient of the central bank independence in Model 1, i.e., $\beta_1$, is negative. That is to say, higher central bank independence is associated with lower inflation. Its t-statistic is statistically significant, and its sign is in line with a priori expectations. The coefficient of the central bank independence in Model 2, $\beta_2$, is positive. That is to say, greater central bank independence is associated with a low budget deficit or budget surplus. It is statistically insignificant but is in line with Figure 2 and economic expectations. Sikken and de Haan (1998) and Lucotte (2009) are among the exemplary papers which show that there is a positive relationship between budget balance and central bank independence. Model 3 clarifies that higher central bank independence leads to lower inflation and a lower budget deficit. When the delegation and seesaw effects are distinguished, the coefficients of the delegation effect, $\beta_3$, and the seesaw effect, $\beta_4$, are statistically significant. The sign of the coefficient of the seesaw effect is positive and is not in line with a priori expectations. Acemoglu et al. (2008) explain the seesaw effect, which means that a higher level of central bank independence and lower inflation are associated with a budget deficit. Model 3, on the other hand, shows that a lower budget deficit leads to lower inflation, which is consistent with the work of Sikken and de Haan (1998) and Lucotte (2009). Acemoglu et al. (2008) cover the period 1972–2001 when budget deficits were generally monetized. This dissertation covers the period 2000-2012 when the direct funding of the budget deficit by central banks was prohibited legally. Therefore, the empirical findings of this dissertation differ from those of Acemoglu et al. (2008). As revealed by Model 3, a rise in central bank independence by 1% is associated with a 1.69 ppts decline in inflation. For example, an improvement in the central bank independence from 0.56 to 0.77, which is close to the improvement in Switzerland's central bank independence index in 2003, is associated with a 0.35 ppts decline in inflation.

The equations (59), (60) and (62) include both lagged dependant variables and fixed effects, so the dependant variable will be correlated with the error term unless the number of observations goes to infinity. To perform a robustness check and ensure consistency, the generalized method of moments (GMM) estimator developed by Arellano and Bond (1991) is implemented, as followed by Acemoglu et al. (2008). The findings of the GMM forms of the equations (59), (60) and (62) are revealed in Table 2.

Table 2

*Arellano-Bond GMM models for the relationship between inflation, budget balance and central bank independence*

| Dep. Var.: $\Delta\pi$ | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| Constant | 4.235 (0.699) | -0.665 (0.523) | 3.672 (0.403) |
| $\rho_1$ | -2.341 (1.088) | | |
| $\rho_2$ | | -0.154 (0.758) | |
| $\rho_3$ | | | -1.083 (0.512) |
| $\rho_4$ | | | 0.134 (0.023) |
| $\chi^2$ | 15.64 | 28.63 | 39.03 |
| $N$ | 455 | 455 | 455 |

***Notes.*** The numbers in parentheses represent the robust standard errors. Model 1, Model 2 and Model 3 denote the GMM forms of the equations (59), (60) and (62), respectively. $\rho_1$, $\rho_2$, $\rho_3$ and $\rho_4$ are the estimated coefficients of the variables in the GMM forms of the equations (59), (60) and (62), respectively. $\chi^2$ denotes Wald test statistics. According to Wald test statistics, all instruments are valid.

Table 2 supports the findings in Table 1. The only difference is that the sign of the coefficient of the central bank independence in Model 2 is different. The coefficient of the central bank independence is not statistically significant, but is compatible with a priori expectations. It means that higher central bank independence is associated with a higher budget deficit. Acemoglu et al. (2008) called this phenomenon as seesaw effect, but this finding is not always robust. As revealed by Model 3, a rise in central bank independence by 1% is associated with a 1.08 ppts decline in inflation. For example, an improvement in the central bank independence from 0.56 to 0.77, which is close to the improvement in Switzerland's central bank independence index in 2003, is associated with a 0.23 ppts decline in inflation.

### 2.5. Concluding Remarks

In this chapter, the relationship between inflation, budget balance and central bank independence is examined in both theoretical and empirical frameworks. To construct a theoretical model, a policy game between the central bank and the government is built. While the central bank is autonomous in its decision-making, if the government pays an exogenous cost for bypassing the central bank's authority on monetary policy determination, the government may pursue its own fiscal and monetary policies independently.

In the case of the perfect information case, the model produces the anticipated (and experimentally confirmed) negative relationship between inflation and central bank independence. Two distinct effects, i.e. delegation and seesaw effects, are already at work: As the central bank gains independence, it is able to conduct relatively less monetary expansion (the delegation effect), but this results in a greater reliance on fiscal expansion on the part of the government, as both monetary and fiscal policies are used to close the output gap. However, the fact that a rise in fiscal expansion is less than a decrease in monetary expansion brings about a lower anticipated inflation level.

On the other hand, in the case of informational asymmetry, the marginal cost of the government is first introduced, and then the model produces a zero correlation between the central bank independence and the anticipated inflation rate. The informational asymmetry defines endogenously the range of costs that the government must bear in order to circumvent the authority of the central bank. If the magnitude of this cost exceeds the interval that was previously determined endogenously, that is, if the institutional quality does not conform to the informational asymmetry, the model produces a zero relationship between inflation and central bank independence. That's why the central bank is no longer able to offer a policy that compels the government at high fiscal cost to tell the truth and accept the contract.

The findings of the dynamic panel models reveal that there is a negative relationship between inflation and central bank independence. The negative impact of central bank independence on inflation is statistically significant and is in line with a priori expectations. When the seesaw and delegation effects are distinguished, the seesaw effect is statistically significant and positive. Acemoglu et al. (2008) explain the seesaw effect, which means that a higher level of central bank independence and lower inflation are associated with a budget deficit. Model 3, on the other hand, shows that a lower budget deficit leads to lower inflation, which is consistent with the work of Sikken and de Haan (1998) and Lucotte (2009). Acemoglu et al. (2008) cover the period 1972–2001 when budget deficits were generally monetized. This dissertation covers the period 2000-2012 when the direct funding of the budget deficit by central banks was prohibited legally. Therefore, the empirical findings of this dissertation differ from those of Acemoglu et al. (2008). A rise in central bank independence by 1% is associated with a decline in inflation by 1.93 ppts in the dynamic panel model with fixed effects, and 1.08 ppts in Arellano-Bond GMM model. As a policy recommendation, the central bank should be strengthened both functionally and legally and ensured to be more independent to combat inflation and the budget deficit.

# CHAPTER III

# MONETARY TRANSMISSION MECHANISM

## 3.1. Introduction

Monetary policy has a substantial and pervasive effect on macroeconomic indicators such as the inflation rate and real output level. The monetary transmission mechanism describes by which channels and how monetary policy impacts the real economy as a whole. Monetary policy literature discusses a variety of transmission channels. Mishkin (1995) defined the most well-known channels as asset price, credit, exchange rate and interest rate channels. Due to the fact that the central bank follows an inflation-targeting regime by using short-term interest rates as its primary policy instrument, the interest rate channel is the most prominent. However, other channels remain significant and relevant in all countries, no matter their development level.

In this chapter, how and by which channels the monetary transmission mechanism works in Turkey is discussed. Since the beginning of 2006, an explicit inflation-targeting regime has been implemented in Turkey. How monetary policy shocks affect inflation and output levels is revealed, demonstrating which channel behaves as anticipated in theory. To differentiate the effects of important external shocks, certain key global factors that have an impact on the domestic economy are examined, together with the main domestic variables that may be influenced by the Central Bank of the Republic of Turkey (CBRT). This chapter adds to the research on the monetary transmission mechanism in Turkey's emerging market environment by examining the explicit inflation-targeting period using different vector autoregressive (VAR) models with various modifications, as well as a structural vector autoregressive (SVAR) framework.

First, a simple baseline model is developed to investigate the relationship between the level of real output, the rate of inflation, the money supply, and the policy interest rate. The baseline model is expanded by including other important and prevalent variables, such as the exchange rate. Due to Turkey's high dollarization level and integrated economy, which results in being susceptible to external innovations through import and balance sheet channels, adding the exchange rate as a dependent variable looks rather relevant and plausible. As such, global commodity prices and the federal funds rate are covered in the structural vector autoregressive model to account for their effect on inflation and real output. A variety of vector autoregressive models are constructed to elucidate the monetary transmission mechanism and channels in question. The findings reveal that the effectiveness of monetary policy is related to the anticipated effects on inflation and real output. Additionally, the fact that liquidity and asset price channels are very apparent in Turkey is demonstrated, despite the country's vulnerability to external shocks. As generally recognized in the literature on the exchange rate pass-through, the exchange rate channel plays a critical role in explaining Turkish inflation.

While the greater part of the literature focuses on various monetary transmission channels in developed markets (Bernanke and Blinder, 1992; Taylor, 1995; Reifschneider et al., 1999), the monetary transmission mechanism for emerging economies has become a widely debated topic in the last two decades[9]. As indicated by Disyatat and Vongsinsirikul (2003), monetary policy shocks have a long-lasting effect on price level; however, they have a transient effect on output level in Thailand. Numerous studies on India's monetary transmission mechanism show that it is ineffective at increasing output but effective at increasing lending [10] (e.g., Sengupta, 2014; Bhoi et al., 2017). As revealed by Cato et al. (2008), interest rate fluctuations have a significant impact on inflation and output levels in Brazil, while the exchange rate is the main driver. Perera and Wickramanayake (2013) demonstrate that monetary policy is an important determinant of inflation and real output level in Sri Lanka as an emerging market environment in a thorough study of the monetary transmission mechanism. Additionally, they demonstrate the effectiveness of the exchange rate, asset price and credit channels.

Numerous studies use VARs or other methods to deduce how Turkey's monetary transmission system operates. Berument (2007) illuminates monetary policy from 1968 to 2000. Because monetary tightening has a negative impact on real output and price levels, the gap between the central bank's policy interest rate implemented in the interbank market and the depreciation of the Turkish lira is used as the monetary policy stance in this study. As indicated by Kara et al. (2007), the interest rate has a significant effect on the output gap level in Turkey after the implementation of the inflation targeting regime. According to Yilmazkuday (2011), Turkey's monetary policy is focused on reducing output volatility and smoothing interest rates via the adjustments in short-term interest

[9] For a more detailed literature review, see Brayton and Mauskopf (1985), Gertler and Gilchrist (1993), Christiano et al. (1999), Dodge (2002), Franta et al. (2014), Mishra et al. (2016) and Can et al. (2020).

[10] Khundrakpam and Jain (2012), Montes (2013), Das (2015) and Dua (2020) are among the other exemplary papers.

rate, and the credit channel affects the real economy positively under both explicit and implicit-inflation targeting regimes. As revealed by Akyurek et al. (2011), the explicit inflation-targeting regime is a persuasive instrument to enhance monetary policy transmission in Turkey. Among the comprehensive studies conducted for Turkey, Kilinc and Tunc (2014) examine the various internal and external shocks' impacts on inflation and real output level, concluding that an interest rate innovation reduces inflation and real income, while a global demand shock effects both, similar to an upward change in commodity prices. According to Domac et al. (2019), monetary policy has a modest influence on the real output level, while external variables such as global economic growth and risk aversion have a larger impact on the Turkish economy. Can et al. (2020) take a similar strategy to Kilinc and Tunc (2014), except that they employ a variety of models to test for resilience with alternative variables and demonstrate for Turkey that the interest and exchange rate channels have a powerful impact on inflation. However, the asset price channel as well as the liquidity channel are the most important determinants of the output level.

The rest of the paper is structured in the following manner. Section 3.2 explains the theoretical framework of the monetary transmission mechanism. Section 3.3 discusses the data and the empirical motivation in detail. Section 3.4 demonstrates the monetary transmission mechanism's efficacy and analyzes the relative significance of various channels and variance decompositions in important macroeconomic indicators, followed by concluding remarks in Section 3.5.

### 3.2. Theoretical Framework

The macroeconomic texture of the monetary transmission mechanism is assumed by the Post-Keynesian endogenous money theory as a function of short-term interest rates, output, and inflation. The doctrine of Post-Keynesian endogenous money theories emphasizes the way the macroeconomic structure of the monetary transmission mechanism is discussed by the New Keynesians and New Consensus Macroeconomists.

The New Consensus Macroeconomics explains why the long-run results of output and employment are policy neutral by pointing out that inflation is set to be the paramount goal and short-term interest rate is used as the only instrument of monetary policy (Fontana, 2007). The New Keynesian and New Consensus Macroeconomics' macro-structural connotation is that the macroeconomic structure of the monetary transmission mechanism is defined by the reciprocal relationship among short-term interest rates as well as inflation and output, as long as the main elements of the New Consensus Macroeconomic structure are presumptions of real wage negotiations, supply-driven equilibrium, inflation determined by demand and also money neutrality (Setterfield, 2006). The relationship between these elements has been represented by (Clarida et al., 1999) using a three-equation model, which completely defines the macroeconomic structure of the monetary transmission mechanism.

By using a Phillips Curve (PC), an interest rate based monetary rule (MR) and the IS Curve, the Post-Keynesian interpretation of the macroeconomic structure of the monetary transmission mechanism is expressed in the general functional form:

$$\pi_t = \beta\pi_{t-1} + \rho(y_{t-1} - y^*_{t-1}) + v_t \tag{63}$$

$$y_t = \alpha y_{t-1} + \theta(R_{t-1} - \pi_{t-1}) + d_t \tag{64}$$

Equation (63) denotes the Phillips curve, $\pi_t$ is the inflation in the current period, $\beta\pi_{t-1}$ is the lagged inflation, $(y_{t-1} - y^*_{t-1})$ is the lagged output gap, and $v_t$ is the cost push shock. Equation (64) is the IS curve equation, $y_t$ is the output in the current period, $\alpha y_{t-1}$ is the lagged output, $(R_{t-1} - \pi_{t-1})$ is the real interest rate and $d_t$ is the demand shock. The structural portrayal of the monetary policy variable is characterized by the monetary rule used, and the rule used is stated by the aspect of the monetary transmission mechanism. Monetary policy tools are commonly alterations in short-term interest rate, when there is a static view of the monetary transmission mechanism. As Taylor (1995) demonstrated, a standard rule for monetary policy can be used in such a passive structure:

$$R_t = \beta\pi_{t-1} + \gamma(y_{t-1} - y^*_{t-1}) + \varepsilon_t \tag{65}$$

where $R_t$ is the monetary policy interest rate. The impact of monetary policy on inflation is represented by the coefficient $\beta$ and effect on output is symbolized by coefficient $\gamma$. These three equations, which outline the dynamics of inflation, interest rates, and the output gap, represent the macrostructural dynamics of monetary transmission. The ideal reduced form structure of the mechanism is commonly used by abounding vector autoregressive (VAR) model-based empirical frameworks:

$$[\pi_t, y_t, R_t] = \alpha + \beta\pi_{t-p} + y_{t-p} + R_{t-p} + \varepsilon_t \quad (66)$$

These variables, forming the theoretical scheme, are the main objects of monetary policy and have been cited as having causative effects on inflation and output. Monetary policy easing causes an increase in both inflation and output, whereas monetary policy tightening causes a decrease in both variables, inflation and output. This theoretical arrangement is accepted as a solid state, and an unforeseen monetary policy tightening has transmissible effects on interest rates, which causes a constant decline in real GDP and price level.

## 3.3. Data and Methodology

### 3.3.1. The Data

The quarterly data from 2006Q1 to 2018Q2 is compiled to perform the empirical analysis. Quarterly data is preferable to monthly data since it has lower volatility and similar base periods. The aforementioned period is chosen to assess the monetary transmission mechanism's efficacy in the absence of any regime changes, whether in terms of exchange rates, inflation, or monetary base targeting. 2018Q3 and subsequent periods are omitted from this study due to the idiosyncratic shocks observed in 2018Q3 and their continuing impacts. The data is compiled from Banking Regulation and Supervision Agency (BRSA), Central Bank of the Republic of Turkey (CBRT), Federal Reserve Bank of St. Louis (FRED), International Monetary Fund (IMF), Istanbul Stock Exchange (BIST) and Turkish Statistical Institute (TURKSTAT). Table 3 contains brief descriptions of the variables.

Table 3
*Labels, definitions and sources of the variables*

| Variable label | Variable definition | Source |
|---|---|---|
| XU100 | Stock market index | BIST |
| SXU100 | Sectoral stock market index | BIST |
| CRD | Total private loans deflated by CPI | BRSA |
| SCRD | Sectoral credits deflated by CPI | BRSA |
| EPR | Effective policy rate (CBRT)[11] | CBRT |
| EXR | Nominal exchange rate[12] | CBRT |
| IPI | Industrial production index (2010=100) | CBRT |
| M1 | Basic money supply | CBRT |
| M3 | Broad money supply | CBRT |
| EFFR | Effective federal funds rate | FRED |
| WCPI | World commodity price index (2010=100) | IMF |
| CPI | Consumer price index (2010=100) | TURKSTAT |
| GDP | Gross domestic product deflated by the CPI | TURKSTAT |
| SPPI | Sectoral producer price index (2010=100) | TURKSTAT |
| SGDP | Sectoral output level deflated by the CPI | TURKSTAT |

The three-month average is used for the data, which is not publicly available every quarter. With the exception of the exchange rate, interest rates, stock market indices, all variables are seasonally adjusted using the X-13 method as suggested by Tena and Tremayne (2009). They are specified logaritmically in accordance with Carpenter and Demiralp (2012). Traditional unit root tests, i.e., Augmented Dickey-Fuller (ADF) and Kwiatkowski et al. (KPSS), reveal that the original versions of some data have a unit root at their level, but the hypothesis of a unit root is rejected in the first difference of all data. According to Johansen's well-known λ-max and λ-trace tests, the variables are cointegrated. Following the exemplary papers by Sims et al. (1990) and Lutkepohl and Reimers (1992), the log-levels of the variables can be used for obtaining a consistent estimate.

[11] The effective policy rate denotes either the weighted average funding cost for after 2010 or the overnight borrowing rate for the 2006-2010 period, as implemented by CBRT. For the period starting in 2011, the weighted average funding cost is used in place of the overnight repurchase rate for the period beginning in 2011, because the CBRT funded the market at variable amounts and various rates as an unconventional liquidity management tool.

[12] The nominal exchange rate is a currency basket, equally consisting of EUR:TRY and USD:TRY because both currency pairs have a significant impact on the Turkish economy due to Turkey's connection to the rest of the world through capital flows, commodity prices and international trade.

### 3.3.2. The VAR Models

Following the influential work by Sims (1980), the economic effects of monetary policy are evaluated by using vector autoregressive models, which are regarded as a trustworthy method for detecting and capturing underlying interactions among the selected variables (Bernanke and Gertler, 1995). Vector autoregressive models are a powerful technique for performing multivariate analysis and forecasting. As a result, this model is often employed to estimate the monetary transmission mechanism in developed and developing economies. The general vector auto regression equation is as follows:

$$\delta_t y_t = \varphi + \sum_{i=1}^{n} \delta_i y_{t-i} + \sum_{j=0}^{n} \beta_j x_{t-j} + \mu_t \tag{67}$$

where $y_t$ is the vector of endogenous variables, $x_t$is the vector of exogenous variables, $\varphi$ is the vector of constants and $\mu_t$ is the vector of white noise error term. $\delta_i$ points out the lag operator's polynomial matrix and $\beta_j$ is the coefficients' matrix.

Various vector autoregression models are constructed to assess the effectiveness of monetary policy for the variables targeted, i.e., real output and inflation, that are influenced by the central bank. All models share the premise that the system is recursive, and Cholesky decomposition is used to identify the impacts of the shocks[13]. To begin, the unrestricted baseline vector autoregressive model with four variables, VAR(4), is constructed with targeted domestic variables, $y_t{}' = (GDP_t, CPI_t, M1_t, EPR_t)$, where the first two variables are the central bank's primary target variables and are expected to be affected by any change in monetary policy stance. As indicated by Ito and Sato (2008), and Laopodis (2013), the VAR(4) model's last two variables are included to analyze the monetary transmission channels, i.e., the liquidity and interest rate channels, in previous literature. The VAR(4) model's variables are ordered in a way that makes sense in terms of the central bank's response to output and inflation cycles. Second, the VAR(4) model is expanded with the exchange rate ($EXR_t$), i.e., the VAR(5) model, to capture the impact of the exchange rate channel. Also, the exchange rate is a significant driver of economic

[13] Stock and Watson (2001) and Hanson (2006) point out that the recursive, reduced and structural vector autoregressive models use a variety of assumptions in order to describe the possible consequences of monetary policy. The Cholesky decomposition separates the structural errors by orthogonalizing them iteratively. Unlike the untransformed innovation in the first equation, the second and following equations are treated as orthogonal to those in the first and subsequent equations sequentially.

integration in the Turkish economy through import prices, risk perception and sentiment, among other things. Later, the VAR(5) model is expanded with external variables, i.e., global commodity prices and the effective federal fund rate, which is called VARX(7).

In order to reveal the relative magnitude of each channel of the monetary transmission mechanism, a shutdown vector autoregressive (VAR(7)) model is built, $y_t{}' = (GDP_t, CPI_t, M1_t, CRD_t, XU100_t\ EPR_t, EXR_t)$, in which $CRD_t$ is the credit channel, $XU100_t$ is the asset price channel, $EPR_t$ is the interest rate channel and $EXR_t$ is the exchange rate channel. Following the blocking-off approach by Ramey (1993), each transmission channel's impact on the real output and price levels is determined.

For the sectoral monetary transmission mechanism, a vector autoregressive (VAR(6)) model is constructed, $y_t{}' = (SGDP_t, SPPI_t, SCRD_t, SXU100_t, EPR_t, EXR_t)$, in which $SGDP_t$ is the sectoral contributions to GDP, $SCPI_t$ is the sectoral producer price index, $SCRD_t$ is the sectoral credit allocations and $SXU100_t$ is related sectoral index in BIST100. The fundemental aim is to focus on the main sectoral aggregates that include agriculture, industry, construction and services sectors[14].

### 3.3.3. The SVAR Model

Based on pioneering research on the monetary transmission mechanism (Kim and Roubini, 2000; Fraser et al., 2014), a structural vector autoregressive (SVAR) model is constructed for Turkey. While being generally consistent with economic theory, the structural vector autoregressive method works very well for diagnosing the impact of policy shocks by adding desirable constraints. It identifies complex connections and linkages between policy and important macroeconomic variables. Additionally, the structural vector autoregressive method is more appropriate for small and open economies, such as Turkey, than other known identification approaches, since the prominent features of these economies may be more accurately described using the structural vector autoregressive approach (Elbourne and de Haan, 2006).

Cushman and Zha (1997) developed a structural vector autoregressive method with block exogeneity that allows one to cover external factors which have an impact on

[14] When compiling data on these sectors, NACE Rev.2. codes developed by Eurostat is taken into consideration. In terms of NACE Rev.2. codes, agriculture sector includes A, industry sector covers B, C, D and E, construction sector contains F, services sector covers G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U. For more detailed information, see Carré (2008) and van den Brakel (2010).

the domestic variables in the system. It is presumed that domestic variables have no effect on external variables. Additionally, block exogeneity is more appropriate since it lowers the number of parameters that must be estimated, as indicated by Mackowiak (2007) and Sosa and Cashin (2009). Thus, the structural vector autoregressive model with seven variables, SVARX(7), is an extended version of the VAR(5) model with two external variables, i.e., global commodity prices and the effective federal fund rate, which is similar to the VARX(7) model. A world commodity price index ($WCPI_t$) is employed for Turkey, as a major commodity importer, and is sensitive to global commodity prices via import prices. Moreover, the federal funds rate ($EFFR_t$) is selected as the second external variable since it is a capital flow indicator and also serves as a proxy for global demand. Both sides of a typical vector autoregressive model specification are multiplied by $\delta_0^{-1}$, resulting in the simplified version of the reduced form of the structural vector autoregressive model:

$$y_t = \gamma + \theta_1 y_{t-i} + \rho x_t + \varepsilon_t \tag{68}$$

where $\theta_1 = \delta_1 \delta_0^{-1}$, $\gamma = \delta_0^{-1}\varphi$, $\rho = \beta\delta_0^{-1}$ and $\varepsilon_t = \delta_0 \mu_t$. Following the exemplary paper by Amisano and Giannini (1997), the structural disturbances are derived to identify the matrix by imposing required restrictions.

$$\begin{bmatrix} u_{WCPIS} \\ u_{EFFRS} \\ u_{GDPS} \\ u_{CPIS} \\ u_{M1S} \\ u_{EPRS} \\ u_{EXRS} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ NA & 1 & 0 & 0 & 0 & 0 & 0 \\ NA & 0 & 1 & 0 & 0 & 0 & 0 \\ NA & 0 & NA & 1 & 0 & 0 & 0 \\ 0 & 0 & NA & NA & 1 & NA & 0 \\ NA & 0 & 0 & 0 & NA & 1 & NA \\ NA & NA & NA & NA & NA & NA & 1 \end{bmatrix} x \begin{bmatrix} \varepsilon_{WCPI} \\ \varepsilon_{EFFR} \\ \varepsilon_{GDP} \\ \varepsilon_{CPI} \\ \varepsilon_{M1} \\ \varepsilon_{EPR} \\ \varepsilon_{EXR} \end{bmatrix} \tag{69}$$

The first and second rows depict the exogenous block, whose shocks originate externally. The third and fourth rows represent the equilibrium of the goods market with nominal rigidity. The fifth and sixth rows show the money market equilibrium, which conveys information about money demand and policy responses. The final row indicates the financial market equilibrium, which includes a risk perception sense. To perform a robustness check, the industrial production index ($IPI_t$) and broad money supply ($M3_t$) are substituted for gross domestic product ($GDP_t$) and narrow money supply ($M1_t$) in the alternative vector autoregressive and structural vector autoregressive models[15].

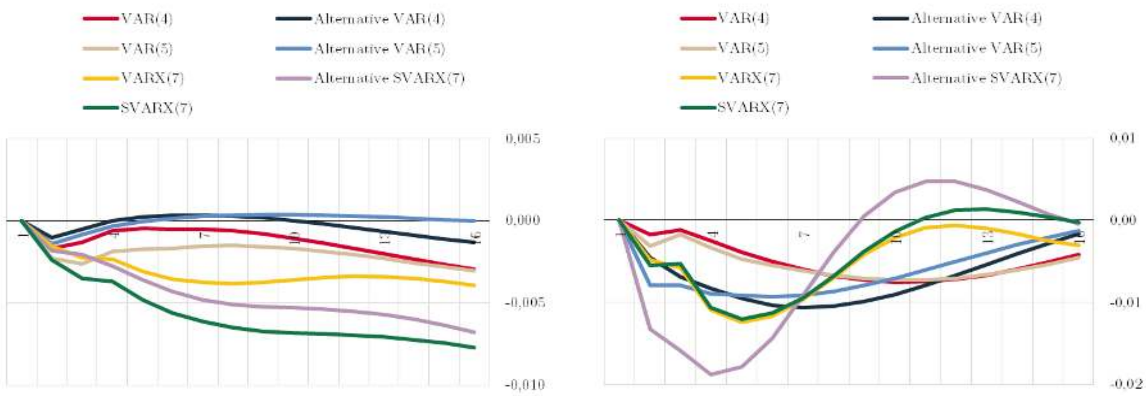
### 3.4. Empirical Findings

Before discussing the empirical findings, it's worth noting that the optimal lag length, according to Schwarz and Hannan-Quinn criteria, is one quarter. However, one lag may be deemed insufficient for understanding the underlying mechanics of the system, resulting in autocorrelation problems in the residuals. As a result, the vector autoregressive and structural autoregressive models are run with two lags, as carried out by Disyatat and Vongsinsirikul (2003), enabling them to show larger impulse response variations. The estimated models seem to be applicable since they pass diagnostic tests.

#### 3.4.1. General Monetary Transmission Mechanism

Impulse response functions and variance decomposition analysis are used to evaluate the effectiveness of the monetary transmission mechanism and the various transmission channels in Turkey. The impulse response functions (IRFs) represent the dynamic responses of endogenous variables to a one-time shock in the effective policy rate, implemented by Central Bank of the Republic of Turkey. The X and Y axes represent quarters and the variables' impulse responses, respectively[16].

(a) Consumer prices (b) Gross domestic product




[15] The coefficients and standard erros of the structural vector autoregressive model, i.e., equation (69), are in Appendix B.

[16] The impulse response functions and confidence intervals are shown in the Appendix B. While the dashed lines represent the confidence intervals, and together above and below x-axis show a statistically significant impact, the dotted lines denote the two standard error confidence intervals for the variables' responses.

(c) Narrow monetary base (d) Effective policy rate

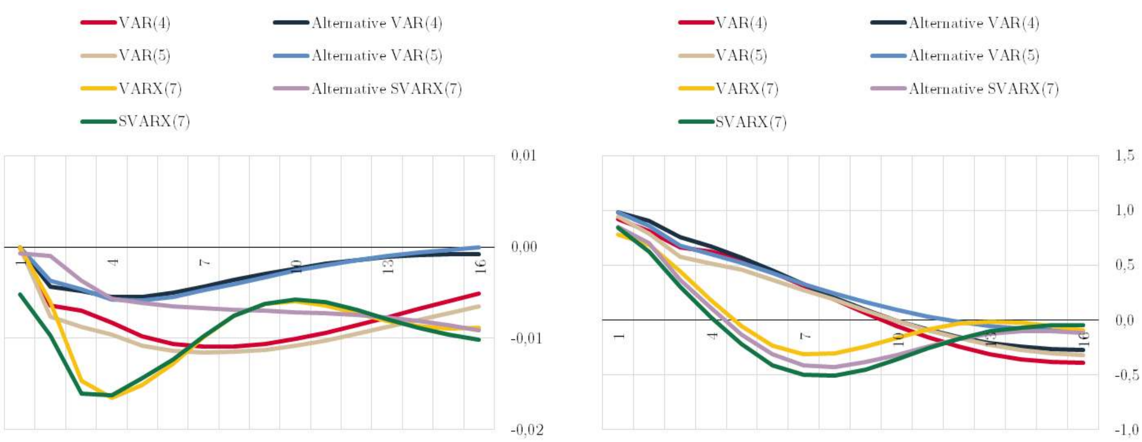



*Figure 3.* Effectiveness of the general monetary transmission mechanism with a combination of the various impulse response functions.

Figure 3 illustrates that a CBRT's policy interest rate increase results in a decrease in GDP, which is compatible with monetary theory; but, only the VARX(7) model is statistically significant. Tighter monetary policy gives rise to a U-shaped trajectory in real output that bottoms out between the fourth and sixth quarters. This trajectory is in line with the exemplary papers carried out by Disyatat and Vongsinsirikul (2003) for Thailand and Berument and Froyen (2006) for United States. Additionally, CPI exhibits a lasting downward trend after positive interest rate shocks, which is consistent with monetary theory; but not statistically significant. The uncertainty of the CPI's impulse response function grows as the horizon lengthens. Similar to the findings of this analysis, Yilmazkuday (2011) shows that the exchange rate shocks and the lagged inflation rate have a significant effect on the inflation rate, demonstrating the importance of inflation inertia and external shocks in a small-open economy experiencing times of high inflation. During the sample period examined, 2006-2018, when inflation was relatively low and steady on a downward spiral, it seems reasonable that monetary policy concentrates on real output, given the deflation induced by the global financial crisis. As revealed by Kim and Roubini (2000), M1 responds quickly to interest rate innovations. It seems contradictory; however, Leeper et al. (1996) refer to this monetary contraction as a liquidity effect. Furthermore, M1 may be seen as a balance-sheet channel since it comprises money in circulation and sight deposits, both of which are considered the banking system's core liabilities. The impulse response functions for M1 is statistically significant, and bottoms up between the fourth and sixth quarters. Meanwhile, interest rate innovation appears to continue until it returns to its initial level, which occurs after about 10–12 quarters. A statistically significant interest rate shock gives rise to a remarkable boost in the beginning, gradually decreases, and eventually becomes economically insignificant by the tenth quarter and afterwards. Additionally, the IRFs' convergence to zero as the horizon extends indicates the models are stable. The results of the analysis suggest that the policy actions implemented by CBRT have a direct effect on both monetary aggregates and interest rates, implying that monetary transmission mechanism operates in Turkey. It is statistically significant and compatible with economic theory due to the fact that the predicted model assumes Turkey to be an open small economy sensitive to external and global dynamics.

To reveal the explanatory power of monetary transmission channels on the target variables, the finding of the VAR(7) model, which covers all the channels, is as follows. According to the blocking-off methodology suggested by Ramey (1993), the analysis is carried out by extracting the variable whose effect is to be determined in the model[17].

(e) Consumer prices (f) Gross domestic product


*Figure 4.* Comparative analysis of the relative significance of various channels with combined impulse response functions.

According to Figure 4, in the case of a policy rate shock, the GDP initially declines, then reverses, hits a high in the third quarter, and begins to decline. These models seem to be statistically and economically significant. On the other hand, CPI responds rapidly, consistently, and negatively to policy shocks, which is not statistically insignificant but economically significant, implying that monetary policy has an impact on the price level under an inflation-targeting regime. When the exchange rate and asset

[17] The blocking channel is represented by W/O.

price channels are blocked, the responses of CPI and GDP are significantly distinct. Blocking the exchange rate channel shows that, starting in the second quarter, the exchange rate is the most important and explanatory variable for CPI. While the asset price channel looks insignificant till the seventh quarter, it gains importance in the long term for GDP, resulting in a positive wealth effect.

Additionally, the variance decompositions for each targeted variable are computed across a range of forecast horizons to ascertain the extent to which fluctuations in an endogenous variable are driven by given shocks in explanatory variables. The primary emphasis is on the extent to which changes in CPI and GDP are explained by which monetary policy channel across forecast horizons of two to sixteen quarters.

Table 4
*Variance decomposition of the price and real output*

| Variables | CPI | | | | GDP | | | |
|---|---|---|---|---|---|---|---|---|
| **Panel A. VAR(5) Model** | | | | | | | | |
| | **2** | **4** | **8** | **16** | **2** | **4** | **8** | **16** |
| GDP | 8,52 | 13,32 | 22,30 | 31,04 | 78,26 | 66,03 | 47,85 | 39,72 |
| CPI | 85,30 | 76,58 | 58,88 | 35,68 | 8,62 | 14,08 | 19,57 | 18,71 |
| M1 | 0,68 | 0,55 | 5,12 | 17,96 | 2,78 | 10,27 | 20,17 | 19,50 |
| EPR | 2,76 | 4,74 | 3,88 | 4,68 | 1,14 | 1,69 | 7,03 | 17,18 |
| EXR | 2,74 | 4,80 | 9,81 | 10,63 | 9,20 | 7,93 | 5,38 | 4,90 |
| **Panel B. VAR(7) Model** | | | | | | | | |
| **Variables** | **CPI** | | | | **GDP** | | | |
| | **2** | **4** | **8** | **16** | **2** | **4** | **8** | **16** |
| GDP | 1,92 | 3,08 | 4,81 | 4,33 | 60,49 | 41,98 | 31,17 | 26,83 |
| CPI | 85,30 | 73,95 | 54,76 | 38,79 | 13,73 | 12,37 | 11,14 | 12,37 |
| M1 | 0,23 | 0,16 | 2,17 | 10,55 | 5,01 | 13,56 | 24,40 | 26,77 |
| EPR | 9,04 | 16,63 | 19,23 | 18,93 | 0,29 | 0,57 | 0,70 | 4,36 |
| EXR | 1,55 | 4,04 | 15,14 | 25,38 | 0,01 | 2,09 | 4,88 | 4,65 |
| CRD | 0,90 | 1,06 | 2,96 | 1,36 | 2,83 | 2,14 | 3,67 | 3,90 |
| XU100 | 1,06 | 1,07 | 0,93 | 0,67 | 17,64 | 27,29 | 24,03 | 21,11 |
| **Panel C. SVARX(7) Model** | | | | | | | | |
| **Variables** | **CPI** | | | | **GDP** | | | |
| | **2** | **4** | **8** | **16** | **2** | **4** | **8** | **16** |
| WCPI | 4,98 | 8,03 | 5,40 | 1,82 | 9,20 | 5,63 | 9,12 | 8,19 |
| EFFR | 0,49 | 1,11 | 0,48 | 0,20 | 1,14 | 9,97 | 14,41 | 9,49 |
| GDP | 1,67 | 0,88 | 1,04 | 4,20 | 97,02 | 56,13 | 27,66 | 21,14 |
| CPI | 83,66 | 68,14 | 48,98 | 33,10 | 9,77 | 8,55 | 5,49 | 3,70 |
| M1 | 0,16 | 1,16 | 2,44 | 7,03 | 4,04 | 3,13 | 3,52 | 4,86 |
| EPR | 2,99 | 8,04 | 14,71 | 15,08 | 5,73 | 18,21 | 28,47 | 18,89 |
| EXR | 6,05 | 12,64 | 26,94 | 38,58 | 5,04 | 10,63 | 11,34 | 33,72 |

Table 4 reveals that the exchange rate, interest rate and liquidity shocks account for the majority of the variance in GDP over the next four years, while GDP shocks explain the majority of the remaining residuals in the VAR(5) model. This result is compatible with prior empirical evidence that interest rate and liquidity fluctuations have long-run effects on economic activity. On the other hand, demand and liquidity shocks explain the majority of CPI variations in the long run, as well as its own innovation. Furthermore, it seems as if the exchange rate has a substantial impact on the CPI over time. In the VAR(7) model, asset price and liquidity shocks are the main drivers of the fluctuations in real output. It is rather logical that M1 has a significant effect on real output through balance sheet and liquidity channels. The asset price channel, also considered a wealth effect, has a large explanatory power for real output, since rising asset values may act as a stimulant for investment and future spending, as emphasized by Tobin (1978). Additionally, since stock prices represent the discounted value of future cash flows, profit and revenue, the equity index may serve as a conduit for expectations or a leading indicator that influences future GDP growth. After sixteen quarters, exchange rate and interest rate shocks are the main drivers of inflation, indicating that both the nominal exchange rate and the policy actions carried out by the central bank are cornerstones in forming inflation expectations in Turkey. These results largely corroborate those of Perera and Wickramanayake (2013) in Sri Lanka, who used a similar approach to mine. As for the SVARX(7) model, interest rate shocks have a meaningful and much larger effect on inflation and real output than the VAR(5) model. Exchange rate innovation is still the main driver of the fluctuations in CPI and GDP over time. This result, known as exchange rate pass-through in the economic literature, is compatible with the findings for open small economies. The fed funds rate, which serves as a barometer of global demand and liquidity, and the world commodity price index, as an indicator of cost channel, have a similar, though small, effect on real output level over time.

### 3.4.2. Sectoral Monetary Transmission Mechanism

Similar to the general monetary transmission mechanism analysis, the effectiveness of the monetary transmission mechanism and the different transmission channels for different sectors are examined by impulse response functions and variance decomposition analysis. The dynamic responses of endogenous variables to a one-time shock in the effective policy rate, implemented by CBRT, are as follows.

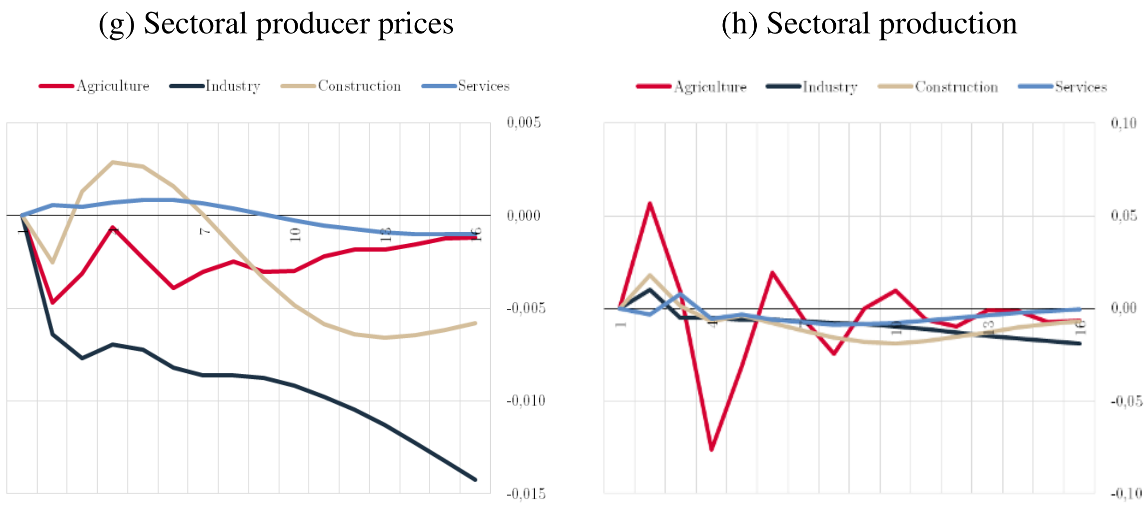


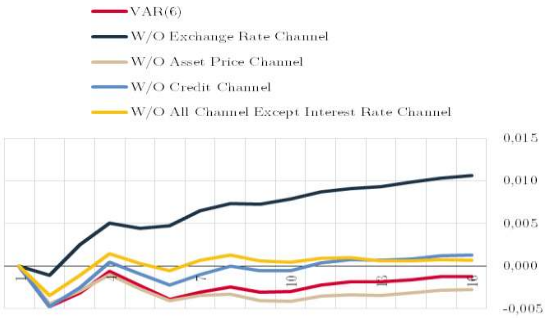

*Figure 5.* Effectiveness of the sectoral monetary transmission mechanism with combined impulse response functions.

Figure 5 shows that an increase in policy interest rate by the CBRT initially brings about a rise in sectoral contributions to GDP, except for the services sector. Monetary policy tightening initially brings an inverse U-shaped trajectory in output, which bottoms up in the second quarter and finally leads to a decline in sectoral output level. At first glance, it may seem counterintuitive, but the share of interest expenses in the total expenses of firms is very small, so it does not affect their production and pricing mechanism much. In fact, firms operating in the agriculture, industry and construction sectors need less working capital compared to those in the service sector. It is estimated that stock turnover ratios increase in response to an increase in the cost of inventory holding in an environment where interest rates rise. Therefore, changes in interest rates can be reflected in prices within a short period of time. In an environment where interest rates are increasing, firms operating in the agriculture, industry and construction sectors primarily increase their production by bringing forward their production in the next period and selling their stocks, resulting in sectoral production increasing. The rise in production creates a positive supply shock and causes sectoral producer prices to go down. On the other hand, there is price stickiness in the services sector due to non-tradable goods. Moreover, firms in the services sector are extremely sensitive to interest rate changes because of their higher working capital requirements and higher leverage. A positive shock in the interest rate and, therefore, the exchange rate reduces sectoral production and increases the transitivity of inflation is in line with the findings in Figure 5. Furthermore, because it affects household consumption and saving behavior, it also affects firms' intertemporal production and inventory decisions. The Figure 5 illustrates that CBRT's policy actions have a statistically and economically significant effect on both the sectoral output level and the sectoral pricing dynamics in Turkey.

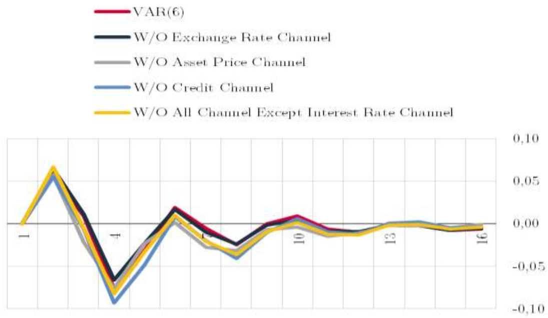
To determine the explanatory power of monetary transmission channels on the target variables, the VAR(6) model, containing all the channels for the different sectors, reveals the relative importance or explanatory power of each channel[18].

**Panel A. Agriculture Sector**

(i) Sectoral producer prices



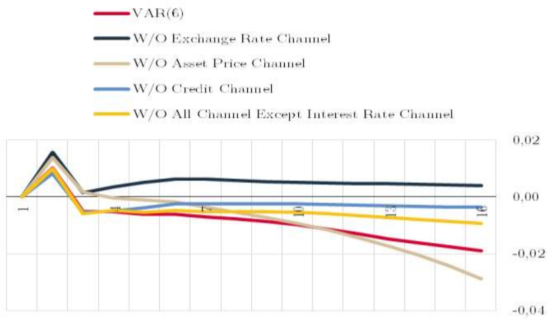

(j) Sectoral production




**Panel B. Industry Sector**

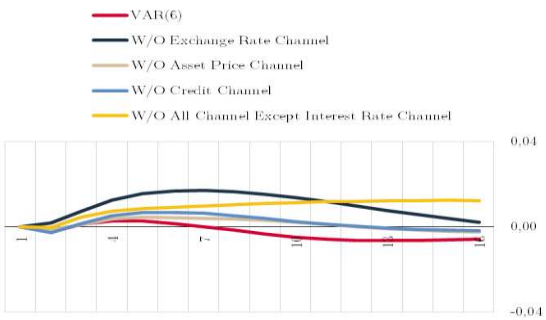
(k) Sectoral producer prices


(l) Sectoral production

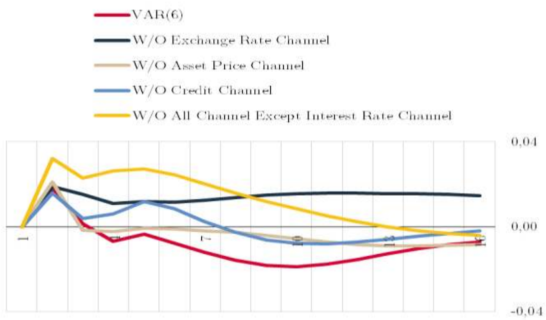



**Panel C. Construction Sector**

(m) Sectoral producer prices



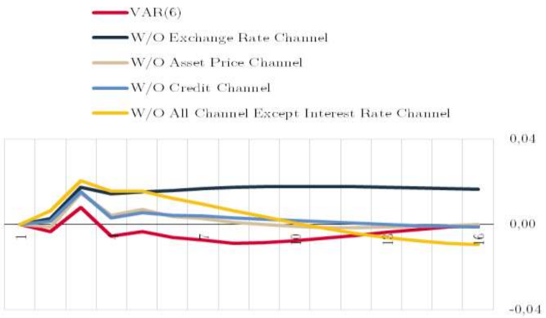

(n) Sectoral production




[18] Firstly, VAR(7) model is established for sectoral monetary transmission mechanism analysis in a similar way to the general monetary transmission mechanism analysis, but the liquidity indicator, $M1$, is removed from the model due to its low explicability.

**Panel D. Services Sector**

(o) Sectoral producer prices




(p) Sectoral production

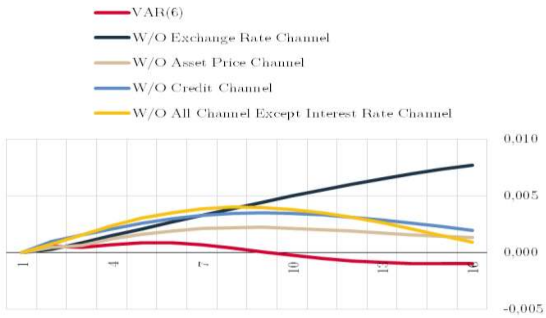



*Figure 6.* Comparison of relative importance of different channels with combined IRFs for different sectors

Figure 6 suggests that the SPPI and SGDP responses to an EPR shock are compatible with Figure 5 and Table 4. The responses of SPPI and SGDP are seriously distinct when blocking the exchange rate channel for all sectors and the interest rate channel for the construction sector, respectively. In a small open economy with a high dependence on imports in production, such as Turkey, the emergence of the exchange rate channel as the most important channel is in line with expectations. Moreover, the findings of the analysis coincide with the emphasis made on the importance of the interest channel, especially by representatives of the construction sector.

Additionally, the variance decompositions for each targeted variable are computed across a range of forecast horizons to ascertain the extent to which fluctuations in an endogenous variable are driven by given shocks in explanatory variables. The primary emphasis is on the extent to which changes in sectoral SPPI and SGDP as targeted variables are explained by which monetary policy channel across forecast horizons of two to sixteen quarters.

Table 5
*Variance decomposition of the sectoral producer prices and production*

| **Panel A. VAR(6) Model for Agriculture Sector** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Variables** | **SPPI** | | | | **SGDP** | | | |
| | **2** | **4** | **8** | **16** | **2** | **4** | **8** | **16** |
| SGDP | 34,98 | 31,09 | 24,84 | 15,37 | 74,84 | 68,86 | 67,90 | 67,61 |
| SPPI | 60,71 | 58,29 | 50,17 | 38,89 | 23,76 | 26,87 | 27,16 | 27,32 |
| SCRD | 0,11 | 0,53 | 0,75 | 0,79 | 0,00 | 0,45 | 0,43 | 0,43 |
| SXU100 | 1,64 | 1,93 | 2,39 | 1,77 | 0,04 | 0,63 | 0,92 | 0,96 |
| EPR | 0,62 | 0,85 | 1,42 | 6,10 | 1,36 | 2,63 | 2,83 | 2,85 |
| EXC | 1,94 | 7,32 | 20,42 | 37,09 | 0,00 | 0,56 | 0,76 | 0,82 |

| Panel B. VAR(6) Model for Industry Sector | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Variables** | **SPPI** | | | | **SGDP** | | | |
| | **2** | **4** | **8** | **16** | **2** | **4** | **8** | **16** |
| SGDP | 8,35 | 7,47 | 11,41 | 16,79 | 78,03 | 57,11 | 38,15 | 20,66 |
| SPPI | 79,33 | 68,55 | 51,98 | 54,31 | 2,79 | 3,07 | 4,06 | 37,73 |
| SCRD | 7,13 | 6,62 | 5,42 | 3,56 | 2,92 | 4,91 | 9,85 | 8,09 |
| SXU100 | 0,02 | 2,60 | 1,97 | 3,06 | 9,31 | 19,88 | 15,55 | 4,94 |
| EPR | 4,74 | 8,48 | 8,34 | 3,82 | 2,41 | 2,55 | 3,36 | 5,78 |
| EXC | 0,42 | 6,28 | 20,88 | 18,47 | 4,54 | 12,47 | 29,03 | 22,80 |
| **Panel C. VAR(6) Model for Construction Sector** | | | | | | | | |
| **Variables** | **SPPI** | | | | **SGDP** | | | |
| | **2** | **4** | **8** | **16** | **2** | **4** | **8** | **16** |
| SGDP | 5,00 | 5,65 | 3,35 | 2,57 | 79,02 | 66,07 | 56,51 | 50,06 |
| SPPI | 92,45 | 82,23 | 55,22 | 43,05 | 10,28 | 14,23 | 12,26 | 15,55 |
| SCRD | 1,58 | 1,98 | 3,13 | 3,42 | 2,82 | 2,56 | 2,58 | 2,59 |
| SXU100 | 0,53 | 0,86 | 0,86 | 4,96 | 1,30 | 1,25 | 2,39 | 6,11 |
| EPR | 0,22 | 6,13 | 10,52 | 7,03 | 4,41 | 12,14 | 12,67 | 12,26 |
| EXC | 0,21 | 3,15 | 26,92 | 38,97 | 2,16 | 3,75 | 13,59 | 13,44 |
| **Panel D. VAR(6) Model for Services Sector** | | | | | | | | |
| **Variables** | **SPPI** | | | | **SGDP** | | | |
| | **2** | **4** | **8** | **16** | **2** | **4** | **8** | **16** |
| SGDP | 9,18 | 19,48 | 28,47 | 27,02 | 78,06 | 61,95 | 51,31 | 46,14 |
| SPPI | 81,83 | 57,55 | 25,31 | 8,11 | 6,47 | 10,21 | 10,90 | 10,40 |
| SCRD | 1,61 | 4,52 | 6,88 | 8,22 | 0,04 | 1,85 | 1,73 | 2,71 |
| SXU100 | 0,61 | 0,92 | 1,01 | 0,81 | 0,19 | 1,17 | 2,50 | 3,82 |
| EPR | 6,65 | 15,40 | 22,76 | 12,21 | 15,06 | 17,29 | 15,54 | 13,65 |
| EXC | 0,12 | 2,13 | 15,58 | 43,63 | 0,17 | 7,53 | 18,02 | 23,27 |

In the agriculture, construction and services sectors, sectoral production and producer price shocks account for most of the variation in sectoral production. Moreover, the exchange rate and interest rate shocks explain a majority of the remaining residuals. Exchange rate shocks, on the other hand, are the primary drivers of variations in sectoral producer prices. This finding is consistent with previous empirical findings indicating that exchange rate and interest rate changes have lasting implications for sectoral economic activity in the long run.

### 3.5. Concluding Remarks

In this chapter, how and to what extent the monetary transmission mechanism is successful in Turkey under an inflation targeting environment is revealed. After reviewing carefully the related theoretical and applied literature on monetary theory, suitable models are developed for Turkey in the context of a small and open economy. Various vector autoregressive models are constructed, starting with a baseline model, VAR(4), consisting of real output, consumer prices, narrow monetary base and policy interest rate, and expanding it with the exchange rate, VAR(5), to better understand what accounts for Turkey's output and inflation fluctuations in a structural vector autoregressive model, SVARX(7), in which Turkey is assumed to have been affected by selected external shocks, such as global commodity prices and federal funds rate shocks, but not to influence the external world. Additionally, a shutdown vector autoregressive model, VAR(7), is built to illustrate how transmission channels operate and their impact on real output and price level. In the structural vector autoregressive model, SVARX(7), a world commodity price index is incorporated as a possible driver of prices and real output through import prices, as well as the fed funds rate as a measure of demand and global liquidity. To assess the efficiency of the monetary transmission mechanism across sectors, a vector autoregressive model, VAR(6), is constructed that incorporates all target variables and transmission channels.

The narrow monetary base, regarded as a liquidity indicator, and policy interest rates are the main determinants of the real output level in the baseline and extended vector autoregressive models, but price levels are controlled by changes in liquidity, income, and the nominal exchange rate.The policy interest rate implemented by the central bank and the nominal exchange rate have a significant effect on real output and consumer prices, whereas external variables have a similar, though small, effect on real output but not on inflation. These results reveal that the CBRT has the ability to influence Turkey's real output level and that monetary transmission is effective. Furthermore, while the exchange rate and interest rate channels have a significant impact on the price level, the asset price channel, liquidity, and money supply are the most important determinants of real output.

As for the sectoral transmission mechanism, CBRT’s policy actions have a statistically and economically significant effect on both the sectoral output level and the sectoral pricing dynamics in Turkey. An increase in policy interest rate initially brings about a rise in sectoral contributions to GDP, except for the services sector. Monetary policy tightening initially brings an inverse U-shaped trajectory in output, which bottoms up in the second quarter and finally leads to a decline in sectoral output level. In an environment where interest rates are increasing, firms operating in the agriculture, industry and construction sectors primarily increase their production by bringing forward their production in the next period and selling their stocks, resulting in sectoral production increasing. The rise in production creates a positive supply shock and causes sectoral producer prices to go down. On the other hand, firms in the services sector are extremely sensitive to interest rate changes because of their higher working capital requirements, higher leverage and price stickiness. A positive shock in the interest rate and, therefore, the exchange rate reduces sectoral production and increases the transitivity of inflation. Moreover, the exchange rate channel is the key driver of the price level and real output for all sectors, as well as the interest rate channel for the construction sector. As a policy recommendation, the fact that the exchange rate channel is important in both the general and sectoral monetary transmission mechanism requires the implementation of a monetary policy that prevents high volatility in the exchange rate in order to avoid negative production and price shocks on both a general and sectoral basis.

# CHAPTER IV

# OPTIMAL MONETARY POLICY

## 4.1. Introduction

Optimal monetary policy is a set of monetary policy rules that minimizes well-being, i.e., the loss function. The optimal interest rate, the most important tool in this set, is the rate that maximizes expected utility in intertemporal consumption choice. Monetary policy is close to optimal in developed countries because of low output gap and inflation deviations. However, it is quite difficult to implement optimal monetary policy in developing countries due to high inflation deviations, exchange rate volatility and output gap.

This chapter figures out several monetary rules' performances for a small open economy under the new Keynesian economic model. Taylor rule, which is the most widely used rule, was developed for closed economies in which financial assets are perfect substitutes and the exchange rate channel is considered to be irrelevant. Thus, it seems feasible to integrate these two ideas into an economy like Turkey, as a country that trades extensively with the rest of the world, which may find that standard Taylor rule cannot be the most efficient. However, since the financial market is so small, long-term and short-term government bonds are not always perfectly substituted.

Following the global financial crisis in 2008, the economic landscape underwent unprecedented changes. The role of financial frictions in the dynamics of the economic cycle has been the topic of much research. Developing innovative estimation techniques like general equilibrium models allows to underline the financial sector's role as an origin of business cycle volatility and a propagator of unfavorable shocks, which has hitherto been overlooked. There has been significant debate about how to preserve economic stability in the face of financial friction that is vulnerable to external shocks. As a consequence, a combination of macroprudential and monetary policy tools has been developed to achieve economic and financial stability.

As for the theoretical framework, the aggregate demand level is determined by a weighted average of long-term and short-term bond interest rates under the canonical new Keynesian model. The Phillips curve, which represents aggregate supply, implies that prices are inflexible and do not shift quickly in response to changes in demand and costs. The uncovered interest rate parity and nominal exchange rate serve to propagate external shocks across the local economy. The optimal allocations are determined by inspiring the seminal paper by Ramsey (1927) in a recursive form. Given the competitive economy's equilibrium circumstances, this allocation is a series of nominal interest rates that maximize the discounted total of the representative agent's utility. Following the exemplary paper by Batini et al. (2003), a complete set of 10 monetary rules is constructed and the welfare-based loss functions are computed.

When it comes to the estimation side, the prior knowledge as well as the maximum likelihood function are used to come up with a posterior distribution for the model's parameters, which is the source of the fluctuation. The likelihood function is computed by using the Kalman filter, and the posterior distribution for each rule is drawn by employing the random walk Metropolis-Hastings algorithm to construct Markov chains. Additionally, each rule in the model is compared using the Bayes factor and marginal probability. To decide which rule is the best and matches the data, some criteria such as minimizing the loss function and minimizing the difference between the prior and posterior distribution are taken into consideration.

The stochastic simulations show that the rules based on nominal exchange rate and domestic inflation forecasts perform well for Turkey in terms of both minimizing the loss function and responding to internal and external monetary policy shocks. However, the estimation findings illustrate that the domestic inflation forecast rule is the most compatible with data and is the most effective rule to respond to productivity, preferences and world price level shocks. Furthermore, domestic inflation forecasting and exchange rate rules outperform the Taylor rule in terms of minimizing the loss function and responding to shocks. Despite an explicit inflation targeting regime being followed in Turkey since 2006, Central Bank of the Republic of Turkey (CBRT) implements a comprehensive set of monetary rules against each kind of shock.

Nevertheless, external shocks may erode competitiveness and cause domestic interest rates to rise in lockstep. According to Banerjee et al. (2015), a negative international monetary shock would result in a decrease in capital flows and a devaluation of the currency in emerging markets. Additionally, optimum policies do not need international coordination. According to Kolasa and Wesolowski (2018), advanced economies' monetary stimulus with zero-bound interest rates has collateral effects on capital flows, resulting in a rise in the term premium's international co-movements and a currency rate appreciation in emerging economies.

As proposed by Schorfheide (2000), Smets and Wouters (2007), Fujiwara et al.

(2011), Brzoza-Brzezina and Kolasa (2013), Merola (2015), Villa (2016) and Zams (2021), Bayesian techniques are used in this chapter. As a result, the estimated parameters suggest that the international interest rate shock is less volatile, while the global price level shock is more persistent. For example, compared to the empirical findings in this chapter and in Miranda (2020) for Peru, whose econometric methodology is very similar, an exchange rate rule increases welfare and a domestic inflation forecast rule fits for data in Turkey; however, an exchange rate rule is optimal for both criteria in Peru.

The adjustment costs associated with the long-term and short-term government bond portfolios have contributed to the study of an open economy. Also, considering portfolio adjustment costs, when real interest rates breach the zero-lower limit, in fact, negative territory in the economy, large-scale asset purchases occur. By carrying out a dynamic stocastic general equilibrium (DSGE) model, Andres et al. (2004) assess the optimal monetary rule in a closed economy under the financial assets' imperfect substitution. This change adds another channel for aggregate demand and long-term returns to be affected by the relative prices of financial assets. Harrison (2012) carries out a new Keynesian model in a closed economy with imperfect long-term and short-term bond substitution to evaluate a policy in which asset purchases by central banks are considered as an unconventional monetary policy tool to help stabilize the inflation level and output gap, which are pushed to their lower limits by a negative demand shock.

Interest rates have not yet hit their lowest point in an economy like Turkey, but there remains a small margin to cover. The interest rate pass-through, i.e., the interaction between the policy interest rate implemented by CBRT and the long-term interest rate, is insufficient. Therefore, the importance of monetary policy is reduced. It is worth noting that CBRT has carried on an expansionary monetary policy since April 2020, ensuring that the policy interest rate continues to decline from September 2021 onwards.

At the moment, the domestic capital market is receiving a small amount of money as a consequence of non-resident investors' decreased demand for sovereign bonds. Compared to Vega (2015), this study evaluates the optimum monetary rule with a stronger focus on capital flows, the domestic economy's dollarization process, and the long-term bond market. These suppositions seem more reasonable in light of the political and economic situation in Turkey.

The rest of this chapter is structured sequentially. Section 4.2 manifests the new Keynesian economic framework for a small and open economy with the financial frictions, including how equilibrium is established, thus bringing out the monetary rules and loss function. Section 4.3 explains the calibration process of the parameters. Section 4.4 points out the data, the estimation, the comparison, and the priors for each rule in the model. Section 4.5 summarizes and examines the findings by following the concluding remarks in Section 4.6.

### 4.2. The Model

Following the exemplary papers by Gali (2015) and Harrison (2017), the open economy model with financial frictions is built. The uncertainty in this economy results in the supply and demand sides; monetary policy, preferences, productivity, international price level and interest rate shocks. Each example discusses the monetary policy implications, with a special address to the principles that the central banks presently employ to construct monetary policy. Given that the domestic economy trades with the rest of the world, it demonstrates how a simple extension of the new Keynesian model in an open economy can be used to emphasize the determination of optimal monetary policy and its contribution to economic fluctuations, welfare and inflation stability. By inspiring Harrison (2017)'s model, it is feasible to concentrate on determining the optimal monetary rule when households suffer from adjustment costs associated with their government bond portfolios due to budget constraints.

#### 4.2.1. Households

It is assumed that a set of identical households, which have infinite lives, populate the economy. It allows them to maximize their discounted utility function by analyzing their behavior as a representative agent.

$$\underset{\{B_t^S, B_t^l, A_{t+1}, C_t, N_t\}_{t=0}^{\infty}}{max} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t g_t \left\{ \frac{C_t^{1-\sigma}-1}{1-\sigma} - \frac{N_t^{1+\varphi}}{1+\varphi} \right\} \tag{70}$$

where $\beta$ is the discount factor, $\sigma$ is the risk aversion coefficient, $\varphi$ is the inverse elasticity of the labor supply, known as Frisch elasticity, and $g_t$ is the preferences shock affecting the natural real interest rate.

Equation (70) maximizes under the budget constraint, which covers the portfolio adjustment costs, $\psi_t$.

$$B_t^s + B_t^l + \mathbb{E}_t Q_{t,t+1} A_{t+1} + P_t C_t = R_{t-1} B_{t-1}^S + R_t^l B_{t-1}^l + A_t + W_t N_t + D_t - \frac{P_t(b^S+b^l)}{2}\left[\delta \frac{B_t^s}{B_t^l} - 1\right]^2 + \frac{P_t(b^s+b^l)}{2}\left[\frac{B_t^s/B_t^l}{B_{t-1}^s/B_{t-1}^l} - 1\right]^2 \tag{71}$$

where $B_t^S$ and $B_t^l$ are the short-term and long-term government bonds, $Q_{t,t+1}$ is the asset price, $A_{t+1}$ is the state-contingent assets, $\mathbb{E}_t$ is the conditional expectation of $Q_{t,t+1}$ and $A_{t+1}$, $C_t$ is the consumer goods, $P_t$ is the consumer price index, $B_{t-1}^l$ and $B_{t-1}^S$ are the nominal long-term and short-term government bonds purchased in previous period and their returns $R_t^l$ and $R_{t-1}$ per bond, $N_t$ is the working time, $W_t$ is the nominal salary, $T_t$ is the net taxes or transfers, $D_t$ is the dividends of the company, $\psi_t$ is the portfolio adjustment costs $R_t^l$ and $R_t$ are the long-term and short-term interest rates, $\delta$ is the long-term versus short-term government bonds ratio, $b^l$ and $b^S$ are the nominal long-term and short-term government bonds in the steady-state. While the left side of the equation (71) covers the spending, the right side of that covers the income in an economy[19]. $\lim_{T\to\infty} \mathbb{E}_t Q_{t,T+1}\{R_t B_t^S + R_{t+1}^l B_t^l + A_{t+1}\}$ restricts the net nominal liabilities of the households to an amount lower than the nominal interest rate, which implies that households renew net debts forever.

Consumer spending, $C_t$, includes spending on domestic and imported goods.

$$P_t C_t \; = \; P_{d,t} C_{d,t} \; + \; P_{m,t} C_{m,t} \tag{72}$$

where $P_{d,t}$ is the domestic price index, $P_{m,t}$ is the imported price index which is expressed in domestic currency, $C_{d,t}$ is the domestic goods' consumption index and $C_{m,t}$ is the imported goods' consumption index. All of these indices are specified as constant elasticity of substitution function.

$$C_t \equiv \left[(1-\alpha)^{\frac{1}{\eta}} C_{d,t}^{\frac{\eta-1}{\eta}} - a^{\frac{1}{\eta}} C_{m,t}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}} \tag{73}$$

$$P_t \equiv \left[(1-\alpha)^{\frac{1}{\eta}} P_{d,t}^{\frac{\eta-1}{\eta}} - a^{\frac{1}{\eta}} P_{m,t}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}} \tag{74}$$

---

[19] Noted that the government bonds are substituted imperfectly and have adjustment costs in a quadratic form. Because of brokerage costs, portfolio adjustment costs are a convex function.

where $\alpha$ is the openness degree, $\eta$ is the substitution degree between these goods. Domestic and imported goods' consumption is specified as follows.

$$C_{d,t} = \left(\int_0^1 C_{d,t}\,(i)^{\frac{\varepsilon-1}{\varepsilon}} di\right)^{\frac{\epsilon}{\epsilon-1}} \tag{75}$$

$$C_{m,t} = \left(\int_0^1 C_{m,t}\,(j)^{\frac{\varepsilon-1}{\varepsilon}} dj\right)^{\frac{\epsilon}{\epsilon-1}} \tag{76}$$

where $i \in [0,1]$ and $j \in [0,1]$ denote the domestic and imported goods varieties, $C_{d,t}(i)$ is domestic individual consumption and $C_{m,t}(j)$ is imported individual consumption, $\varepsilon$ is elasticity of substitution. The domestic and imported goods' price index reads as follows.

$$P_{d,t} = \left(\int_0^1 P_{d,t}\,(i)^{1-\varepsilon} di\right)^{\frac{1}{1-\epsilon}} \tag{77}$$

$$P_{m,t} = \left(\int_0^1 P_{m,t}\,(j)^{1-\varepsilon} dj\right)^{\frac{1}{1-\epsilon}} \tag{78}$$

where $P_{d,t}(i)$ is domestic price of good $i$ and $P_{m,t}(j)$ is imported price of good $j$, which is expressed all in domestic currency. The domestic and imported goods' demand is defined as follows.

$$C_{d,t}(i) = (1-\alpha)\left(\frac{P_{d,t}(i)}{P_{d,t}}\right)^{-\varepsilon}\left(\frac{C_{d,t}}{P_t}\right)^{-\eta} C_t \tag{79}$$

$$C_{m,t}(i) = \alpha\left(\frac{P_{m,t}(i)}{P_{m,t}}\right)^{-\varepsilon}\left(\frac{C_{m,t}}{P_t}\right)^{-\eta} C_t \tag{80}$$

The equations (79) and (80) show the optimal allocations based on the diversity of domestic and imported goods.

Taking the derivative of the utility function, equation (70) under the budget constraint, the first-order condition reads as follows.

$$\hat{c}_t = \mathbb{E}_t\hat{c}_{t+1} - \frac{1}{\sigma}\left[\hat{R}_t - \mathbb{E}_t\hat{\pi}_{t+1}\right] + \frac{\delta(1+\delta)}{\sigma}\left[\hat{b}_t^s - \hat{b}_t^l\right] + \frac{(1+\delta)}{\sigma}\Delta\left[\hat{b}_t^s - \hat{b}_t^l\right] - \frac{(1+\delta)}{\sigma}\beta\mathbb{E}_t\Delta\left[\hat{b}_{t+1}^s - \hat{b}_{t+1}^l\right] + \frac{1}{\sigma}(1-p_g)\hat{g}_t \quad (81)$$

where $E_t\hat{c}_{t+1}$ is the expected consumption, $\hat{R}_t$ is the nominal interest rate, $E_t\hat{\pi}_{t+1}$ is the expected inflation, $\hat{b}_t^s$ and $\hat{b}_t^l$ are the short-term and long-term real bond holding and $\hat{g}_t$ is the preferences shock, which follows an first-order autoregression (AR(1)) process, i.e., $\hat{g}_t = \rho_g\hat{g}_{t-1} + \varepsilon_t^g$ and $\varepsilon_t^g \sim iid\left(0, \sigma_g^2\right)$. Equation (81) is also known as Euler equation[20].

Expected long term nominal interest rate denoted as,

$$\mathbb{E}_t\hat{R}_{t+1}^l = \hat{R}_t - \delta\gamma\left[\hat{b}_t^s - \hat{b}_t^l\right] - \gamma\Delta\left[\hat{b}_t^s - \hat{b}_t^l\right] + \beta\gamma\mathbb{E}_t\Delta\left[\hat{b}_{t+1}^s - \hat{b}_{t+1}^l\right] \quad (82)$$

where $\gamma \equiv \frac{(1+\delta)^2}{\delta}$. Equation (82) reveals that the long-term interest rate expectation covers the long-term and short-term bonds held by households. As a result, a rise in the short-term bonds held by households lowers the nominal long-term interest rate, thus boosting demand.

### 4.2.2. Firms

It is assumed that the monopolistic competition environment is set in the goods markets. Each firm produces differentiated goods which are purchased by households and is indexed by $i \in [0,1]$. The production function is denoted as follows.

$$Y_t \equiv \left(\int_0^1 Y_t\,(i)^{\frac{\varepsilon-1}{\varepsilon}}di\right)^{\frac{\varepsilon}{\epsilon-1}} \quad (83)$$

where $Y_t$ is the aggregate domestic product. Firms have a constant return production function, which reads,

$$Y_t(i) \equiv A_t N_t(i) \quad (84)$$

[20] Following the method of Uhlig (1995), each variable, which is marked with a circumflex, is specified in log-linear form. $\hat{x}_t = \log(x_t) - \log(x_{ss})$ where $\hat{x}_t$ is the deviation of $x_t$ from $x_{ss}$, i.e., its steady-state value.

where $Y_t(i)$ is the output of firm $i$, $A_t$ is the technology level which evolves exogenously and $N_t(i)$ is the labor level of firm $i$. Following the seminal paper by Calvo (1983), a staggered pricing strategy is followed by domestic firms. The objective function of the firms represents,

$$\max_{\tilde{P}_{d,t}} \quad \mathbb{E}_t \sum_{k=0}^{\infty} Q_{t,t+k}\theta^k \left\{\tilde{P}_{d,t} - (1-S)\frac{W_{t+k}}{A_{t+k}}\right\} Y_{t+k|\,t} \tag{85}$$

where $\tilde{P}_{d,t}$ is the price that maximizes the market benefits' present value, $Q_{t,t+k}$ is the stochastic discount factor, $\theta$ is the probability of re-optimizing the price, $S$ is a subsidy that compensates for the distortion caused by companies' market dominance.

### 4.2.3. Important Identities

Terms of trade represents the difference between the imported and domestic price index.

$$\widehat{tt}_t = \hat{p}_{m,t} - \hat{p}_{d,t} \tag{86}$$

where $\widehat{tt}_t$ is the terms of trade, $\hat{p}_{m,t}$ and $\hat{p}_{d,t}$ are the imported and domestic price index.

The consumer price index consists of domestic and imported price indexes. It can also be represented in terms of the identity's terms of trade.

$$\hat{p}_t = (1-a)\hat{p}_{d,t} + a\hat{p}_{m,t} \tag{87}$$

$$\hat{p}_t = \hat{p}_{d,t} + a\widehat{tt}_t \tag{88}$$

where $\hat{p}_t$ is aggregate consumer price index, $a$ is openness degree.

The inflation rate shows the rate of change in CPI.

$$\hat{\pi}_t = \hat{p}_t - \hat{p}_{t-1} \tag{89}$$

$$\hat{\pi}_{d,t} = \hat{p}_{d,t} - \hat{p}_{d,t-1} \tag{90}$$

$$\hat{\pi}_t = \hat{\pi}_{d,t} + a(\hat{tt}_t - \hat{tt}_{t-1}) \quad (91)$$

where $\hat{\pi}_t$ is the inflation and $\hat{\pi}_{d,t}$ is the domestic inflation. The inflation can be written in terms of terms of trade, as indicated by equation (91).

The nominal exchange rate can be defined as,

$$\hat{e}_t = \hat{tt}_t - \hat{p}_t^* + \hat{p}_{d,t} \quad (92)$$

where $\hat{e}_t$ is the nominal exchange rate, $\hat{p}_t^*$ is the world price level represented by a shock, $\hat{p}_t^* = \rho_{p^*}\hat{p}_{t-1}^* + \varepsilon_t^{p^*}$ and $\varepsilon_t^{p^*} \sim iid(0, \sigma_{p^*}^2)$. It is a crucial assumption that the law of one price is valid for all periods.

Real exchange rate can be written as,

$$\hat{q}_t = \hat{p}_{m,t} - \hat{p}_t \quad (93)$$

$$\hat{q}_t = (1-a)\hat{tt}_t \quad (94)$$

where $\hat{q}_t$ is the real exchange rate.

Uncovered interest rates parity reads,

$$\hat{R}_t = \hat{R}_t^* + E_t\hat{e}_{t+1} - \hat{e}_t \quad (95)$$

where $\hat{R}_t^*$ is the international interest rate represented by a shock, which follows an AR(1) process, i.e., $\hat{R}_t^* = \rho_{R^*}\hat{R}_{t-1}^* + \varepsilon_t^{R^*}$ and $\varepsilon_t^{R^*} \sim iid(0, \sigma_{R^*}^2)$. It is assumed that a flexible exchange rate regime is related to perfect capital mobility. Beginning with the difference between international and domestic interest rates, the nominal exchange rate gradually adjusts.

Exports can be defined as,

$$X_t = aTT_{ss}^{\eta}Y_t^* \quad (96)$$

where $TT_{ss}$ is the steady state value of the terms of trade, $Y_t^*$ is the world product level. Equation (96) presumes that the preferences of domestic households and the rest of the world are identical, which implies the world product level is equal to international consumption, $C_t^* = Y_t^*$.

International risk sharing reads,

$$\hat{c}_t = \hat{y}_t^* + \frac{1}{\sigma} g_t + \left(\frac{1-\alpha}{\sigma}\right) \hat{tt}_t \tag{97}$$

The Phillips curve reads,

$$\hat{\pi}_{d,t} = \beta E_t \hat{\pi}_{d,t+1} - \lambda \hat{\mu}_t \tag{98}$$

where $\lambda \equiv (1 - \theta)(1 - \beta\theta)/\theta$, $E_t \hat{\pi}_{d,t+1}$ is the domestic inflation expectation, $\hat{\mu}_t$ is the markup gap.

### 4.2.4. Equilibrium

By combining the equations (79), (83) and (96), domestic goods market equilibrium reads,

$$\hat{y}_t = (1-\alpha)\hat{c}_t + \alpha(2-\alpha)\eta \hat{tt}_t + \alpha y_t^* \tag{99}$$

Terms of trade may be defined using the equation (97) and (99),

$$\hat{tt}_t = \sigma_\alpha(\hat{y}_t - \hat{y}_t^*) - (1-\alpha)\phi \hat{g}_t \tag{100}$$

where $\sigma_\alpha \equiv \sigma\phi$, $\phi \equiv \frac{1}{(1+\alpha(\omega-1))}$, and $\omega = \sigma\eta + (1+\alpha)(\sigma\eta - 1)$.

Using the equation (81) and (91), consumption function reads,

$$\hat{c}_t = \mathbb{E}_t \hat{c}_{t+1} - \frac{1}{\sigma}\left\{\frac{1}{1+\delta}\hat{R}_t - \mathbb{E}_t \hat{\pi}_{d,t+1} + \frac{\delta}{1+\delta}\mathbb{E}_t \hat{R}_{t+1}^l\right\} + \frac{\alpha}{\sigma}\mathbb{E}_t \Delta \hat{tt}_{t+1} + \frac{1}{\sigma}\left(1-\rho_g\right) \tag{101}$$

The equations (99), (100), and (101) results in the dynamic IS equation for a small open economy.

$$\hat{y}_t = \mathbb{E}_t \hat{y}_{t+1} - \frac{1}{\sigma_\alpha}\left\{\frac{1}{1+\delta}\hat{R}_t - \mathbb{E}_t \hat{\pi}_{d,t+1} + \frac{\delta}{1+\delta}\mathbb{E}_t \hat{R}_{t+1}^l\right\} + \Gamma_\omega \mathbb{E}_t \Delta \hat{y}_{t+1}^* + \frac{1-\alpha}{\sigma}\left(1-\rho_g\right)\hat{g}_t \tag{102}$$

where $\Gamma_{\omega} \equiv \alpha\omega - \alpha$. The dynamic IS curve covers the weighted average of the long-term and short-term interest rates. The equation (102) denotes the aggregate demand.

The markup gap can be defined as,

$$\mu_t = -(\sigma + \varphi)\hat{y}_t + \alpha(\omega - 1)\widehat{tt}_t + (1 + \varphi)\hat{a}_t - \alpha g_t \tag{103}$$

Using the equation (98) and (103), the Phillips curve reads,

$$\hat{\pi}_{d,t} = \beta \mathbb{E}_t \hat{\pi}_{d,t+1} + \kappa \hat{y}_t - \lambda\alpha(\omega - 1)\widehat{tt}_t - \lambda(1 + \varphi)\hat{a}_t + \lambda\alpha g_t \tag{104}$$

where $\kappa \equiv \lambda(\sigma + \varphi)$, $\hat{a}_t$ is the productivity shock that follows an AR(1) process, i.e., $\hat{a}_t = \rho_a \hat{a}_{t-1} + \varepsilon_t^a$ and $\varepsilon_t^a \sim iid(0, \sigma_a^2)$. Equation (104) indicates that while the production level has a positive impact on inflation, the terms of trade have a negative impact. Moreover, productivity and preference shocks influence inflation.

#### 4.2.5. Monetary policy

Following the exemplary paper by Batini et al. (2003) and Miranda (2020), different monetary rules that can be implemented by the central bank are revealed in Table 6. The main assumption is that the changes in policy interest rates are transmitted to an emerging economy, like Turkey, through short-term nominal interest rate and then real interest rate.

Table 6
*Definition of different policy rules*

| Rules | Formulations |
|---|---|
| Rule 1 | $\hat{R}_t = \varphi_\pi \hat{\pi}_t + \hat{\xi}_t$ |
| Rule 2 | $\hat{R}_t = \varphi_\pi \hat{\pi}_{d,t} + \hat{\xi}_t$ |
| Rule 3 | $\hat{e}_t = 0$ |
| Rule 4 | $\hat{R}_t = \varphi_\pi \hat{\pi}_t + \varphi_x \hat{x}_t + \hat{\xi}_t$ |
| Rule 5 | $\hat{R}_t = \varphi_\pi \hat{\pi}_{d,t} + \varphi_x \hat{x}_t + \hat{\xi}_t$ |
| Rule 6 | $\hat{R}_t = \varphi_R \hat{R}_{t-1} + \varphi_\pi \hat{\pi}_{d,t} + \varphi_x \hat{x}_t + \hat{\xi}_t$ |
| Rule 7 | $\hat{R}_t = \varphi_R \hat{R}_{t-1} + \varphi_{\pi F} \hat{\pi}_{d,t+1} + \varphi_x \hat{x}_t + \hat{\xi}_t$ |
| Rule 8 | $\hat{R}_t = \varphi_R \hat{R}_{t-1} + \varphi_\pi \hat{\pi}_{d,t} + \varphi_e \hat{e}_t + \hat{\xi}_t$ |
| Rule 9 | $\hat{R}_t = \varphi_{R1} \hat{R}_{t-1} + \varphi_{\pi 0} \hat{\pi}_{d,t} + \varphi_{\pi 1} \hat{\pi}_{d,t-1} + \varphi_{x0} \hat{x}_t + \varphi_{x1} \hat{x}_{t-1} + \varphi_{\Delta e} \Delta \hat{e}_t + \varphi_{tt} \widehat{tt}_t + \hat{\xi}_t$ |
| Rule 10 | $\hat{R}_t = \varphi_R \hat{R}_{t-1} + \varphi_\pi \hat{\pi}_{d,t} + \varphi_x \hat{x}_t + \varphi_e \hat{e}_t + \hat{\xi}_t$ |

$\varphi_\pi$ is the inflation coefficient, $\varphi_x$ is the output gap coefficient, $\varphi_R$ is the interest rate smoothing coefficient, $\varphi_{\pi F}$ is the domestic inflation forecast based coefficient, $\varphi_e$ is the exchange rate coefficient, $\varphi_{tt}$ is the terms of trade coefficient, $\hat{\xi}_t$ is the monetary policy shock that follows an AR(1) process, i.e., $\hat{\xi}_t = \rho_\xi \hat{\xi}_{t-1} + \varepsilon_t^\xi$ and $\varepsilon_t^\xi \sim iid(0, \sigma_\xi^2)$.

Rule 1 is the consumer price index inflation targeting regime. Rule 2 is the domestic inflation targeting regime. Rule 3 is the fixed nominal exchange rate regime, the benefits of which are discussed by Banerjee et al. (2015). Rule 4 is an extended version of Rule 2 with an output gap, also known as a Taylor-type inflation targeting regime, which does not cover the exchange rate channel. Rule 5 is a Taylor-type domestic inflation targeting regime. As indicated by Orphanides (2003), Rule 6 covers the inertial component of the interest rate. Rule 7 is a domestic inflation forecast-based rule, as revealed by Batini and Haldane (1998). Rule 8 covers the nominal exchange rate channel in the monetary transmission mechanism. Rule 9 is a modified version of Cabrera et al. (2011) and indicates that interest rates are a function of the fluctuations in domestic inflation, nominal exchange rate, output gap and terms of trade. Rule 10 is the extended version of Rule 8 with an output gap.

### 4.2.6. Welfare

The profit-based loss function can be used to evaluate and compare the welfare level of various monetary rules. To get the most acceptable welfare criterion, it is feasible to derive second order approximation of the domestic representative consumer's discounted utility loss related to deviations from optimal policy.

$$L = \sum_{t=0}^{\infty} \beta^t \frac{(1-\alpha)\epsilon}{2\lambda} \hat{\pi}_{d,t}^2 + \frac{(1-\alpha)(1+\varphi)}{2} \hat{x}_t^2 \tag{105}$$

Under the financial frictions in a small and open economy, it can be assumed $\sigma = \eta = 1$. The loss function, $L$, is denoted by the output gap and domestic inflation at equation (105) and it can be expressed in terms of their variance by taking the unconditional expectation of equation (105) and leaving $\beta \to 1$.

$$V = \frac{(1-\alpha)\epsilon}{2\lambda} var(\hat{\pi}_{d,t}) + \frac{(1-\alpha)(1+\varphi)}{2} var(\hat{x}_t) \tag{106}$$

The loss function, $L$, accounts for a significant portion of welfare loss. This is unavoidable, but significantly mitigated when the central bank commits to policy objectives that include maintaining low interest rates for a long time.

### 4.3. Calibration

To explore the optimal monetary rule for Turkey, this part presents an illustrative configuration[21]. The discount factor, $\beta$, which is one of the main parameters for households, is calibrated at 0.9928, which means that the annual risk-free real interest rate is about 3% (Alp and Elekdag, 2011; Yuksel, 2013; Can et al., 2021). Compatible to current literature, it is assumed that the intertemporal elasticity of substitution, $\sigma$, is 1 (Alp and Elekdag, 2011; Yuksel, 2013). The inverse of labor supply elasticity, $\varphi$, is assumed to be 1, which indicates a unit elastic labor offer that could be more sensitive to wages (Alp and Elekdag, 2011; Yuksel, 2013). To allow the openness of degree parameter, $\alpha$, to replace a natural index indicating the external openness of the economy, the elasticity of substitution between goods in the domestic market, $\varepsilon$, is calibrated at 1. As indicated by Cebi (2012) and Yagcibasi and Yildirim (2017), the Calvo parameter, $\theta$, is assumed to be 0.5, which means the average duration of the change in prices is about two-quarters. As shown by Alp and Elekdag (2011) and Yuksel (2013), the openness degree parameter, $\alpha$, is 0.75, which implies a 75% share of household goods in the consumer basket. The elasticity of intratemporal substitution between imported and domestic goods $\eta$, is set to 1, implying an environment where one can easily substitute imported goods with domestic goods. The long-term versus short-term government bond holding rate, $\delta$, is assumed to be 3 in the literature for emerging markets (Kuttner, 2006; Harrison, 2012).

The monetary rule parameters are in line with the studies of Henderson and McKibbin (1993), Taylor (1993) and Ball (1999). As indicated by Cebi (2012), Yagcibasi and Yildirim (2017) and Can et al. (2021), the interest rate smoothing parameter, $\varphi_R$, is calibrated at 0.7, implying that the policy response of the central bank to various innovations does not directly occur. Moreover, the inflation deviations and output gap parameters, $\varphi_\pi$ and $\varphi_e$, are calibrated at 1.5 and 0.25, respectively, which are widely used

---

[21] The parametrization process depends on various studies for Turkey, historical values of the variables and my own estimates. Although there are very few studies that include the DSGE model for Turkey, some of the parameters' values are assigned based on studies conducted for emerging economies.

values for Taylor-type rules in emerging markets. Based on Batini et al. (2003) and Cabrera et al. (2011), the coefficient of domestic inflation forecast based, $\varphi_{\pi F}, \varphi_{R1}$, $\varphi_{\pi 0}$, $\varphi_{\pi 1}$, $\varphi_{x0}$, $\varphi_{x1}$, $\varphi_{\Delta e}, \varphi_{tt}$, are set 5, 0.763, 0.107, 0.028, 0.346, 0.062, 0.053, and 0.082 respectively, for an emerging economy.

The autocorrelation coefficients of the monetary policy shock, $\rho_{\xi}$, technological shock, $\rho_a$, preferences shock, $\rho_g$, international interest rate shock, $\rho_{R^*}$ and world price level shock autocorrelation, $\rho_{p^*}$ are respectively calibrated at 0.5, 0.9, 0.9, 0.9 and 0.95.

## 4.4. Data and Methodology

### 4.4.1. The Data

To carry out the empirical analysis, the data set is compiled from the database of CBRT on a quarterly basis for 2006Q1-2021Q2. The reason for choosing this period is that the optimal monetary rule can be determined without being exposed to any regime changes. This choice is consistent with the explicit inflation targeting regime's validity.

The set of observables, $y_t = \{y_t\}_{t=1}^{T}$, is denoted as,

$$y_t = [logY_t, logC_t, log\pi_t, logR_t]' \tag{107}$$

where $y_t$ is the vector of observables, $Y_t$ is production, $C_t$ is private consumption expenditure, $\pi_t$ is consumer price index inflation and $R_t$ is the policy interest rate[22]. The production and private consumption expenditure data are seasonally adjusted with the Census X-13 method, and detrended with a one-sided Hodrick-Prescott filter[23]. All parameters are linearized around their steady-state values.

Also, the parameters to be estimated, i.e. the exogenous shocks' autocorrelation slopes and standard deviations, are included in the parameter vector, $\Theta$.

$$\Theta = \left[\rho_{\xi}, \rho_a, \rho_g, \rho_{R^*}, \rho_{p^*}, \sigma_{\xi}, \sigma_a, \sigma_g, \sigma_{R^*}, \sigma_{p^*}\right]' \tag{108}$$

The choice of a priori values is based on many considerations. First, the structural

[22] Private consumption expenditure is equal to the sum of household and non-profit institutions serving households' consumption.

[23] For more detailed information about the data transformation process, see Pfeifer (2014).

parameters choice reflects the judgment of researchers on the structure of the Turkish economy. Second, the absence of studies analyzing the microeconomic foundations in order to learn the estimated parameters for Turkey has been overcome by using the results of other studies of emerging countries. Last, the choice of a priori is also reflected by the imposition of non-negativity constraints. This is because the beta distribution was used to confine parameters within a unit interval. The inverse gamma distribution was chosen to consider the accuracy of the shocks.

It is assumed that the autocorrelation coefficients of all shocks have a beta distribution, but their standard deviations have an inverse gamma distribution. In Table 7, the a priori distributions of parameters and standard deviations are revealed in detail.

Table 7
*A priori densities of the model parameters*

| Parameters | Distribution (Limit) | Mean | SD |
|---|---|---|---|
| $\rho_{\xi}$ | Beta [0.1] | 0.50 | 0.01 |
| $\rho_a$ | Beta [0.1] | 0.90 | 0.01 |
| $\rho_g$ | Beta [0.1] | 0.90 | 0.01 |
| $\rho_{R^*}$ | Beta [0.1] | 0.90 | 0.01 |
| $\rho_{p^*}$ | Beta [0.1] | 0.95 | 0.01 |
| $\sigma_{\xi}$ | Inverse Gamma [0.∞] | 0.10 | 0.02 |
| $\sigma_a$ | Inverse Gamma [0.∞] | 0.40 | 0.02 |
| $\sigma_g$ | Inverse Gamma [0.∞] | 0.20 | 0.02 |
| $\sigma_{R^*}$ | Inverse Gamma [0.∞] | 0.20 | 0.02 |
| $\sigma_{p^*}$ | Inverse Gamma [0.∞] | 1.00 | 0.02 |

#### 4.4.2. The Methodology

For various apparent reasons, the Bayesian approach was used in this work. Several researchers indicate that Bayesian methodology have an advantage that it allows complete characterization of uncertainty in estimating structural parameters in estimating structural parameters by simulating posterior distributions. This methodology also provides an elegant way to incorporate a priori parameter information from both microeconomic studies and previous macroeconomic exercises and, therefore, creates a connection between calibration-based literature and rigorous policy analysis.

Another point to note is that DSGE models usually have a singularity because they generate predictions on a large number of observable endogenous variables compared to the exogenous shocks used to feed the model. This implies that there is a linear combination between the variables that is true in the absence of noise. The Bayesian method applies even in the case where the variance-covariance matrix of endogenous variables is singular, whereas this is a problem in the case where the maximum likelihood method is used.

The Bayesian approach assumes that each model has a set of unknown parameters $\theta \in \Theta$ associated with it. The objective of implementing a Bayesian estimate is to characterize the posterior distribution of the model parameters. From Bayes' theorem, the posterior distribution can be obtained as follows:

$$p(\Theta|y_t) = \frac{L(y_t|\Theta)p(\Theta)}{\int L(y_t|\Theta)p(\Theta)d\Theta} \propto (y_t|\Theta)p(\Theta) \tag{109}$$

where $p(\Theta)$ indicates the density a priori of the vector parameter $\Theta$, $L(y_t|\Theta)$ is the likelihood of the sample $y_t$ with $T$ observations and $\int L(y_t|\Theta)p(\Theta)d\Theta$ corresponds to the unconditional density of a sample.

Knowledge of the posterior distribution makes it possible to implement Bayesian inference. In general, the goal of Bayesian inference can be expressed by $E[g(\Theta)|y_t]$ where $g(\theta)$ is a function of interest, defined by:

$$E[g(\Theta)|y_t\,] = \int g(\Theta)p(\Theta|y_t)d\Theta = \frac{\int g(\Theta)p^*(\Theta|y_t)d\Theta}{\int p^*(\Theta|y_t)d\Theta} = \frac{\int g(\Theta)L(y_t|\Theta)p(\Theta)d\Theta}{\int L(y_t|\Theta)p(\Theta)d\Theta} \tag{110}$$

where $p^*(\Theta|y_t) \propto p(\Theta|y_t) \propto L(y_t|\Theta)p(\Theta)$ is any posterior Kernel density for $\Theta$. To get the posterior density results, the random walk Metropolis-Hastings algorithm by constructing Monte Carlo Markov chains, in short, RWMH-MCMC, is implemented.

The Kalman filter is used for this purpose in order to obtain the likelihood in order to obtain the results inherent in the posteriori distribution. Indeed, the model described above can be rewritten in a state-space form as follows:

$$\wp_t = F(\Theta) + G(\Theta)\varepsilon_t \tag{111}$$

$$Y_t = H(\Theta)\wp_t \tag{112}$$

where $F(\Theta)$, $G(\Theta)$ and $H(\Theta)$ are non-linear functions of the vector $\Theta$ of the structural parameters. $\wp_t$ represents the vector of state variables, including endogenous and estimated variables. $\varepsilon_t \sim iid(0, I)$ represents the vector of the innovation shocks. The state-space representation is described by the transition equation (111) and the measurement equation (112).

### 4.5. Empirical Findings

To indicate which monetary rule is most effective, the value of the loss function is calculated under all and individual shocks, respectively.

#### 4.5.1. All Shocks

Table 8 shows the effectiveness of various monetary policy rules in the presence of all shocks.

Table 8
*Monetary rules under all shocks*

| Rules | $\sigma(\hat{y})$ | $\sigma(\hat{x})$ | $\sigma(\hat{\pi}_d)$ | $\sigma(\hat{\pi})$ | $\sigma(\hat{tt})$ | $\sigma(\Delta\hat{e})$ | $L$ |
|---|---|---|---|---|---|---|---|
| Rule 1 | 2.304 | 0.686 | 3.968 | 3.985 | 2.545 | 4.128 | 0.040 |
| Rule 2 | 2.480 | 0.611 | 3.905 | 4.068 | 2.727 | 4.280 | 0.039 |
| Rule 3 | 2.238 | 0.682 | 0.984 | 0.930 | 2.478 | 0.000 | 0.004 |
| Rule 4 | 2.315 | 0.644 | 3.789 | 3.809 | 2.558 | 3.961 | 0.037 |
| Rule 5 | 2.472 | 0.569 | 3.733 | 3.892 | 2.720 | 4.109 | 0.035 |
| Rule 6 | 2.486 | 0.544 | 1.024 | 1.542 | 2.735 | 2.048 | 0.003 |
| Rule 7 | 2.483 | 0.549 | 0.841 | 1.426 | 2.732 | 1.960 | 0.003 |
| Rule 8 | 2.356 | 0.499 | 0.795 | 1.081 | 2.604 | 1.369 | 0.002 |
| Rule 9 | 2.494 | 0.561 | 1.178 | 1.842 | 2.826 | 2.848 | 0.021 |
| Rule 10 | 2.357 | 0.466 | 0.758 | 1.041 | 2.605 | 1.349 | 0.002 |

According to Rule 1 and Rule 2, the deviations of the variables are generally high compared to other rules. The greatest volatility results from reacting to consumer price index inflation. As a result, responding to domestic inflation efficiently minimizes the loss function. Generally, central banks enforce inflation tolerance ranges to keep inflation from changing excessively. In Rule 3, the deviations of the variables decrease compared to the first two rules, and the nominal exchange rate is zero. However, since this regime weakens the effectiveness of the monetary policy, it will not be considered later. As for Rule 4 and Rule 5, the deviations of the variables decrease compared to the first two rules. As a result, responding to the output gap with domestic inflation efficiently minimizes the loss function. The advanced economies' central banks use these rules for adverse shocks. In the Rule 6 and Rule 7, the deviations of the variables decrease compared to the previous two types of rules. Responding to future inflation, to the nominal interest rate's smoothing component, and to the output gap is more effective for minimizing the loss function. As stated by Batini et al. (2009), incorporating the exchange rate into the monetary rule yields significant benefits in a highly dollarized economy, like Turkey. According to Rule 8 and Rule 10, responding to the exchange rate and output gap efficiently minimizes the loss function. As for Rule 9, responding to the nominal exchange rate variation is less effective for minimizing the loss function. Briefly, Rule 8 and Rule 10, which respond to the exchange rate and output gap deviations, seem the most effective rules to minimize the loss function.

### 4.5.2. Individual Shocks

To get a better understanding of why certain rules perform better than others, it is feasible to re-evaluate the rules using the lower loss function. Assuming the economy is struck by one sort of shock at a time, it is feasible to determine which rules create responsive reactions to each of the shocks and whether the rules that perform well do so due to their robustness to diverse shocks. This is a test of the robustness of each rule's specification.

Table 9
*Monetary rules under individual shocks*

| Shocks | Rules | $\sigma(\hat{y})$ | $\sigma(\hat{x})$ | $\sigma(\hat{\pi}_d)$ | $\sigma(\hat{\pi})$ | $\sigma(\hat{tt})$ | $\sigma(\Delta\hat{e})$ | $L$ |
|---|---|---|---|---|---|---|---|---|
| Monetary policy shock | Rule 2 | 0,462 | 0,462 | 0,924 | 1,137 | 0,462 | 1,222 | 2,6E-03 |
| | Rule 5 | 0,420 | 0,420 | 0,840 | 1,034 | 0,420 | 1,111 | 2,2E-03 |
| | Rule 7 | 0,294 | 0,294 | 0,535 | 0,687 | 0,294 | 0,747 | 9,3E-04 |
| | Rule 8 | 0,318 | 0,318 | 0,431 | 0,638 | 0,318 | 0,715 | 7,1E-04 |
| | Rule 10 | 0,296 | 0,296 | 0,404 | 0,596 | 0,296 | 0,667 | 6,2E-04 |
| Productivity shock | Rule 2 | 2,254 | 0,040 | 0,376 | 0,765 | 2,254 | 0,994 | 3,5E-04 |
| | Rule 5 | 2,256 | 0,038 | 0,360 | 0,762 | 2,256 | 0,993 | 3,3E-04 |
| | Rule 7 | 2,269 | 0,046 | 0,064 | 0,678 | 2,269 | 0,922 | 1,6E-05 |
| | Rule 8 | 2,174 | 0,171 | 0,365 | 0,422 | 2,174 | 0,619 | 4,0E-04 |
| | Rule 10 | 2,179 | 0,161 | 0,352 | 0,441 | 2,179 | 0,642 | 3,7E-04 |
| Preferences shock | Rule 2 | 0,835 | 0,025 | 0,235 | 0,478 | 1,409 | 0,621 | 1,4E-04 |
| | Rule 5 | 0,837 | 0,024 | 0,225 | 0,476 | 1,410 | 0,620 | 1,3E-04 |
| | Rule 7 | 0,845 | 0,029 | 0,040 | 0,424 | 1,418 | 0,576 | 6,1E-06 |
| | Rule 8 | 0,787 | 0,107 | 0,228 | 0,264 | 1,359 | 0,387 | 1,6E-04 |
| | Rule 10 | 0,790 | 0,100 | 0,220 | 0,276 | 1,362 | 0,402 | 1,4E-04 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| International interest rate shock | Rule 2 | 0,397 | 0,397 | 3,757 | 3,789 | 0,397 | 3,801 | 3,5E-02 |
| | Rule 5 | 0,381 | 0,381 | 3,601 | 3,632 | 0,381 | 3,643 | 3,3E-02 |
| | Rule 7 | 0,461 | 0,461 | 0,644 | 0,960 | 0,461 | 1,083 | 1,6E-03 |
| | Rule 8 | 0,291 | 0,291 | 0,346 | 0,571 | 0,291 | 0,655 | 5,1E-04 |
| | Rule 10 | 0,271 | 0,271 | 0,325 | 0,533 | 0,271 | 0,611 | 4,4E-04 |
| World price level shock | Rule 2 | 0,016 | 0,016 | 0,290 | 0,290 | 0,016 | 1,003 | 2,1E-04 |
| | Rule 5 | 0,016 | 0,016 | 0,282 | 0,283 | 0,016 | 1,003 | 2,0E-04 |
| | Rule 7 | 0,022 | 0,022 | 0,032 | 0,047 | 0,022 | 0,963 | 3,8E-06 |
| | Rule 8 | 0,150 | 0,150 | 0,376 | 0,433 | 0,150 | 0,633 | 4,1E-04 |
| | Rule 10 | 0,142 | 0,142 | 0,366 | 0,418 | 0,142 | 0,654 | 3,8E-04 |

Table 9 reveals that Rule 10 is the most effective monetary rule to minimize the loss function under monetary policy and international interest rate shocks. However, Rule 7 is the most effective monetary rule to minimize the loss function under productivity, preferences and world price level shocks. When compared to the other rules, the deviations from the variables in Rules 7 and 10 are smaller.

In the case of individual shocks, the impulse response functions of the selected variables under the various monetary rules are revealed in Appendix C. Figure 39 illustrates the selected variables' impulse responses to a 100 basis points (bps) positive monetary policy shock. When policy interest rates rise, nominal and real interest rates rise, lowering consumption, products, the output gap, and the consumer price index. On the external side, the nominal exchange rate appreciates; however, terms of trade falls. On the financial side, the demand for short and long-term bonds declines, which therefore gives rise to an increase in long-term interest rates and a decrease in the consumer price index. As seen in Figure 39, Rule 8 and Rule 10 capture the aforementioned dynamics. The consumer price index follows a U-shaped trajectory and converges to a steady-state value. For Rule 2 and Rule 5, the decline in the consumer price index is below 100 bps and is permanent. For Rule 7, the decline in the consumer price index is also permanent and below 50 bps.

Figure 40 clarifies the selected variables' impulse responses to a positive productivity shock. A rise in productivity declines the natural real interest rate, boosts natural product and product, and drops the output gap and consumer price index. On the external side, the nominal exchange rate depreciates; however, terms of trade increase. On the financial side, as the central bank lowers the policy interest rate, demand for short- and long-term bonds rises, resulting in a drop in long-term interest rates and an increase in the consumer price index. As clarified in Figure 40, Rule 8 and Rule 10 capture the aforementioned dynamics. The consumer price index follows a declining trajectory and converges to a steady-state value. For Rule 2 and Rule 5, the decline in the consumer price index is below 100 bps and is permanent. For Rule 7, the decline in the consumer price index is also permanent and below 20 bps.

Figure 41 exhibits the selected variables' impulse responses to a positive preferences shock. A preferences shock boosts the natural real interest rate and natural product, diminishes the natural terms of trade, and therefore raises the output gap and consumer price index. On the external side, the nominal exchange rate appreciates; however, terms of trade falls. On the financial side, when the central bank increases the policy interest rate, the demand for short and long-term bonds declines, which therefore leads to an increase in long-term interest rates and a decrease in the consumer price index. As indicated in Figure 41, Rule 8 and Rule 10 capture the aforementioned dynamics. The consumer price index follows an upward and then downward trajectory and converges to a steady-state value. For Rule 2 and Rule 5, the rise in the consumer price index is above 100 bps and is permanent. For Rule 7, the rise in the consumer price index is also permanent and above 20 bps.

Figure 42 manifests the selected variables' impulse responses to a positive international interest rate shock. The latter gives rise to the capital outflow to the foreign economy and the depreciation of the nominal exchange rate, which persistently enhances the competitiveness of the real sector and net exports. As a result, the terms of trade, product, output gap, and consumer price index all rise. On the financial side, the central bank raises the policy interest rate, following a rise in the real interest rate. As indicated by Banerjee et al. (2015), when the international interest rate increases, investors seek returns abroad while the demand for long-term bonds of the domestic economy drops. A rise in capital outflows engenders a rise in the long-term interest rate. As revealed in Figure 42, Rule 10 captures the aforementioned dynamics, real interest rate and net exports, following an inverse U-shaped trajectory and converges to the steady-state value.

Figure 43 reveals the selected variables' impulse responses to a positive world price level. The latter raises the terms of trade and the nominal exchange rate, which are then followed by the product, output gap, and consumer price index. On the financial side, the central bank boosts the policy interest rate, and therefore the real interest rate, the demand for short and long-term bonds, and the long-term interest rate increase. As illustrated in Figure 43, Rule 8 and Rule 10 capture the aforementioned dynamics; the product output gap follows a declining trajectory and converges to the steady-state value.

### 4.5.3. Posterior Estimation

To indicate which rule is more effective to explain the variables' behavior, the posterior estimation result is gives in Table 10.

Table 10
*Posterior probability*

| Rules | $\log p(\Theta \vert y_t)$ | $BF$ | $p$ |
|---|---|---|---|
| Rule 1 | 198,002 | 1,000E+06 | 3,969E-12 |
| Rule 2 | 151,552 | 6,714E-21 | 2,665E-32 |
| Rule 3 | 75,532 | 6,485E-54 | 2,574E-65 |
| Rule 4 | 200,718 | 1,512E+01 | 6,000E-11 |
| Rule 5 | 154,896 | 1,902E-19 | 7,548E-31 |
| Rule 6 | 211,460 | 6,993E+05 | 2,776E-06 |
| Rule 7 | 224,255 | 2,519E+11 | 9,970E-01 |
| Rule 8 | 138,287 | 1,164E-26 | 4,621E-38 |
| Rule 9 | 133,794 | 4,845E-42 | 1,923E-83 |
| Rule 10 | 139,363 | 3,414E-26 | 1,355E-37 |

Table 10 reveals the logarithmic marginal probability, Bayesian factor and posterior probability, respectively. As seen in 10, Rule 7 is the best rule that explains the variables' behavior. As indicated before, Rule 7 is a domestic inflation forecast based rulet that includes inflation inertia, domestic inflation forecast and output gap as policy variables. The second optimal policy is Rule 6, which is an extended Taylor-type rule with inflation inertia. Moreover, there is no clear evidence for Rule 8, Rule 9 or Rule 10 to accept one of them. Due to high inflation inertia and the clear differences between expected, realized and forecasted inflation rates in Turkey, Rule 7 seems to be fit. Moreover, as revealed in Table 7, Rule 7 minimizes the loss function under productivity, preferences and world price level shocks.

Table 11 reveals the prior and posterior means and %90 intervals of the autocorrelation coefficients and standard deviations of the shocks. The prior mean is very similar to its posterior estimates for autocorrelation coefficients of all shocks. The prior mean of the standard deviation of all shocks, except the world price level shock, is higher than their posterior mean, which means low volatility in these shocks. Table 11 clearly illustrates that the world price level shock has the greatest volatility among all shocks, which seems plausible for Turkey, as a small and open economy.

Table 11
*Rule 7 estimate*

| Parameters | Prior Mean | Posterior Mean | Intervals (Lower-Higher) |
|---|---|---|---|
| $\rho_\xi$ | 0.50 | 0.4979 | 0.4816-0.5149 |
| $\rho_a$ | 0.90 | 0.8993 | 0.8824-0.9160 |
| $\rho_g$ | 0.90 | 0.8999 | 0.8839-0.9165 |
| $\rho_{R^*}$ | 0.90 | 0.8981 | 0.8821-0.9155 |
| $\rho_{p^*}$ | 0.95 | 0.9598 | 0.9472-0.9723 |
| $\sigma_\xi$ | 0.10 | 0.0818 | 0.0702-0.0929 |
| $\sigma_a$ | 0.40 | 0.3524 | 0.3267-0.3774 |
| $\sigma_g$ | 0.20 | 0.1373 | 0.1218-0.1509 |
| $\sigma_{R^*}$ | 0.20 | 0.1389 | 0.1232-0.1531 |
| $\sigma_{p^*}$ | 1.00 | 0.9978 | 0.9659-1.0311 |

By using the Laplace approximation and the RWHH-MCMC algorithm, the posterior distributions of the autocorrelation coefficients and variances of the variables are calculated. As revealed by Cristiano, Trabandt and Walentin (2010), the RWHH-MCMC algorithm is widely used for research papers. As indicated in Appendix C, the results of the Laplace approximation and the RWHH-MCMC algorithm are very close, which means the posterior distributions are consistent.

### 4.6. Concluding Remarks

This chapter focuses on the determination of the optimal monetary policy to minimize the loss function in Turkey. Following the extraordinary works by Gali (2015) and Harrison (2017), a New Keynesian dynamic stochastic general equilibrium (NK-DSGE) model in which Bayesian estimations are constructed is presented. Monetary policy, productivity, preferences, international interest rate and world price level shocks are introduced as an autoregressive process that has an impact on all economic agents. Following the exemplary papers by Batini et al. (2003) and Miranda (2020), ten different monetary rules implemented by central banks are examined for the purpose of minimizing the loss function.

Considering all shocks together, Rule 8 and Rule 10, which respond to the exchange rate and output gap deviations, seem the most effective rules to minimize the loss function. Considering all shocks individually, Rule 10 is the most effective monetary rule to minimize the loss function under monetary policy and international interest rate shocks. However, Rule 7 is the most effective monetary rule to minimize the loss function under productivity, preferences and world price level shocks. As to selected variables' impulse responses, Rule 7, Rule 8 and Rule 10 are suitable for explaining the propagation dynamics of the shocks. The posterior probability clearly illustrates that Rule 7, which includes the inflation inertia, forecasted domestic inflation and output gap, is the best monetary rule to explain the behavior of the variables. Under Rule 7, the prior mean of the autocorrelation coefficient of the shocks is very similar to the posterior mean; however, the standard deviations of the shocks, except the world price level shock, are greater than their posterior mean. The world price level shock has the greatest volatility among all shocks. During the period under review, commodity prices have been very volatile due to the Global Financial Crisis in 2008, Taper Tantrum by Fed in 2013 and Covid-19 pandemic since 2020.

For a long time, inflation inertia has been a major problem in controlling inflation in Turkey.The volatility of the inflation and output gap is so high lately due to exchange rate and world price level shocks. Recently, the output level has exceeded potential output levels, which has created upward pressure on inflation. Moreover, the domestic inflation forecast is considered as a barometer for the exchange rate and inflation rate expectations. Considering all these grounds, Rule 7 looks plausible for Turkey as an optimal monetary policy. Moreover, CBRT could implement a comprehensive set of monetary rules, such as Rule 8 and Rule 10, against each kind of shock.

# CHAPTER V

# CONCLUSION

## 5.1. Key Findings and Policy Recommandations

Macroeconomic policy is composed of two distinct components: monetary and fiscal policies. Monetary policy, which gained prominence with monetarist and new Keynesian economics, is the backbone of economic literature. Among the hot subjects in this field, central bank independence, monetary transmission mechanism and optimal monetary policy are explored in this dissertation via the use of a diverse sample size and a variety of analytic methodologies.

The degree to which central bankers are free from government control is known as central bank independence. After the late 1980s, central bank independence became a crucial institutional formula for fighting inflation, sparking a surge of changes at central banks across the world. In Chapter Two, following the seminal paper by Acemoglu et al. (2008), the relationship between inflation, budget balance and central bank independence is examined in both theoretical and empirical frameworks.

In the case of the perfect information case, the model produces the anticipated (and experimentally confirmed) negative relationship between inflation and central bank independence. Two distinct effects, i.e., delegation and seesaw effects, are already at work: As the central bank gains independence, it is able to conduct relatively less monetary expansion (the delegation effect), but this results in a greater reliance on fiscal expansion on the part of the government, as both monetary and fiscal policies are used to close the output gap. However, the fact that a rise in fiscal expansion is less than a decrease in monetary expansion brings about a lower anticipated inflation level.

On the other hand, in the case of informational asymmetry, the marginal cost of the government is first introduced, and then the model produces a zero correlation between the central bank independence and the anticipated inflation rate. The informational asymmetry defines endogenously the range of costs that the government must bear in order to circumvent the authority of the central bank. If the magnitude of this cost exceeds the interval that was previously determined endogenously, that is, if the institutional quality does not conform to the informational asymmetry, the model produces a zero relationship between inflation and central bank independence. That’s why the central bank is no longer able to offer a policy that compels the government at high fiscal cost to tell the truth and accept the contract.

The findings of the dynamic panel models reveal that there is a negative relationship between inflation and central bank independence. The negative impact of central bank independence on inflation is statistically significant and is in line with a priori expectations. When the seesaw and delegation effects are distinguished, the seesaw effect is statistically significant and positive. Model 3, on the other hand, shows that a lower budget deficit leads to lower inflation, which is consistent with the work of Sikken and de Haan (1998) and Lucotte (2009). Acemoglu et al. (2008) cover the period 1972–2001 when budget deficits were generally monetized. This dissertation covers the period 2000-2012 when the direct funding of the budget deficit by central banks was prohibited legally. Therefore, the empirical findings of this dissertation differ from those of Acemoglu et al. (2008). A rise in central bank independence by 1% is associated with a decline in inflation by 1.93 ppts in the dynamic panel model with fixed effects, and 1.08 ppts in Arellano-Bond GMM model. As a policy recommendation, the central bank should be strengthened both functionally and legally and ensured to be more independent to combat inflation and the budget deficit.

The monetary transmission mechanism describes by which channels and how monetary policy impacts the real economy as a whole. Monetary policy literature discusses a variety of transmission channels. Mishkin (1995) defined the most well-known channels as asset price, credit, exchange rate and interest rate channels. Chapter three reveals how and to what extent the monetary transmission mechanism is effective in Turkey under an inflation targeting environment.

The narrow monetary base, regarded as a liquidity indicator, and policy interest rates are the main determinants of the real output level in the baseline and extended vector autoregressive models, but price levels are controlled by changes in liquidity, income, and the nominal exchange rate.The policy interest rate implemented by the central bank and the nominal exchange rate have a significant effect on real output and consumer prices, whereas external variables have a similar, though small, effect on real output but not on inflation. These results reveal that the CBRT has the ability to influence Turkey's real output level and that monetary transmission is effective. Furthermore, while the exchange rate and interest rate channels have a significant impact on the price level, the asset price channel, liquidity, and money supply are the most important determinants of real output.

As for the sectoral transmission mechanism, CBRT’s policy actions have a statistically and economically significant effect on both the sectoral output level and the sectoral pricing dynamics in Turkey. An increase in policy interest rate initially brings about a rise in sectoral contributions to GDP, except for the services sector. Monetary policy tightening initially brings an inverse U-shaped trajectory in output, which bottoms up in the second quarter and finally leads to a decline in sectoral output level. In an environment where interest rates are increasing, firms operating in the agriculture, industry and construction sectors primarily increase their production by bringing forward their production in the next period and selling their stocks, resulting in sectoral production increasing. The rise in production creates a positive supply shock and causes sectoral producer prices to go down. On the other hand, firms in the services sector are extremely sensitive to interest rate changes because of their higher working capital requirements, higher leverage and price stickiness. A positive shock in the interest rate and, therefore, the exchange rate reduces sectoral production and increases the transitivity of inflation. Moreover, the exchange rate channel is the key driver of the price level and real output for all sectors, as well as the interest rate channel for the construction sector. As a policy recommendation, the fact that the exchange rate channel is important in both the general and sectoral monetary transmission mechanism requires the implementation of a monetary policy that prevents high volatility in the exchange rate in order to avoid negative production and price shocks on both a general and sectoral basis.

Optimal monetary policy is a set of monetary policy rules that minimizes well-being, i.e., the loss function. The optimal interest rate, the most important tool in this set, is the rate that maximizes expected utility in intertemporal consumption choice. Monetary policy is close to optimal in developed countries because of the low output gap and inflation deviation. However, it is quite difficult to implement optimal monetary policy in developing countries due to high inflation deviation, exchange rate volatility and output gap. Chapter Four focuses on the determination of the optimal monetary policy to minimize the loss function in Turkey.

Considering all shocks together, Rule 8 and Rule 10, which respond to the exchange rate and output gap deviations, seem the most effective rules to minimize the loss function. Considering all shocks individually, Rule 10 is the most effective monetary rule to minimize the loss function under monetary policy and international interest rate shocks. However, Rule 7 is the most effective monetary rule to minimize the loss function under productivity, preferences and world price level shocks. As to selected variables' impulse responses, Rule 7, Rule 8 and Rule 10 are suitable for explaining the propagation dynamics of the shocks. The posterior probability clearly illustrates that Rule 7, which includes the inflation inertia, forecasted domestic inflation and output gap is the best monetary rule to explain the behavior of the variables. Under Rule 7, the prior mean of the autocorrelation coefficient of the shocks is very similar to the posterior mean; however, the standard deviations of the shocks, except the world price level shock, are greater than their posterior mean. The world price level shock has the greatest volatility among all shocks, During the period under review, commodity prices have been very volatile due to the Global Financial Crisis in 2008, Taper Tantrum by Fed in 2013 and Covid-19 pandemic since 2020.

For a long time, inflation inertia has been a major problem in controlling inflation in Turkey.The volatility of the inflation and output gap is so high lately due to exchange rate and world price level shocks. Recently, the output level has exceeded potential output levels, which has created upward pressure on inflation. Moreover, the domestic inflation forecast is considered as a barometer for the exchange rate and inflation rate expectations. Considering all these grounds, Rule 7 looks plausible for Turkey as an optimal monetary policy. Moreover, CBRT could implement a comprehensive set of monetary rules, such as Rule 8 and Rule 10, against each kind of shock.

### 5.2. Limitations and Directions for Future Research

Certain limitations of the study have opened some avenues for future research. In the second chapter, the dataset is quite limited, that is to say, it covers only 13 years, because the compilations of the central bank independence index and structural budget deficit are quite straightforward. The latest up-to-date central bank independence index data, which is compiled from the work by Garriga and Rodriguez (2020), covers the period 1980-2012; however, the structural budget deficit data is available since 2000. These limitations can affect the findings. Therefore, this analysis should be repeated as soon as a more up-to-date central bank independence data set is published. Moreover, the dynamic panel model with fixed effects (DFE) and Arellano-Bond GMM are implemented as econometric methodologies. Other dynamic panel models, e.g., mean group estimator (MG) or pooled mean group estimator (PMG) techniques, can be carried out.

In the third chapter, 2018Q3 and subsequent periods are omitted due to the idiosyncratic shocks observed in 2018Q3 and their continuing impacts. As the number of observations expands, the macroeconomic variables will converge their long-run path. Therefore, a more consistent analysis can be conducted. Furthermore, various vector autoregressive (VAR, VARX, SVAR, SVARX) models are implemented as an econometric methodology. To evaluate the overall interaction in the economy using the Bayesian estimation methodology, dynamic stochastic general equilibrium (DSGE) and Bayesian vector autoregressive (BVAR) techniques can be used as an alternative estimation strategy.

In the fourth chapter, the dataset covers 2006Q1-2021Q2; however, trend changing events took place later. In order for the findings to be more consistent, the analysis should be repeated at a later time and the optimal monetary policy that minimizes the loss function should be determined again.

# REFERENCES


Acemoglu, D., Johnson, S., Querubin, P., & Robinson, J. A. (2008). When does policy reform work? The case of central bank independence. *Brookings Papers on Economic Activity*, *1*, 351-417.

Akyurek, C., Kutan, A. M., & Yilmazkuday, H. (2011). Can inflation targeting regimes be effective in developing countries? The Turkish experience. *Journal of Asian Economics, 22*(5), 343-355.

Alesina, A. (1988). Macroeconomics and politics. *NBER Macroeconomics Annual*, *3*, 13-52.

Alesina, A., & Summers, L. H. (1993). Central bank independence and macroeconomic performance: Some comparative evidence. *Journal of Money, Credit and Banking*, *25*(2), 151-162.

Alesina, A., Mirrlees, J., & Neumann, M.J.M. (1989). Politics and cusiness cycles in industrial democracies. *Economic Policy*, *4*(8), 55-98.

Almeida, A., Fry, M. J., & Goodhart, C. (1996). Central banking in developing countries: Objectives, activities and independence. *Routledge*.

Alp, H., & Elekdag, S. (2011). The role of monetary policy in Turkey during the global financial crisis. In the Great Recession: Lessons for central bankers. *The MIT Press*, 51-80.

Alpanda, S., & Honig, A. (2014). The impact of central bank independence on the performance of inflation targeting regimes. *Journal of International Money and Finance*, *44*, 118-135.

Amisano, G., & Giannini, C. (1997). From VAR models to structural VAR models. *In Topics in Structural VAR Econometrics.* Berlin: Springer-Verlag.

Andres, J., Lopez-Salido, J. D., & Nelson, E. (2004). Tobin's imperfect asset substitution in optimizing general equilibrium. *Journal of Money, Credit and Banking*, *36*(4), 665-690.

Arawatari, R., Hori, T., & Mino, K. (2018). On the nonlinear relationship between inflation and growth: A theoretical exposition. *Journal of Monetary Economics*, *94*, 79-93.

Ayres, K., Belasen, A. R., & Kutan, A. M. (2014). Does inflation targeting lower inflation and spur growth?. *Journal of Policy Modeling*, *36*(2), 373-388.

Bade, R., & Parkin, M. (1978). Central Bank Laws and Monetary Policies: A Preliminary Investigation. *The Australian Monetary System in the 1970s*. Monash University.

Bade, R., & Parkin, M. (1988). Central bank laws and monetary policies. *Working Paper*, *University of Western Ontario*, Canada.

Bagheri, F. M., & Habibi, N. (1998). Political institutions and central bank independence: A cross-country analysis. *Public Choice*, *96*(1), 187-204.

Ball, L. (1999). Efficient rules for monetary policy. *International Finance*, *2*(1), 63-83.

Banaian, K., Burdekin, R. C., & Willett, T. D. (1998). Reconsidering the principal components of central bank independence: The more the merrier?. *Public Choice*, *97*(1), 1-12.

Banerjee, R., Devereux, M. B., & Lombardo, G. (2015). Self-oriented monetary policy, global financial markets and excess volatility of international capital flows. *National Bureau of Economic Research Working Papers*, 21737.

Barro, R. J. (1995). Inflation and economic growth, *Bank of England Quarterly Bulletin*, 166–176.

Barro, R. J., & Gordon, D. B. (1983). Rules, discretion and reputation in a model of monetary policy. *Journal of Monetary Economics*, *12*(1), 101-121.

Batini, N., & Haldane, A. G. (1998). Forward-looking rules for monetary policy. *National Bureau of Economic Research Working Papers*, 6543.

Batini, N., Harrison, R., & Millard, S. P. (2003). Monetary policy rules for an open economy. *Journal of Economic Dynamics Control*, *27*(12), 2059-2094.

Batini, N., Levine, P., & Pearlman, J. (2009). Monetary policy rules in an emerging small open economy. *IMF Working Papers*, 22.

Bernanke, B. S., & Gertler, M. (1995). Inside the black box: the credit channel of monetary policy transmission. *Journal of Economic Perspectives*, *9*(4), 27-48.

Bernanke, B., & Blinder, A. S. (1992). The federal funds rate and the transmission of monetary policy. *American Economic Review*, *82*(4), 901-921.

Bernhard, W., Broz, J. L., & Clark, W. R. (2002). The political economy of monetary institutions. *International Organization*, 693-723.

Berument, H. (2007). Measuring monetary policy for a small open economy: Turkey. *Journal of Macroeconomics*, *29*(2), 411-430.

Berument, H., & Froyen, R. T. (2006). Monetary policy and long-term US interest rates. *Journal of Macroeconomics, 28*(4), 737-751.

Bhoi, B. K., Mitra, A. K., Singh, J. B., & Sivaramakrishnan, G. (2017). Effectiveness of alternative channels of monetary policy transmission: Some evidence for India. *Macroeconomics and Finance in Emerging Market Economies*, *10*(1), 19-38.

Bick, A. (2010). Threshold effects of inflation on economic growth in developing countries. *Economics Letters*, *108*(2), 126-129.

Bittencourt, M. (2012). Inflation and economic growth in Latin America: Some panel time-series evidence. *Economic Modelling*, *29*(2), 333-340.

Blinder, A. S. (2000). Central-bank credibility: Why do we care? How do we build it?. *American Economic Review*, *90*(5), 1421-1431.

Bodea, C., & Hicks, R. (2015a). Price stability and central bank independence: Discipline, credibility, and democratic institutions. *International Organization*, 35-61.

Bodea, C., & Hicks, R. (2015b). International finance and central bank independence: Institutional diffusion and the flow and cost of capital. *The Journal of Politics*, *77*(1), 268-284.

Brayton, F., & Mauskopf, E. (1985). The Federal Reserve Board MPS quarterly econometric model of the US economy. *Economic Modelling*, *2*(3), 170-292.

Brzoza-Brzezina, M., & Kolasa, M. (2013). Bayesian evaluation of DSGE models with financial frictions. *Journal of Money, Credit and Banking*, *45*(8), 1451-1476.

Burdekin, R. C., Denzau, A. T., Keil, M. W., Sitthiyot, T., & Willett, T. D. (2004). When does inflation hurt economic growth? Different nonlinearities for different economies. *Journal of Macroeconomics*, *26*(3), 519-532.

Cabrera, N., Bejarano, E., & Savino, M. (2011). Preferences of the Central Reserve Bank of Peru and optimal monetary policy rules in the inflation targeting regime. *Working Papers*, *Banco Central de Reservas del Perû*, 10.

Calvo, G. A. (1983). Staggered prices in a utility-maximizing framework. *Journal of Monetary Economics*, *12*(3), 383-398.

Can, U., Bocuoglu, M. E., & Can, Z. G. (2020). How does the monetary transmission mechanism work? Evidence from Turkey. *Borsa Istanbul Review*, *20*(4), 375-382.

Can, U., Can, Z. G., Bocuoglu, M. E., & Dogru, M. E. (2021). The effectiveness of the post-Covid-19 recovery policies: Evidence from a simulated DSGE model for Turkey. *Economic Analysis and Policy*, *71*, 694-708.

Carlstrom, C. T., & Fuerst, T. S. (2009). Central bank independence and inflation: A note. *Economic Inquiry*, *47*(1), 182-186.

Carpenter, S., & Demiralp, S. (2012). Money, reserves, and the transmission of monetary policy: Does the money multiplier exist? *Journal of Macroeconomics*, *34*(1), 59-75.

Carré, H. (2008). NACE Rev. 2, Statistical classification of economic activities in the European Community. *General and Regional Statistics*.

Catão, L., Pagan, A. R., & Laxton, D. (2008). Monetary transmission in an emerging targeter: The case of Brazil. *IMF Working Papers*, 191.

Cebi, C. (2012). The interaction between monetary and fiscal policies in Turkey: An estimated New Keynesian DSGE model. *Economic Modelling*, *29*(4), 1258-1267.

Chatziantoniou, I., Duffy, D., & Filis, G. (2013). Stock market response to monetary and fiscal policy shocks: Multi-country evidence. *Economic Modelling*, *30*, 754-769.

Christiano, L. J., Eichenbaum M., & Evans C. L. (1999). Monetary policy shocks: What have we learned and to what end?. *Handbook of Macroeconomics*, *1*(A), 65-148.

Clarida, R., Gali, J., & Gertler, M. (1999). The science of monetary policy: A new Keynesian perspective. *Journal of Economic Literature*, *37*(4), 1661-1707.

Crowe, C., & Meade, E. E. (2007). The evolution of central bank governance around the world. *Journal of Economic Perspectives*, *21*(4), 69-90.

Cukierman, A. (1992). Central bank strategy, credibility, and independence: Theory and evidence. *The MIT Press, Cambridge*.

Cukierman, A., & Webb, S. B. (1995). Political influence on the central bank: International evidence. *The World Bank Economic Review*, *9*(3), 397-423.

Cukierman, A., Miller, G. P., & Neyapti, B. (2002). Central bank reform, liberalization and inflation in transition economies—an international perspective. *Journal of Monetary Economics*, *49*(2), 237-264.

Cukierman, A., Webb, S. B., & Neyapti, B. (1992). Measuring the independence of central banks and its effect on policy outcomes. *The World Bank Economic Review*, *6*(3), 353-398.

Cushman, D. O., & Zha, T. (1997). Identifying monetary policy in a small open economy under flexible exchange rates. *Journal of Monetary Economics*, *39*(3), 433-448.

Dale, S., & Haldane, A. G. (1995). Interest rates and the channels of monetary transmission: Some sectoral estimates. *European Economic Review*, *39*(9), 1611-1626.

Das, M. S. (2015). Monetary policy in India: Transmission to bank interest rates. *IMF Working Papers*, 129.

De Dios Tena, J., & Tremayne, A. R. (2009). Modelling monetary transmission in UK manufacturing industry. *Economic Modelling*, *26*(5), 1053-1066.

De Haan, J., & Kooi, W. J. (2000). Does central bank independence really matter?: New evidence for developing countries using a new indicator. *Journal of Banking & Finance*, *24*(4), 643-664.

De Haan, J., & Siermann, C. L. (1996). Central bank independence, inflation and political instability in developing countries. *The Journal of Policy Reform*, *1*(2), 135-147.

De Haan, J., Bodea, C., Hicks, R., & Eijffinger, S. C. (2018). Central bank independence before and after the crisis. *Comparative Economic Studies*, *60*(2), 183-202.

Desai, R. M., Olofsgård, A., & Yousef, T. M. (2003). Democracy, inequality, and inflation. *American Political Science Review*, 391-406.

Disyatat, P., & Vongsinsirikul, P. (2003). Monetary policy and the transmission mechanism in Thailand. *Journal of Asian Economics, 14*(3), 389-418.

Dixit, A., & Lambertini, L. (2003). Interactions of commitment and discretion in monetary and fiscal policies. *American Economic Review*, *93*(5), 1522-1542.

Dodge, D. (2002). The interaction between monetary and fiscal policies. *Canadian Public Policy/Analyse de Politiques, 28*(2), 187-201.

Domac, I., Isiklar, G., & Kandil, M. (2019). On the potential and limitations of monetary policy in Turkey. *Middle East Development Journal*, *11*(2), 220-235.

Dua, P. (2020). Monetary policy framework in India. *Indian Economic Review*, *55*(1), 117-154.

Duguay, P. (1994). Empirical evidence on the strength of the monetary transmission mechanism in Canada: An aggregate approach. *Journal of Monetary Economics*, *33*(1), 39-61.

Elbourne, A., & de Haan, J. (2006). Financial structure and monetary policy transmission in transition countries. *Journal of Comparative Economics*, *34*(1), 1-23.

Fedelino, A., Ivanova, A., & Horton, M. A. (2009). Computing cyclically-adjusted balances and automatic stabilizers. *Technical Notes and Manuals*, 5.

Fischer, S. (1993). The role of macroeconomic factors in growth. *Journal of Monetary Economics*, *32*(3), 485-512.

Fischer, S. (1995). Central-bank independence revisited. *The American Economic Review*, *85*(2), 201-206.

Fischer, S., & Modigliani, F. (1978). Towards an understanding of the real effects and costs of inflation. *Review of World Economics*, *114*(4), 810-833.

Fontana, G. (2007). Why money matters: Wicksell, Keynes, and the new consensus view on monetary policy. *Journal of Post Keynesian Economics*, *30*(1), 43-60.

Franta, M., Horváth, R., & Rusnak, M. (2014). Evaluating changes in the monetary transmission mechanism in the Czech Republic. *Empirical Economics*, *46*(3), 827-842.

Fraser, P., Macdonald, G. A., & Mullineux, A. W. (2014). Regional monetary policy: An Australian perspective. *Regional Studies*, *48*(8), 1419-1433.

Friedman, M. (1962). Should there be an independent monetary authority?. *Cambridge, Mass.: Harvard University Press*, 219-243.

Fujiwara, I., Hirose, Y., & Shintani, M. (2011). Can news be a major source of aggregate fluctuations? A Bayesian DSGE approach. *Journal of Money, Credit and Banking*, *43*(1), 1-29.

Gali, J. (2015). Monetary policy, inflation and the business cycle. *Princeton University Press*.

Garriga, A. C. (2016). Central bank independence in the world: A new data set. *International Interactions*, *42*(5), 849-868.

Garriga, A. C., & Rodriguez, C. M. (2020). More effective than we thought: Central bank independence and inflation in developing countries. *Economic Modelling*, *85*, 87-105.

Gertler, M., & Gilchrist, S. (1993). The role of credit market imperfections in the monetary transmission mechanism: Arguments and evidence. *Scandinavian Journal of Economics*, 43-64.

Goodfriend, M. (2007). How the world achieved consensus on monetary policy. *Journal of Economic Perspectives*, *21*(4), 47-68.

Grilli, V., Masciandaro, D., & Tabellini, G. (1991). Political and monetary institutions and public financial policies in the industrial countries. *Economic Policy*, *6*(13), 341-392.

Hanson, M. S. (2006). Varying monetary policy regimes: A vector autoregressive investigation. *Journal of Economics and Business, 58*(5-6), 407-427.

Harrison, R. (2012). Asset purchase policy at the effective lower bound for interest rates. *Bank of England Working Papers*, 444.

Harrison, R. (2017). Optimal quantitative easing. *Bank of England Working Papers*, 678.

Hefeker, C., & Hayo, B. (2008). Does central bank independence cause low inflation? A sceptical view. *Paolo Baffi Centre Research Paper*, *4*.

Henderson, D. W., & McKibbin, W. J. (1993). A comparison of some basic monetary policy regimes for open economies: Implications of different degrees of instrument adjustment and wage persistence. *Board of Governors of the Federal Reserve System International Finance Discussion Papers*, 458.

Hillman, A. L. (1999). Political culture and the political economy of central-bank independence. *Central Banking, Monetary Policies, and the Implications for Transition Economies, Springer,* 73-86.

Ibarra, R., & Trupkin, D. R. (2016). Reexamining the relationship between inflation and growth: Do institutions matter in developing countries?. *Economic Modelling*, *52*, 332-351.

Ito, T., & Sato, K. (2008). Exchange rate changes and inflation in post-crisis Asian Economies: Vector autoregression analysis of the exchange rate pass-through. *Journal of Money, Credit and Banking, 40*(7), 1407-1438.

Jácome, L. I., & Vázquez, F. (2008). Is there any link between legal central bank independence and inflation? Evidence from Latin America and the Caribbean. *European Journal of Political Economy*, *24*(4), 788-801.

Kara, H., Küçük-Tuğer, H., Özlale, Ü., Tuğer, B., & Yücel, E. M. (2007). Exchange rate regimes and pass-through: Evidence from the Turkish Economy. *Contemporary Economic Policy*, *25*(2), 206-225.

Kashyap, A. K., & Stein, J. C. (1995). The role of banks in the transmission of monetary policy. *Carnegie Rochester Conference Series on Public Policy*, *42*, 151–195.

Kern, A., Reinsberg, B., & Rau-Göhring, M. (2019). IMF conditionality and central bank independence. *European Journal of Political Economy*, *59*, 212-229.

Khundrakpam, J. K., & Jain, R. (2012). Monetary policy transmission in India: A peep inside the black box. *Reserve Bank of India Working Paper Series*, *11*, 1-45.

Kilinc, M., & Tunc, C. (2014). Identification of monetary policy shocks in Turkey: A structural VAR approach, *CBT Working Paper*, 23.

Kim, S., & Roubini, N. (2000). Exchange rate anomalies in the industrial countries: A solution with a structural VAR approach. *Journal of Monetary Economics, 45*(3), 561-586.

Klomp, J., & De Haan, J. (2010). Central bank independence and inflation revisited. *Public Choice*, *144*(3), 445-457.

Kolasa, M., & Wesolowski, G. (2018). International spillovers of quantitative easing. *European Central Bank Working Papers*, 2172.

Kuttner, K. (2006). Can central banks target bond prices? *National Bureau of Economic Research Working Papers*, 12454.

Kydland, F. E., & Prescott, E. C. (1977). Rules rather than discretion: The inconsistency of optimal plans. *Journal of Political Economy*, *85*(3), 473-491.

Landström, M. (2011). Do central bank independence reforms matter for inflation performance?. *International Journal of Banking, Accounting and Finance*, *3*(4), 320-335.

Laopodis, N. T. (2013). Monetary policy and stock market dynamics across monetary regimes. *Journal of International Money and Finance, 33*, 381-406.

Leeper, E. M., Sims, C. A., Zha, T., Hall, R. E., & Bernanke, B. S. (1996). What does monetary policy do? *Brookings Papers on Economic Activity,* 2, 1-78.

Li, H., & Zou, H. F. (2002). Inflation, growth, and income distribution: A cross-country study. *Annals of Economics and Finance*, *3*(1), 85-101.

Logue, D. E., & Sweeney, R. J. (1981). Inflation and real growth: Some empirical results: Note. *Journal of Money, Credit and Banking*, *13*(4), 497-501.

López-Villavicencio, A., & Mignon, V. (2011). On the impact of inflation on output growth: Does the level of inflation matter?. *Journal of Macroeconomics*, *33*(3), 455-464.

Loungani, P., & Sheets, N. (1997). Central bank independence, inflation, and growth in transition economies. *Journal of Money, Credit, and Banking*, 381-399.

Lucotte, Y. (2009). Central bank independence and budget deficits in developping countries: New evidence from panel data analysis. *HAL Working Paper,* 19.

Lütkepohl, H., & Reimers, H. E. (1992). Impulse response analysis of cointegrated systems. *Journal of Economic Dynamics and Control, 16*(1), 53-78.

Maćkowiak, B. (2007). External shocks, US monetary policy and macroeconomic fluctuations in emerging markets. *Journal of Monetary Economics, 54*(8), 2512-2520.

Mangano, G. (1998). Measuring central bank independence: A tale of subjectivity and of its consequences. *Oxford Economic Papers*, *50*(3), 468-492.

Mayes, D. G., & Virén, M. (2000). The exchange rate and monetary conditions in the euro area. *Review of World Economics*, *136*(2), 199-231.

Merola, R. (2015). The role of financial frictions during the crisis: An estimated DSGE model. *Economic Modelling*, *48*, 70-82.

Milcheva, S. (2013). A bank lending channel or a credit supply shock? *Journal of Macroeconomics, 37*, 314-332.

Miranda-Agrippino, S., Nenova, T., & Rey, H. (2020). Global footprints of monetary policy. *Center for Macroeconomics Discussion Papers*, 2004.

Mishkin, F. S. (1995). Symposium on the monetary transmission mechanism. *Journal of Economic Perspectives*, *9*(4), 3-10.

Mishra, P., Montiel, P. J., & Sengupta, R. (2016). Monetary transmission in developing countries: Evidence from India. *Monetary Policy in India*, 59-110.

Mishra, P., Montiel, P. J., & Spilimbergo, A. (2012). Monetary transmission in low-income countries: Effectiveness and policy implications. *IMF Economic Review*, *60*(2), 270-302.

Montes, G. C. (2013). Credibility and monetary transmission channels under inflation targeting: An econometric analysis from a developing country. *Economic Modelling*, *30*, 670-684.

Morris, C. S., & Sellon, G. H. (1995). Bank lending and monetary policy: Evidence on a credit channel. *Federal Reserve Bank of Kansas City Economic Review, 80*(2), 59-75.

Neyapti, B. (2001). Central bank independence and economic performance in Eastern Europe. *Economic Systems*, *25*(4), 381-399.

Neyapti, B. (2012). Monetary institutions and inflation performance: cross-country evidence. *Journal of Economic Policy Reform*, *15*(4), 339-354.

Nurbayev, D. (2018). The rule of law, central bank independence and price stability. *Journal of Institutional Economics*, *14*(4), 659-687.

Orphanides, A. (2003). Historical monetary policy analysis and the Taylor rule. *Board of Governors of the Federal Reserve System Finance and Economics Discussion Series*, 36.

Orphanides, A., & Solow, R. M. (1990). Money, inflation and growth. *Handbook of Monetary Economics*, *1*, 223-261.

Oztunali, O. (2016). Three essays in dynamic macroeconomics. [Unpublished doctoral dissertation]. Bogazici University.

Perera, A., & Wickramanayake, J. (2013). Monetary transmission in the emerging country context: The case of Sri Lanka. *Central Bank of Sri Lanka International Research Conference-2013*, 1–80.

Pfeifer, J. (2014). A guide to specifying observation equations for the estimation of DSGE models. *Research Series*, 1-150.

Ramaswamy, R., & Sløk, T. (1998). The real effects of monetary policy in the European Union: What are the differences? *Staff Papers, 45*(2), 374-396.

Ramey, V. (1993). How important is the credit channel in the transmission of monetary policy?. *NBER Working Paper*, 4285.

Ramsey, F. P. (1927). A contribution to the theory of taxation. *The Economic Journal*, *37*(145), 47-61.

Reifschneider, D., Tetlow, R., & Williams, J. (1999). Aggregate disturbances, monetary policy, and the macroeconomy. *Federal Reserve Bulletin*, *85*, 1-19.

Rogoff, K. (1985). The optimal degree of commitment to an intermediate monetary target. *The Quarterly Journal of Economics*, *100*(4), 1169-1189.

Schorfheide, F. (2000). Loss function-based evaluation of DSGE models. *Journal of Applied Econometrics*, *15*(6), 645-670.

Sellon, G. H. (2002). The changing US financial system: some implications for the monetary transmission mechanism. *Economic Review-Federal Reserve Bank of Kansas City*, *87*(1), 5-36.

Sengupta, N. (2014). Changes in transmission channels of monetary policy in India. *Economic and Political Weekly, 49*(49), 62-71.

Setterfield, M. (2007). Is there a stabilizing role for fiscal policy in the New Consensus?. *Review of Political Economy*, *19*(3), 405-418.

Sikken, B., & De Haan, J. (1998). Budget deficits, monetization, and central-bank independence in developing countries. *Oxford Economic Papers*, *50*, 493-511.

Sims, C. A. (1980). Macroeconomics and reality. *Econometrica*, *48*(1), 1-48.

Sims, C. A., Stock, J. H., & Watson, M. W. (1990). Inference in linear time series models with some unit roots. *Econometrica*, *58*(1), 113-144.

Smets, F., & Wouters, R. (2007). Shocks and frictions in US business cycles: A Bayesian DSGE approach. *European Central Bank Working Papers*, 109.

Sosa, S., & Cashin, M. P. (2009). Macroeconomic fluctuations in the Caribbean: The role of climatic and external shocks. *IMF Working Papers*, 159.

Stock, J. H., & Watson, M. W. (2001). Vector autoregressions. *Journal of Economic Perspectives*, *15*(4), 101-115.

Taylor, J. B. (1993). Discretion versus policy rules in practice. *Carnegie-Rochester Conference Series on Public Policy*, *39*(1), 195-214.

Taylor, J. B. (1995). The monetary transmission mechanism: An empirical framework. *Journal of Economic Perspectives, 9*(4), 11-26.

Tobin, J. (1965). Money and economic growth. *Econometrica: Journal of the Econometric Society*, 671-684.

Tobin, J. (1978). Monetary policies and the economy: The transmission mechanism. *Southern Economic Journal*, 421-431.

Uhlig, H. F. (1995). A toolkit for analyzing nonlinear dynamic stochastic models easily. *Federal Reserve Bank of Minneapolis Discussion Papers*, 101.

Van den Brakel, J. (2010). Sampling and estimation techniques for the implementation of new classification systems: The change-over from NACE Rev. 1.1 to NACE Rev. 2 in business surveys. *Survey Research Methods, 4*(2), 103-119.

Vega, M. (2015). Monetary policy, financial dollarization and agency costs. *Banco Central de Reservas del Peru Working Papers*, 19.

Villa, S. (2016). Financial frictions in the Euro Area and the United States: A Bayesian assessment. *Macroeconomic Dynamics*, *20*(5), 1313-1340.

Weber, A. A., Gerke, R., & Worms, A. (2011). Changes in euro area monetary transmission? *Applied Financial Economics, 21*(3), 131-145.

Yagcibasi, O. F., & Yildirim, M. O. (2017). Welfare implications of alternative monetary policy rules: A New Keynesian DSGE model for Turkey. *Review of Economic Perspectives*, *17*(4), 363-379.

Yilmazkuday, H. (2011). Monetary policy and credit cards: Evidence from a small open economy. *Economic Modelling*, *28*(1-2), 201-210.

Yuksel, C. (2013). Role of investment shocks in explaining business cycles in Turkey. *Central Bank of the Republic of Turkey Working Papers*, *2013*(12).

Zams, B. M. (2021). Frictions and empirical fit in a DSGE model for Indonesia. *Economic Modelling*, *99*, 105487.

# APPENDICES

## Appendix A. Derivation of Equation (20)

The equation (19)'s first order condition is rearranged given an arbitrary fiscal policy choice.

$$K = b\varphi \mathrm{z}(x) + (a + bc)x - \frac{\xi}{a\varphi \frac{\partial z}{\partial x} + (a+bc)} \tag{113}$$

Now the implicit expression between the fiscal and monetary policies is being evaluated at $x' = x + \Delta x$. By holding this implicit expression, the new equilibrium is determined. The new equilibrium is subtracted from the first implicit expression.

$$b\varphi[\mu(x + \Delta x) - \mu(x)] + (a + bc)\Delta x - \frac{\xi b\varphi\left(\frac{\partial z}{\partial x}\Big|_{x=x} - \frac{\partial z}{\partial x}\Big|_{x=x+\Delta x}\right)}{\left[b\varphi \frac{\partial z}{\partial x}\Big|_{x=x} + (a+bc)\right]\left[b\varphi \frac{\partial z}{\partial x}\Big|_{x=x+\Delta x} + (a+bc)\right]} = 0 \tag{114}$$

Rearranging the equation (114) by dividing both sides with $\Delta x$ and taking the limit results in:

$$\lim_{\Delta x \to 0} \frac{\xi b\varphi\left[\frac{\partial z}{\partial x}\Big|_{x=x} - \frac{\partial z}{\partial x}\Big|_{x=x+\Delta x}\right]}{\left[b\varphi \frac{\partial z}{\partial x}\Big|_{x=x} + (a+bc)\right]\left[b\varphi \frac{\partial z}{\partial x}\Big|_{x=x+\Delta x} + (a+bc)\right]} = \lim_{\Delta x \to 0} (a + bc) + a\sigma \frac{[z(x+\Delta x) - z(x)]}{\Delta x} \tag{115}$$

Therefore:

$$\frac{\xi b\varphi}{\left[b\varphi \frac{\partial z}{\partial x} + (a+bc)\right]^2} \frac{\partial^2 z}{\partial x^2} = \left[b\varphi \left.\frac{\partial z}{\partial x}\right|_{x=x} + (a + bc)\right] \tag{116}$$

$$\frac{\partial^2 \mu}{\partial x^2} = \left[b\varphi \left.\frac{\partial z}{\partial x}\right|_{x=x} + (a + bc)\right]^3 \tag{117}$$

When $f(x)$ is defined as $f(x) = (a + bx)x + b\varphi \mathrm{z}(x)$, the first order condition specifies:

$$K = f(x) + \frac{\xi}{\frac{\partial f}{\partial x}} \tag{118}$$

It is also noted that $\frac{\partial f}{\partial x} = b\varphi \frac{\partial z}{\partial x} + (a + bc)$ and $\frac{\partial^2 f}{\partial x^2} = b\varphi \frac{\partial^2 z}{\partial x^2}$ . The equation (119) gives the monetary policy's second derivative with respect to derivatives of the function.

$$\frac{\partial^2 f}{\partial x^2} = \frac{\left(\frac{\partial f}{\partial x}\right)^3}{\xi} \tag{119}$$

If $f(x)$ is actually a constant function, i.e., $f(x) = c \forall x \in R$, the derivative of the policy offer from the central bank with respect to fiscal policy choice of the government, $\frac{\partial z}{\partial x}$, is zero. This result arrives at a contradiction. While $K$ is a constant and finite number, the equation (118) cannot satisfy because the right side of the equation would goes to infinity. Thus, the monetary policy offer from the central bank does not express in terms of the fiscal policy variable, $z(x)$; however, it is only a constant number, $z$.

# Appendix B. General and Sectoral Monetary Transmission Mechanism

## B.1. The results of the SVAR model (Equation 69)

Table 12
*Identification of the matrices A and B*

| | | | | | | |
|---|---|---|---|---|---|---|
| A = | | | | | | |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| $C(1)$ | 1 | 0 | 0 | 0 | 0 | 0 |
| $C(2)$ | 0 | 1 | 0 | 0 | 0 | 0 |
| $C(3)$ | 0 | $C(7)$ | 1 | 0 | 0 | 0 |
| 0 | 0 | $C(8)$ | $C(10)$ | 1 | $C(14)$ | 0 |
| $C(4)$ | 0 | 0 | 0 | $C(12)$ | 1 | $C(16)$ |
| $C(5)$ | $C(6)$ | $C(9)$ | $C(11)$ | $C(13)$ | $C(15)$ | 1 |
| B = | | | | | | |
| $C(17)$ | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | $C(18)$ | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | $C(19)$ | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | $C(20)$ | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | $C(21)$ | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | $C(22)$ | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | $C(23)$ |

***Notes.*** $A\varepsilon = Bu$ where $E[uu'] = I$.

| | Coefficients (Standart Errors) |
|---|---|
| $C(1)$ | 0.536 (0.154) |
| $C(2)$ | 0.045 (0.071) |
| $C(3)$ | 0.013 (0.018) |
| $C(4)$ | 0.052 (0.427) |
| $C(5)$ | 0.079 (0.092) |
| $C(6)$ | 0.099 (0.074) |
| $C(7)$ | -0.033 (0.036) |
| $C(8)$ | 0.481 (0.098) |
| $C(9)$ | -0.439 (0.218) |
| $C(10)$ | -2.357 (0.500) |
| $C(11)$ | 1.321 (1.005) |
| $C(12)$ | -0.798 (1.717) |
| $C(13)$ | 0.890 (0.338) |
| $C(14)$ | -0.124 (0.035) |
| $C(15)$ | 0.025 (0.067) |
| $C(16)$ | 3.310 (1.402) |
| $C(17)$ | 0.088 (0.009) |
| $C(18)$ | 0.096 (0.010) |
| $C(19)$ | 0.044 (0.004) |
| $C(20)$ | 0.011 (0.001) |
| $C(21)$ | 0.030 (0.004) |
| $C(22)$ | 0.256 (0.045) |
| $C(23)$ | 0.047 (0.009) |

## B.2. General Monetary Transmission Mechanism

### B.2.1. Effectiveness of the General Transmission Mechanism

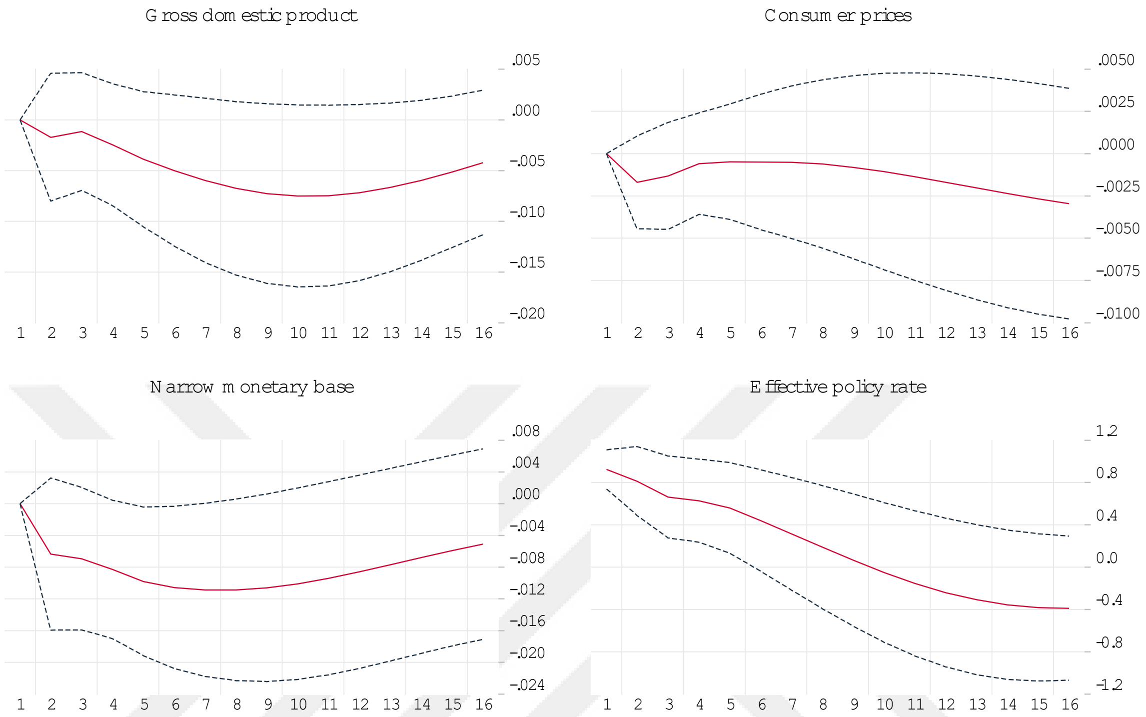



*Figure 7.* VAR(4) model

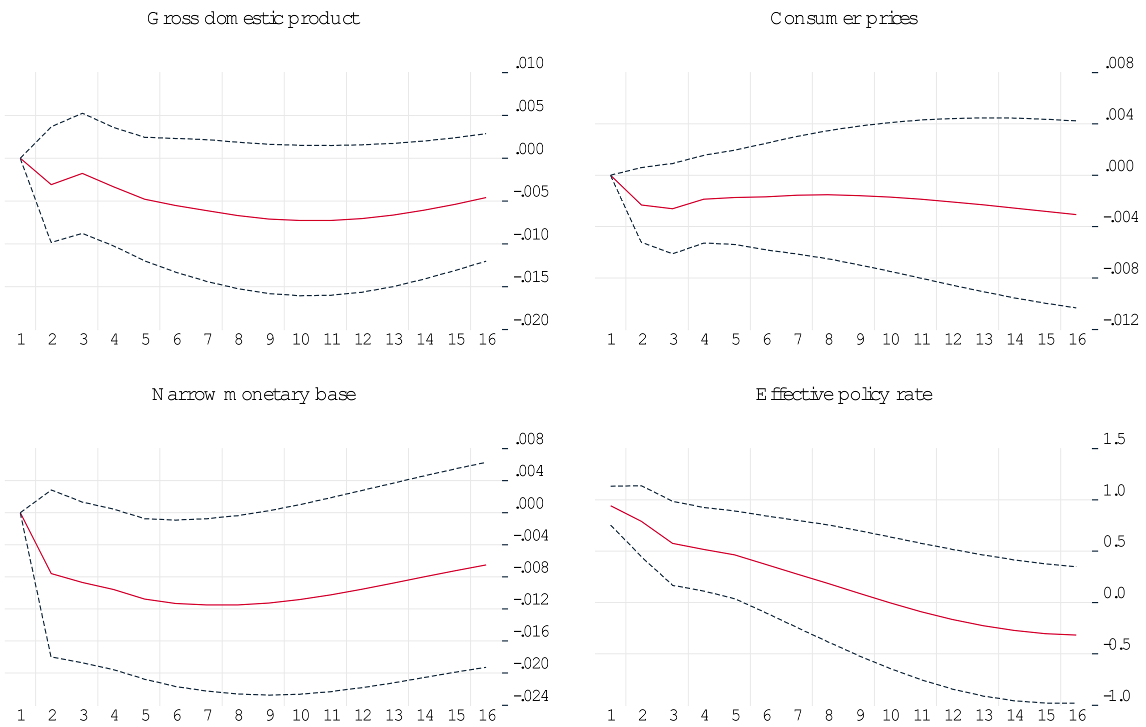



*Figure 8.* VAR(5) model

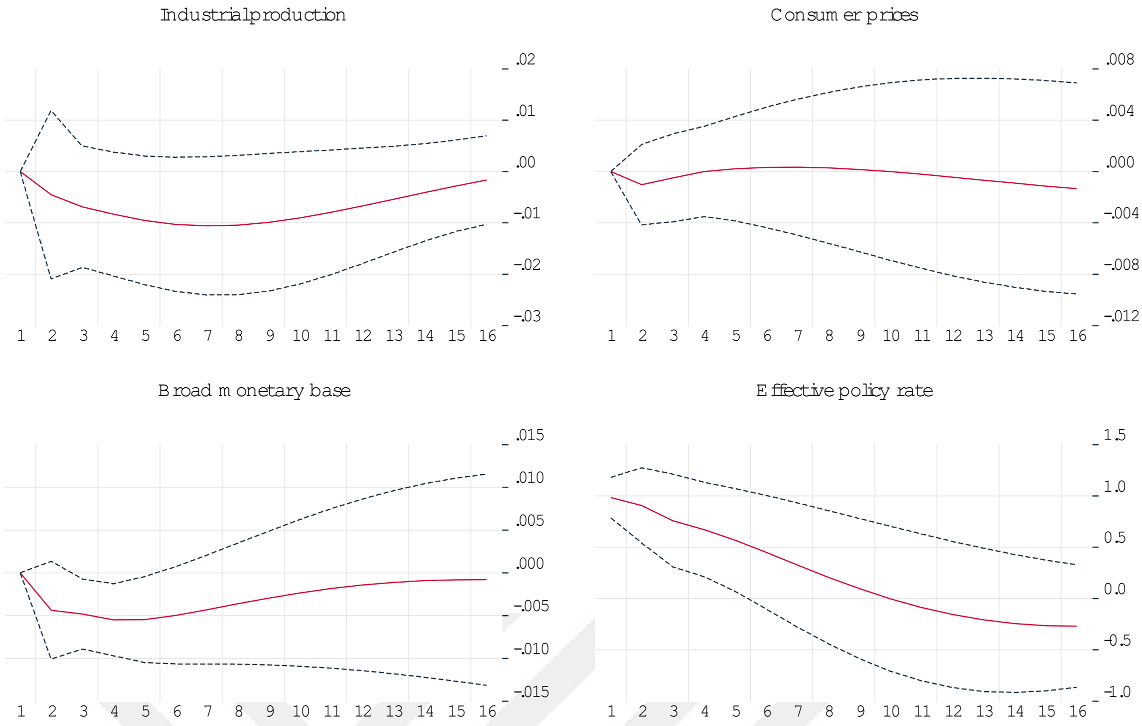



*Figure 9.* Alternative VAR(4) model

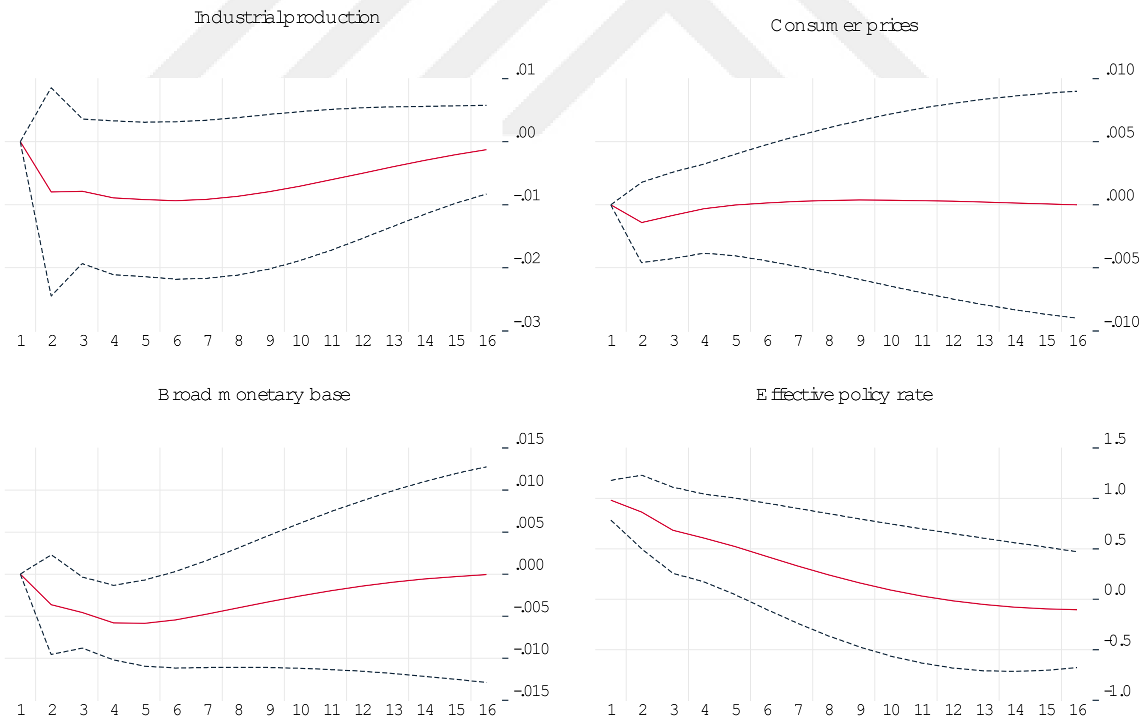



*Figure 10.* Alternative VAR(5) model

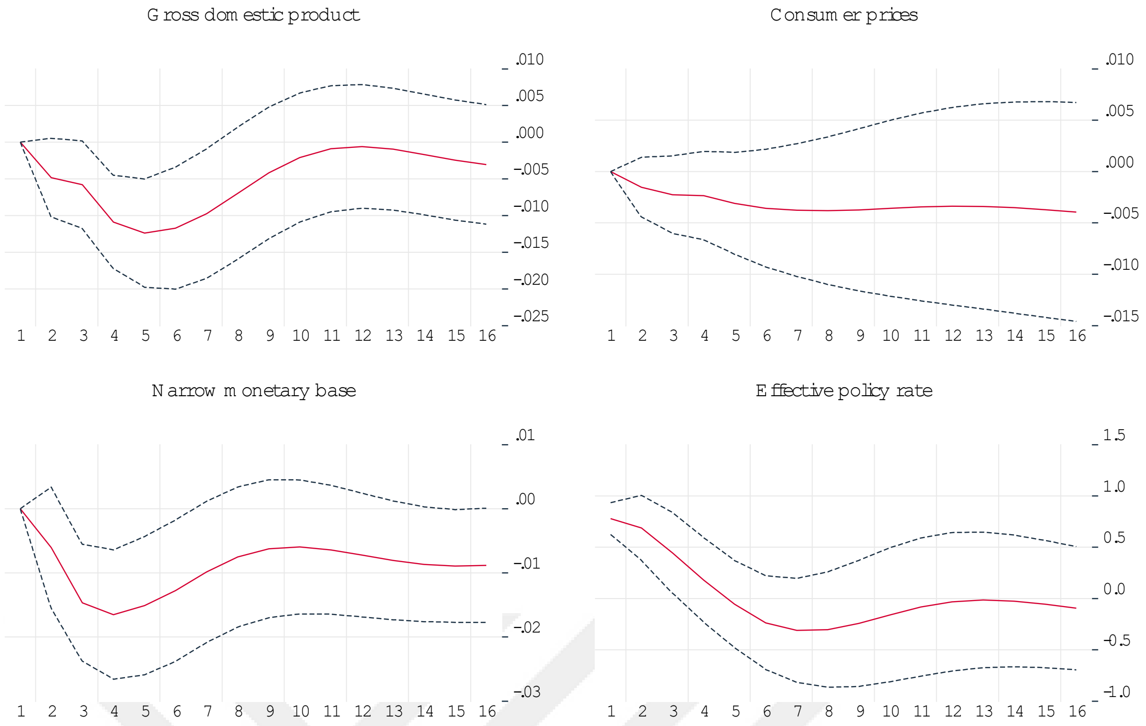



*Figure 11.* VARX(7) model

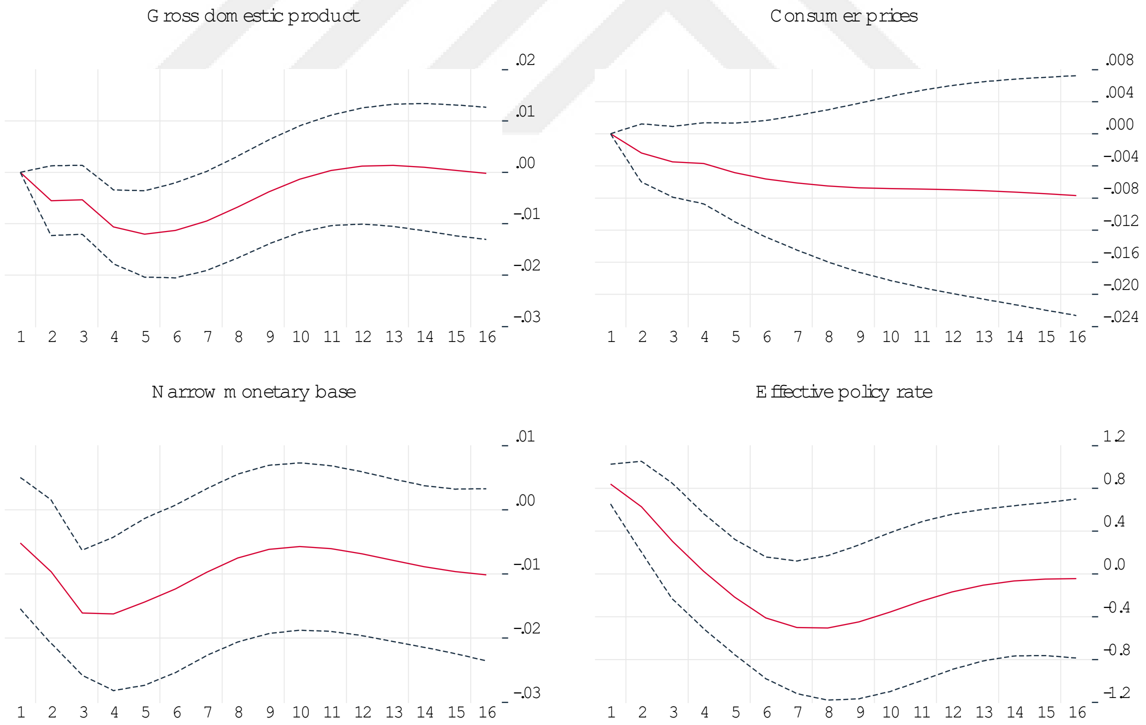



*Figure 12.* SVARX(7) model

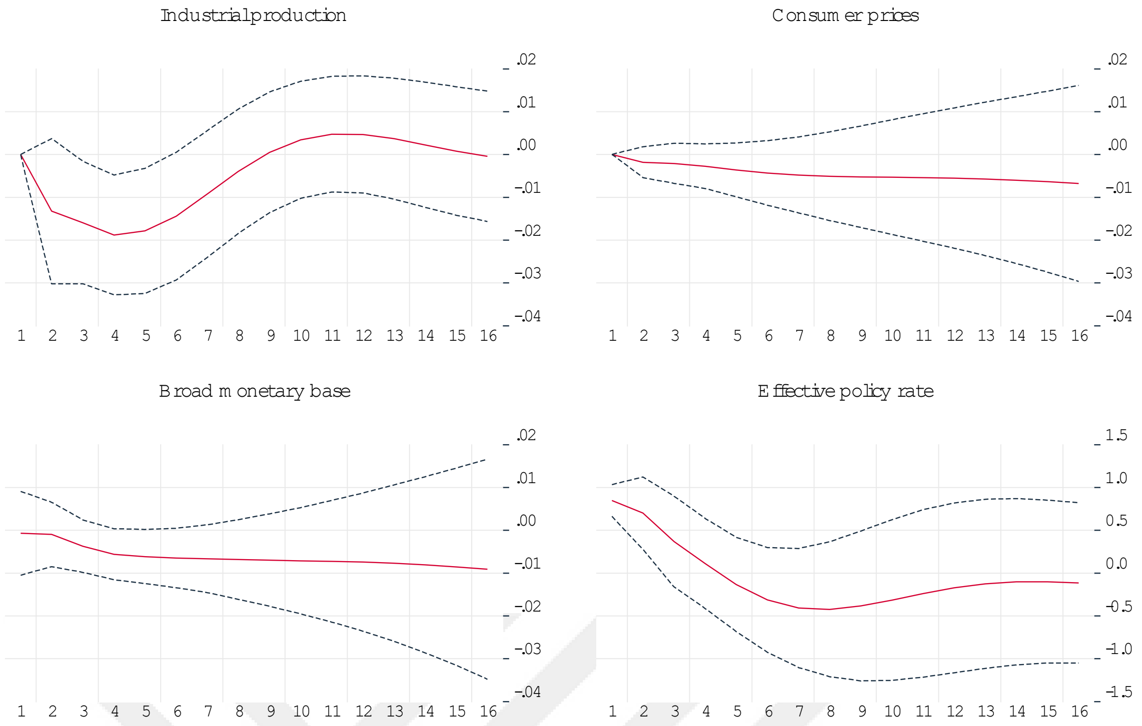



*Figure 13.* Alternative SVARX(7) model

### B.2.2. The Shutdown Analysis

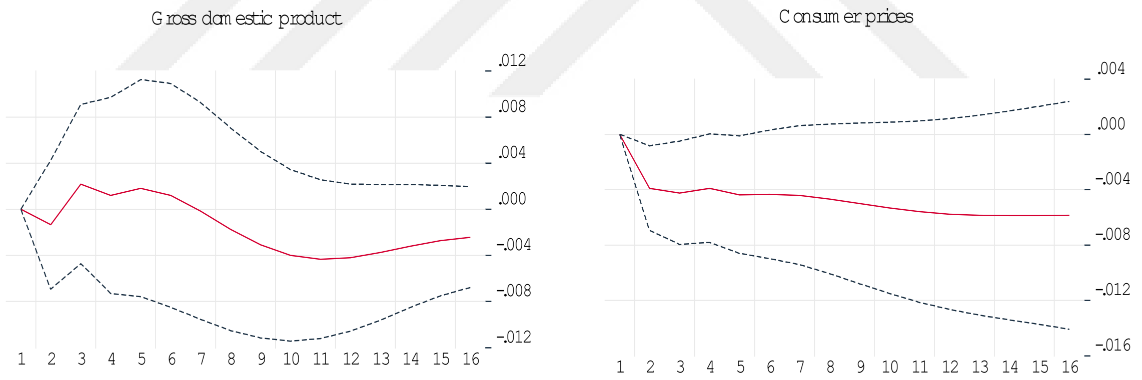



*Figure 14.* VAR(7) model

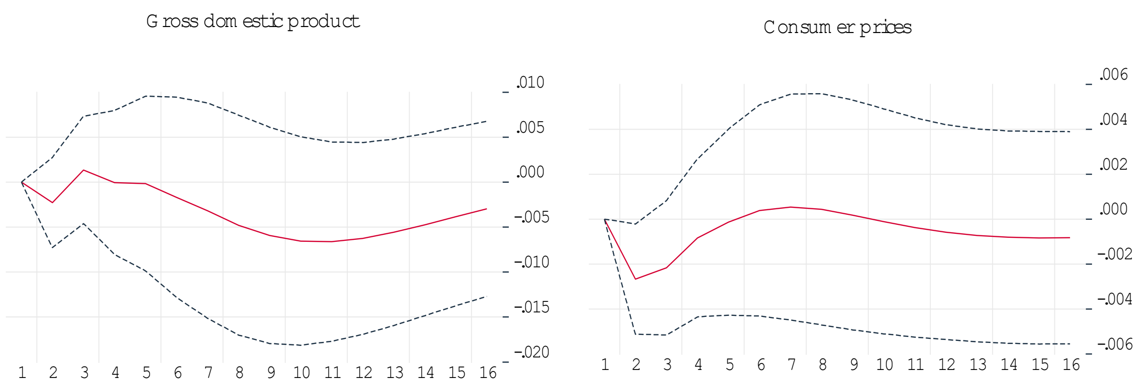



*Figure 15.* VAR(7) model with W/O exchange rate channel

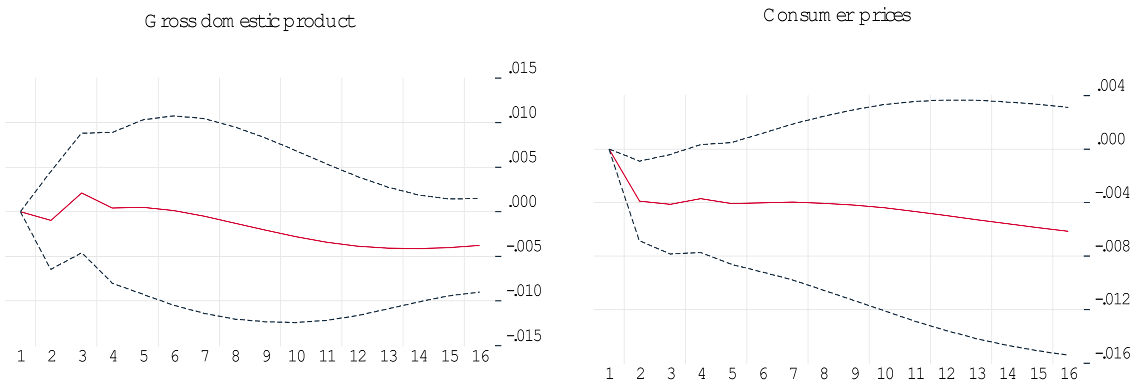



*Figure 16.* VAR(7) model with W/O credit channel

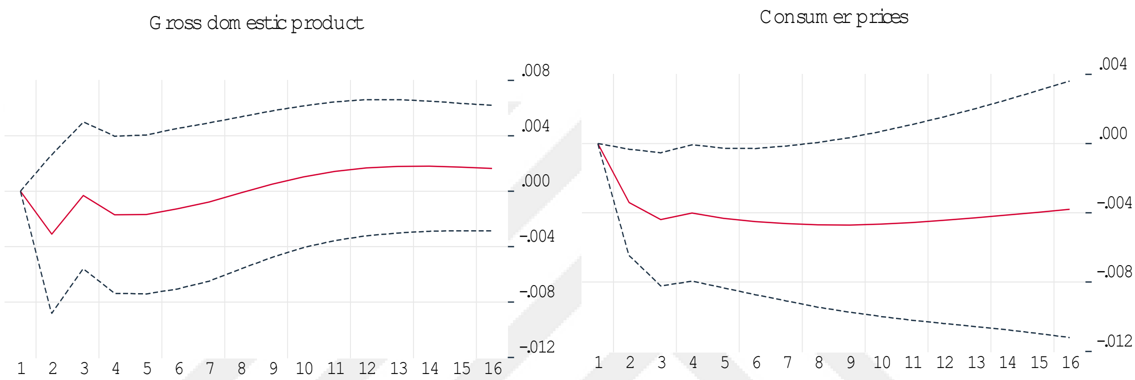



*Figure 17.* VAR(7) model with W/O asset price channel

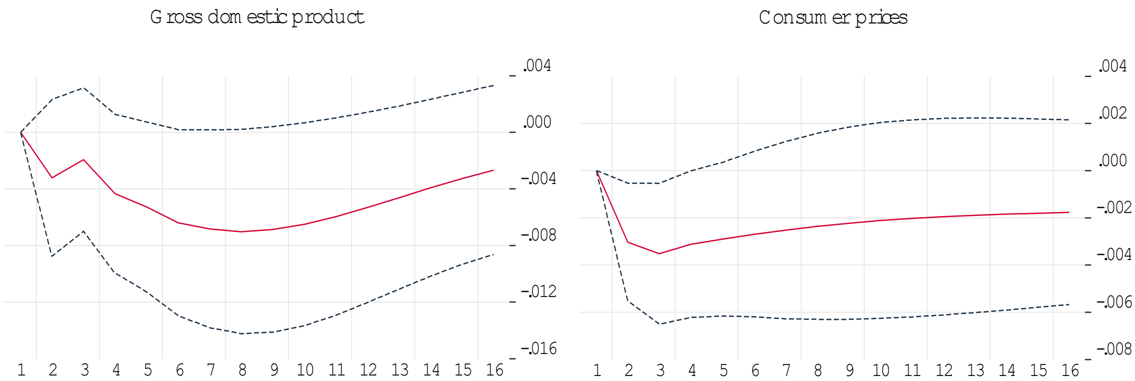



*Figure 18.* VAR(7) model with W/O all channels except interest rate channel

## B.3. Sectoral Monetary Transmission Mechanism

### B.3.1. Effectiveness of the Sectoral Monetary Transmission Mechanism

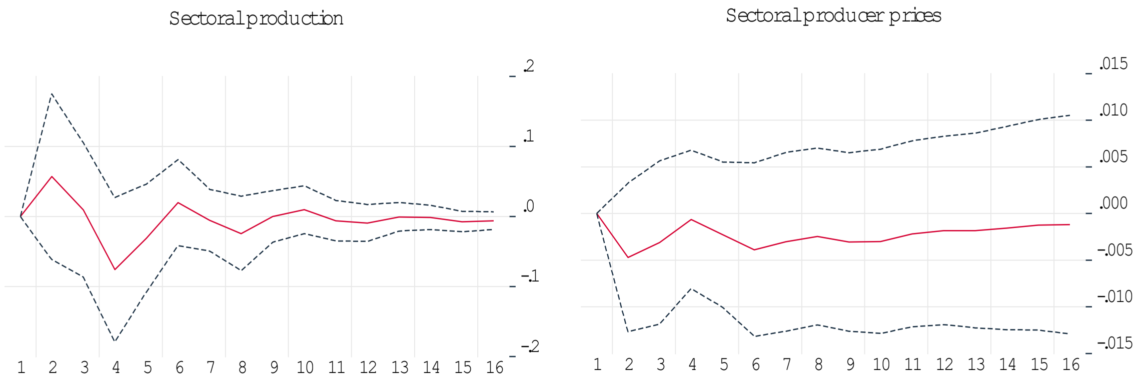



*Figure 19.* VAR(6) model for agriculture sector

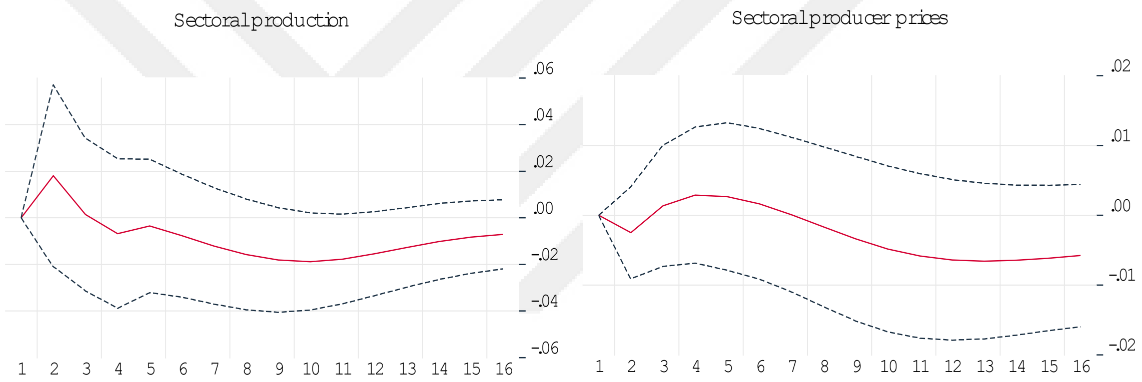



*Figure 20.* VAR(6) model for construction sector

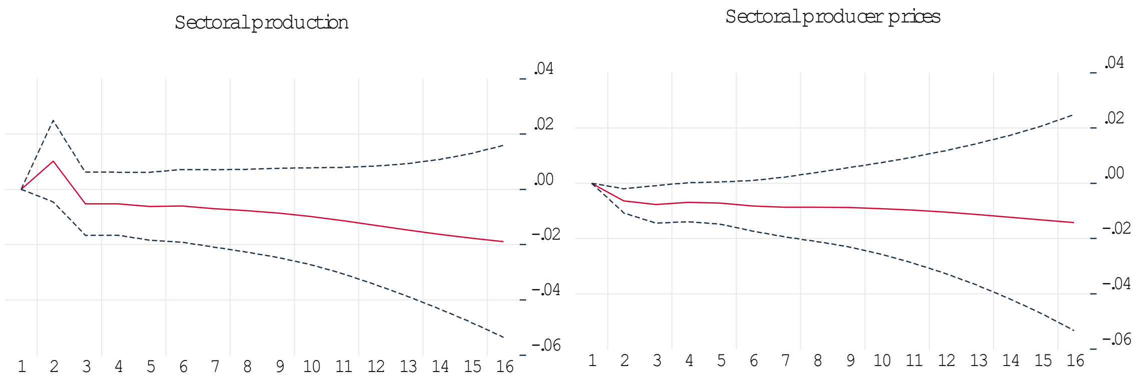



*Figure 21.* VAR(6) model for industry sector

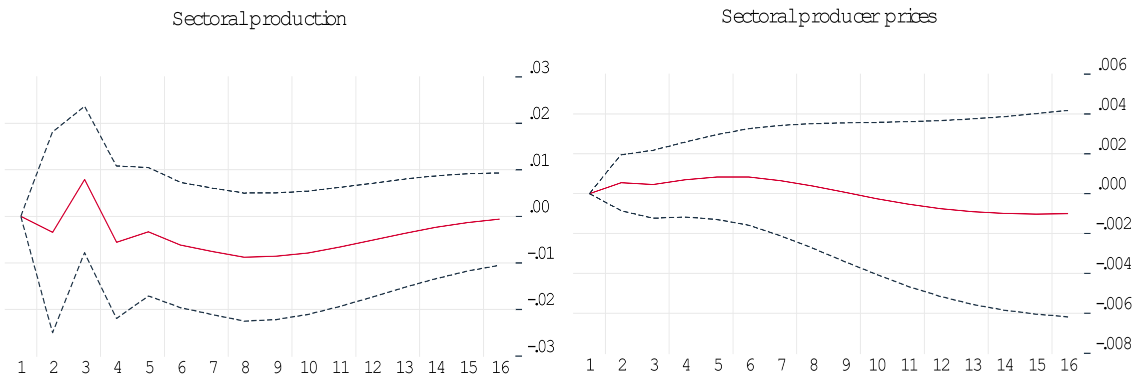



*Figure 22.* VAR(6) model for services sector

## B.3.2. The Shutdown Analysis

### B.3.2.1. Agriculture Sector

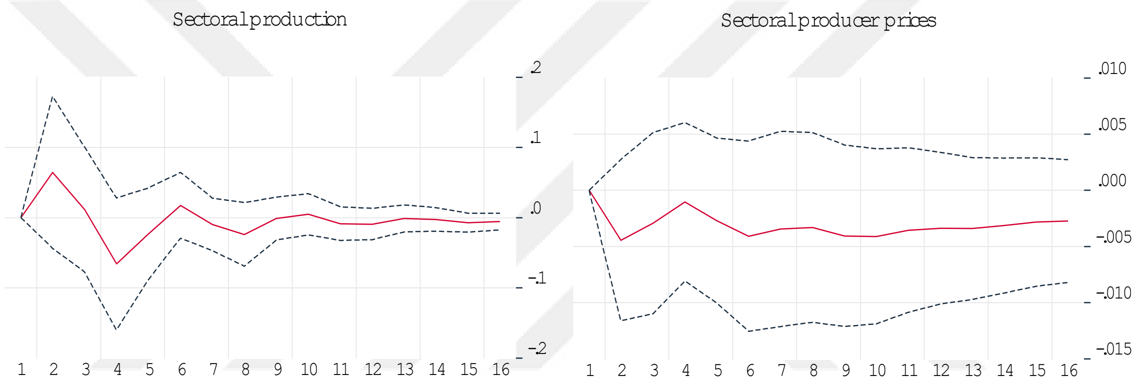



*Figure 23.* VAR(6) model with W/O exchange rate channel

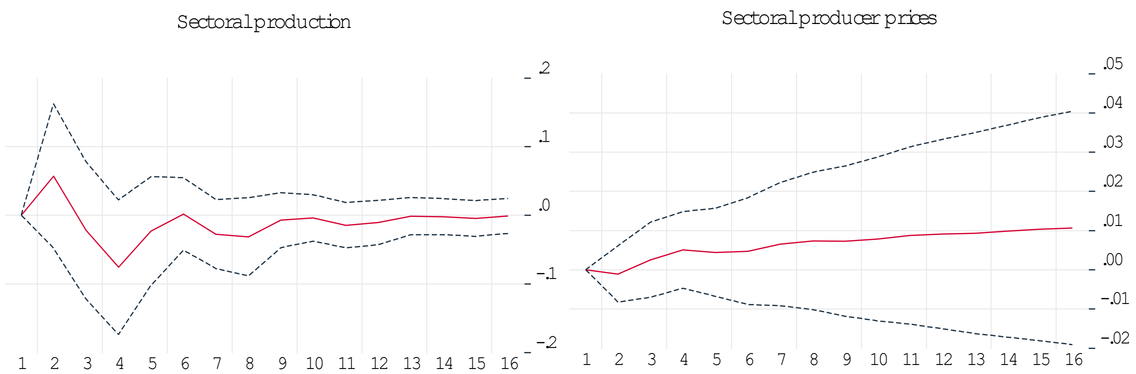



*Figure 24.* VAR(6) model with W/O asset price channel

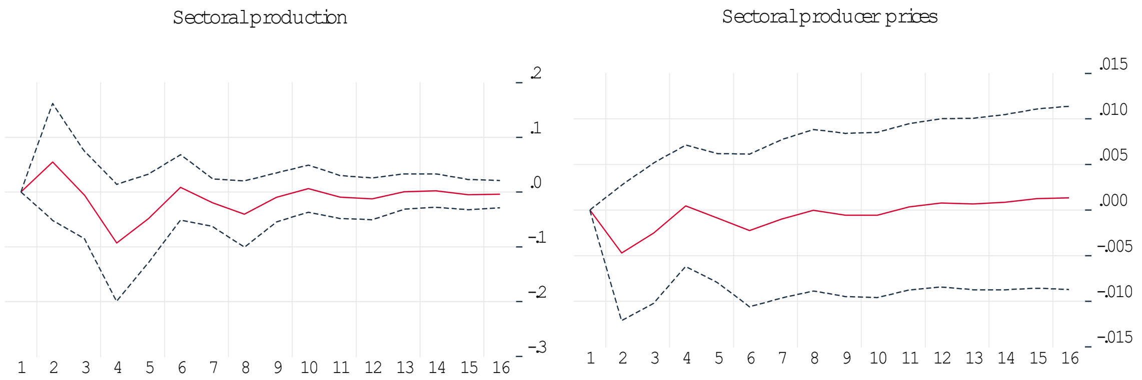



*Figure 25.* VAR(6) model with W/O credit channel

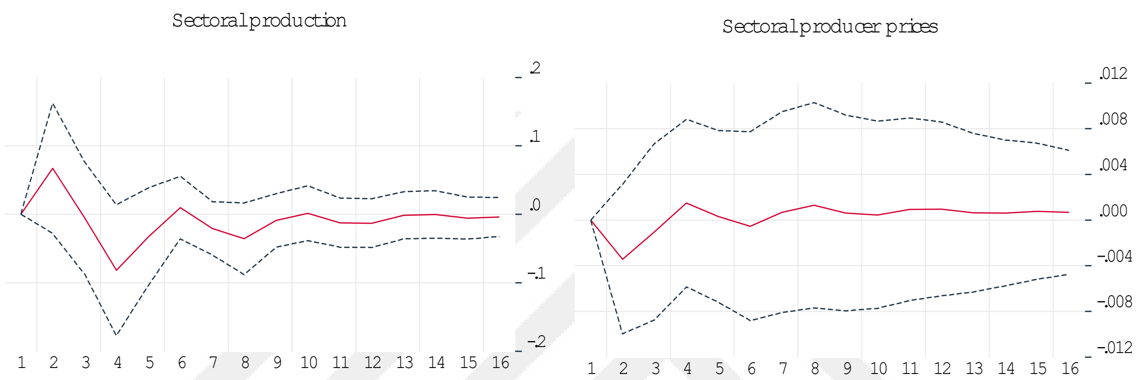



*Figure 26.* VAR(6) model with all channels except interest rate channel

**B.3.2.2. Construction Sector**

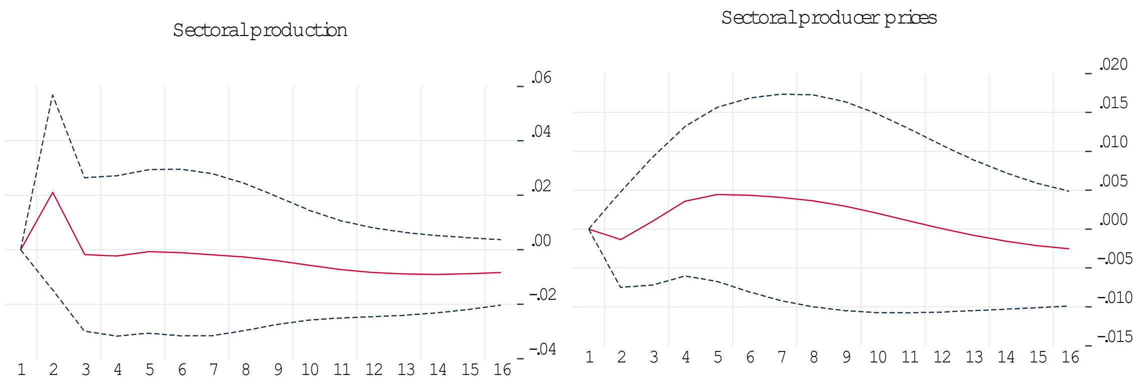



*Figure 27.* VAR(6) model with W/O exchange rate channel

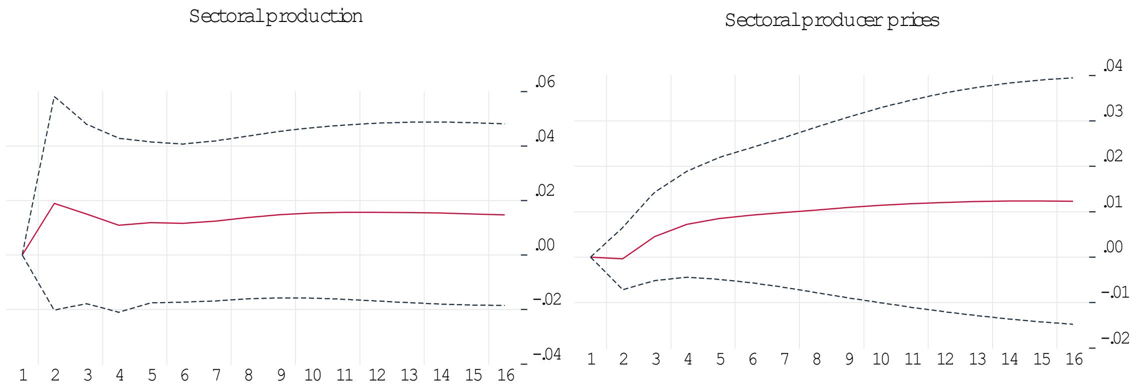



*Figure 28.* VAR(6) model with W/O asset price channel

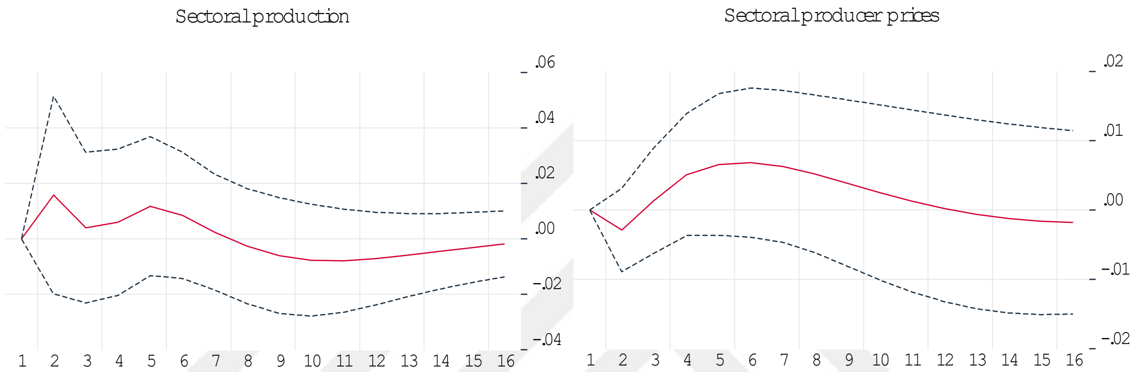



*Figure 29.* VAR(6) model with W/O credit channel

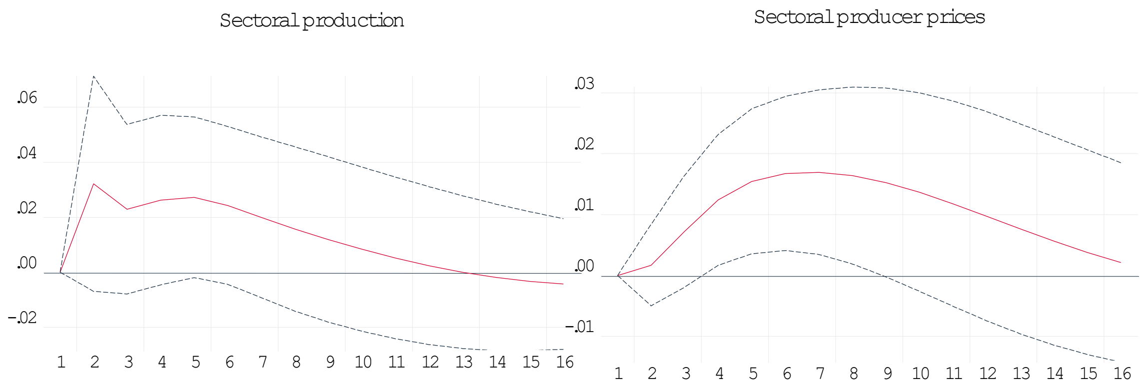



*Figure 30.* VAR(6) model with all channels except interest rate channel

### B.3.2.3 Industry Sector

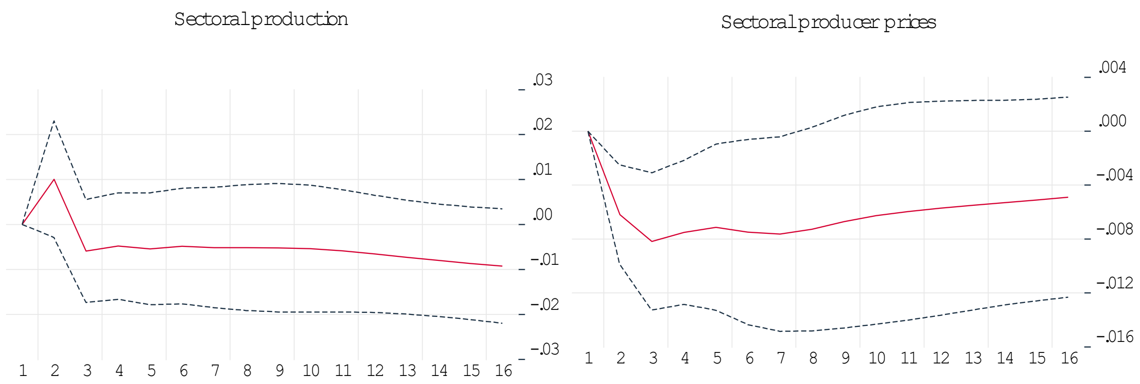



*Figure 31.* VAR(6) model with W/O exchange rate channel

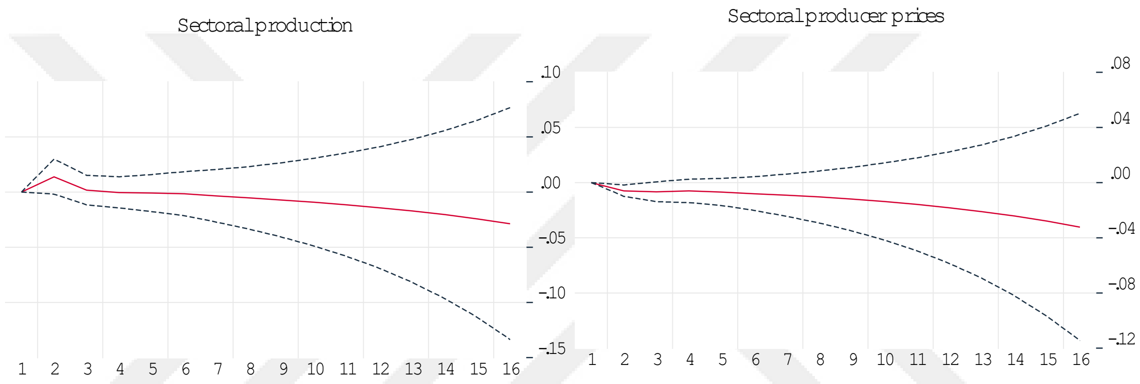



*Figure 32.* VAR(6) model with W/O asset price channel

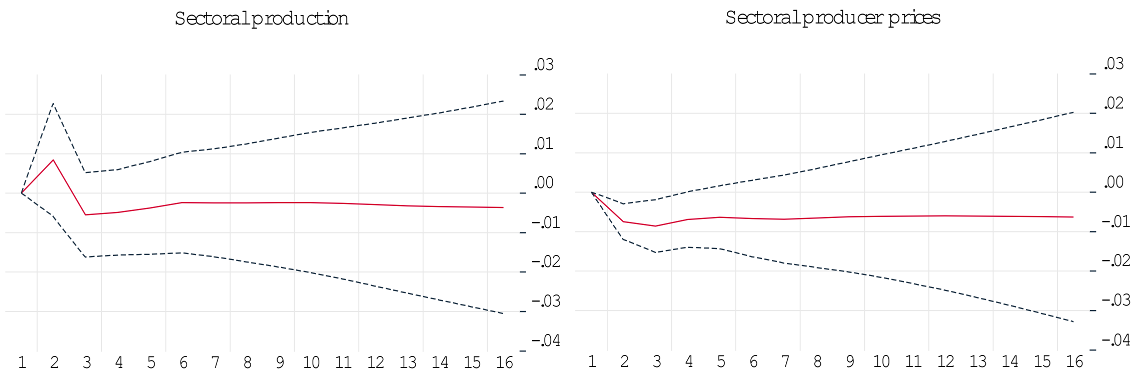



*Figure 33.* VAR(6) model with W/O credit channel

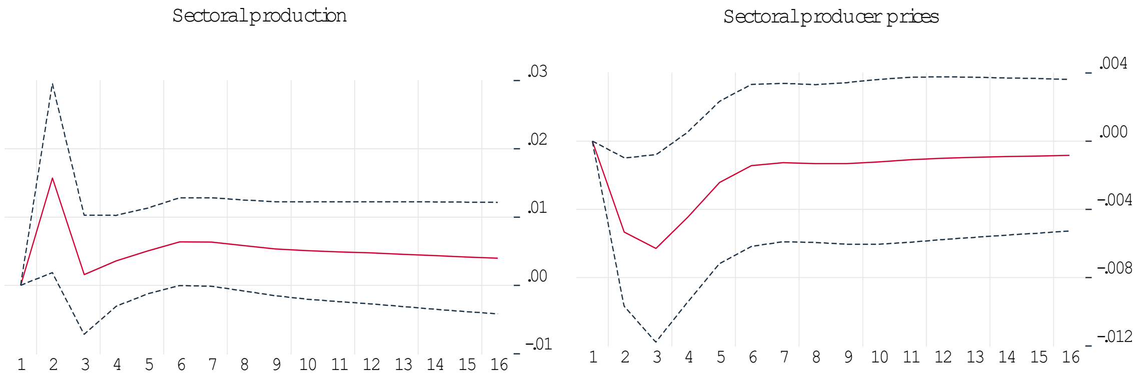



*Figure 34.* VAR(6) model with W/O all channels except interest rate channel

**B.3.2.4. Services Sector**

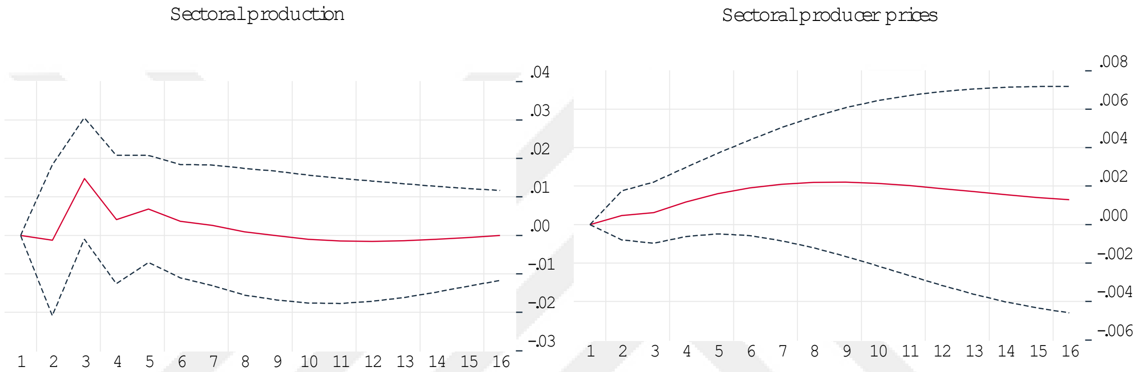



*Figure 35.* VAR(6) model with W/O exchange rate channel

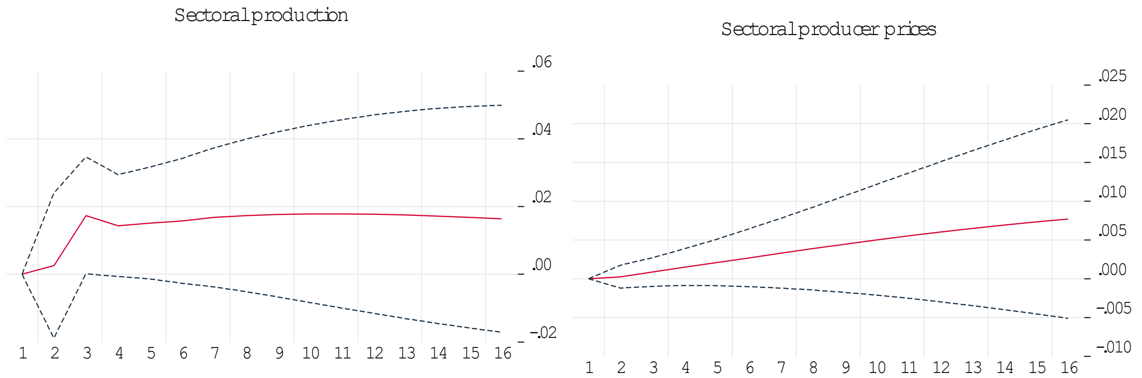



*Figure 36.* VAR(6) model with W/O asset price channel

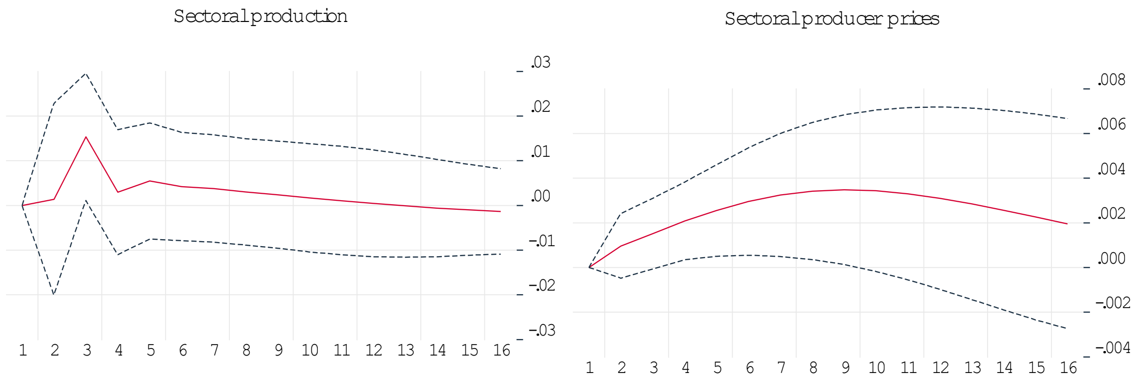



*Figure 37.* VAR(6) model with W/O credit channel

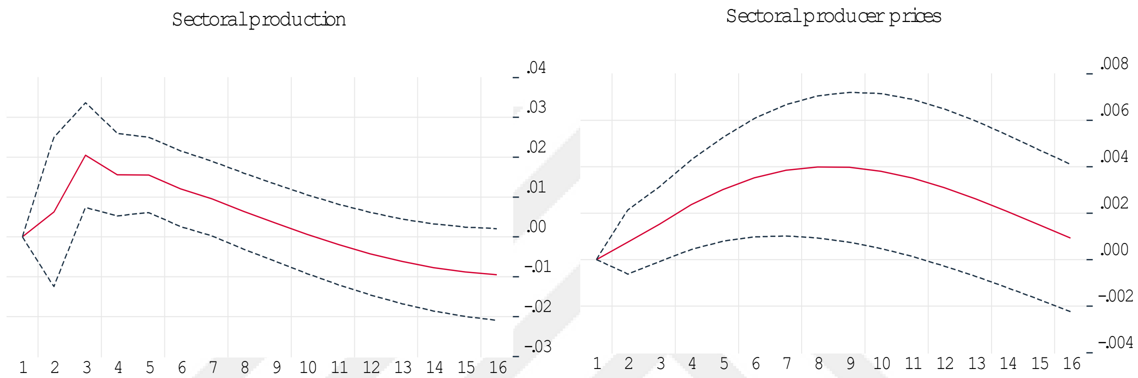



*Figure 38.* VAR(6) model with W/O all sectors with interest rate channel

## Appendix C. Impacts of the Individual Shocks on Macroeconomic Variables

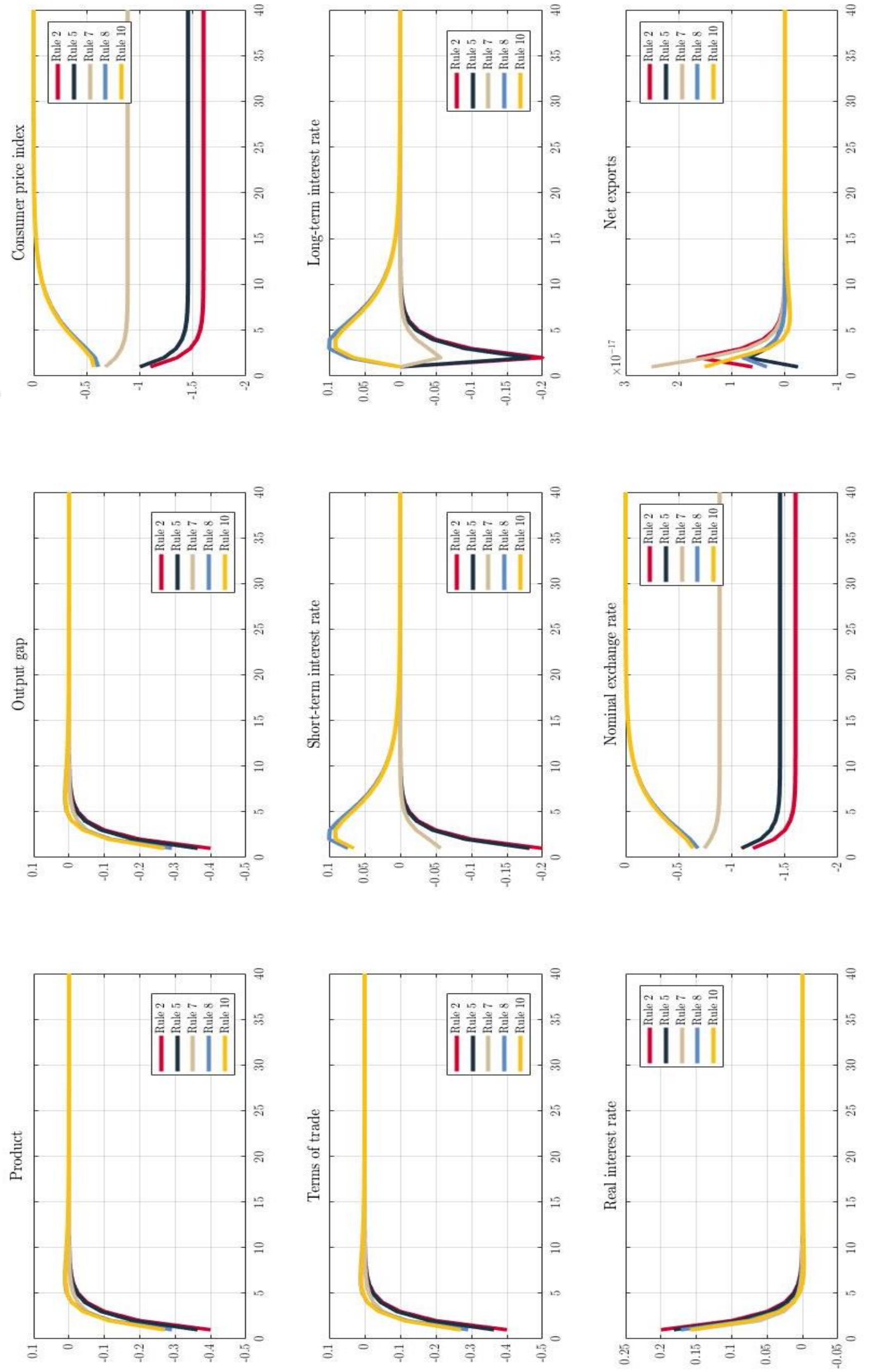



*Figure 39*. Monetary policy shock

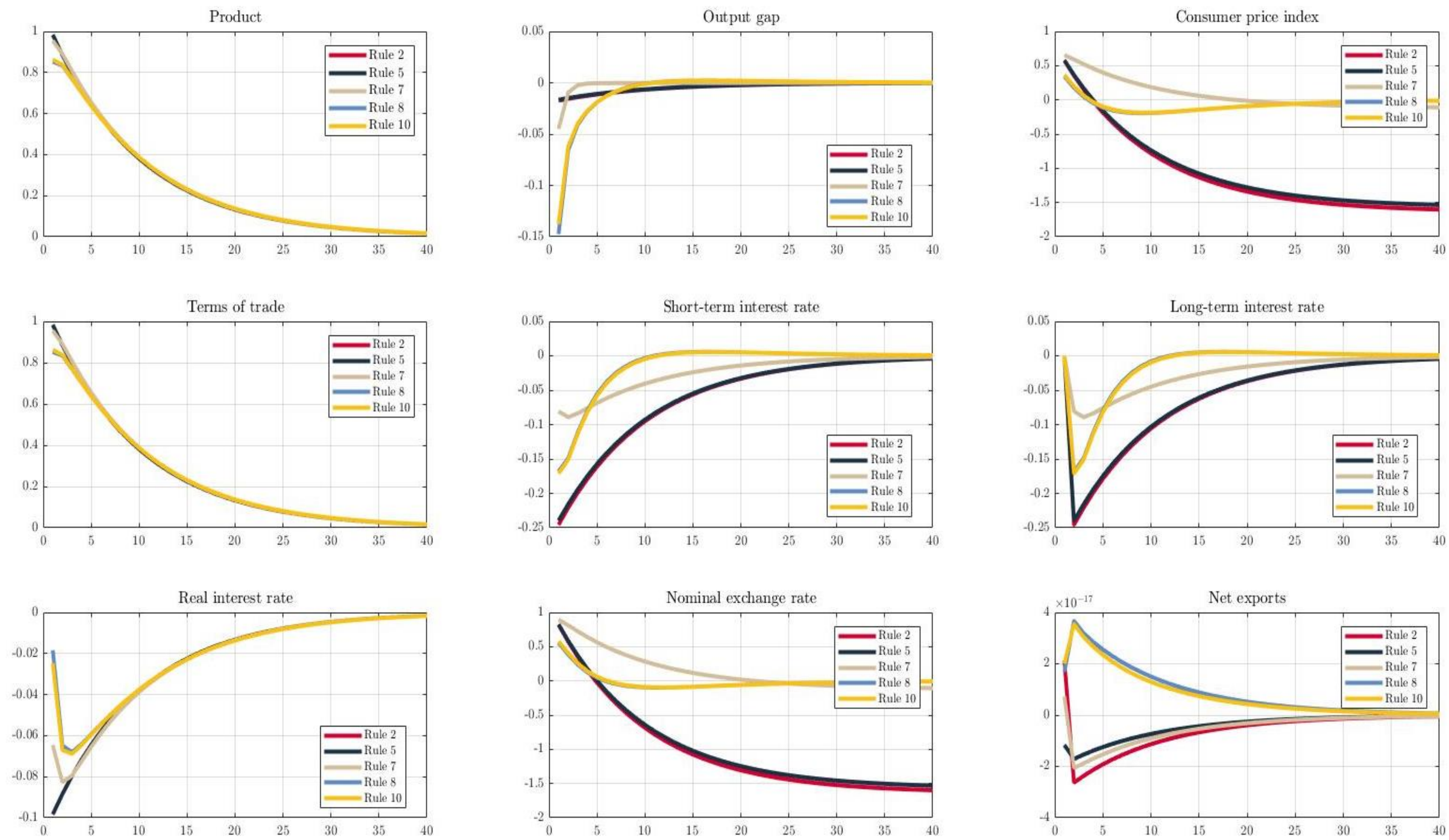



*Figure 40*. Productivity shock

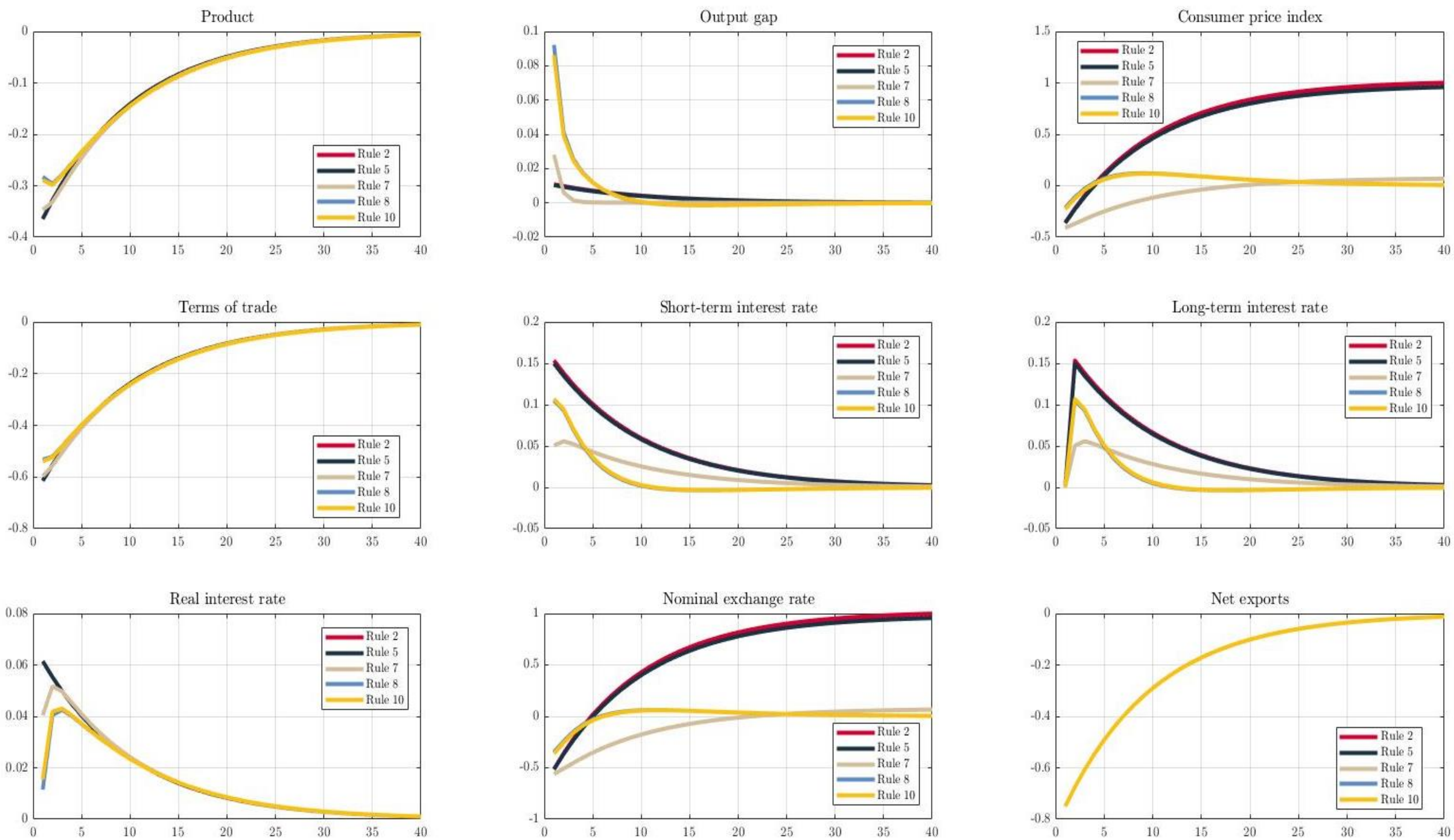



*Figure 41*. Preferences shock

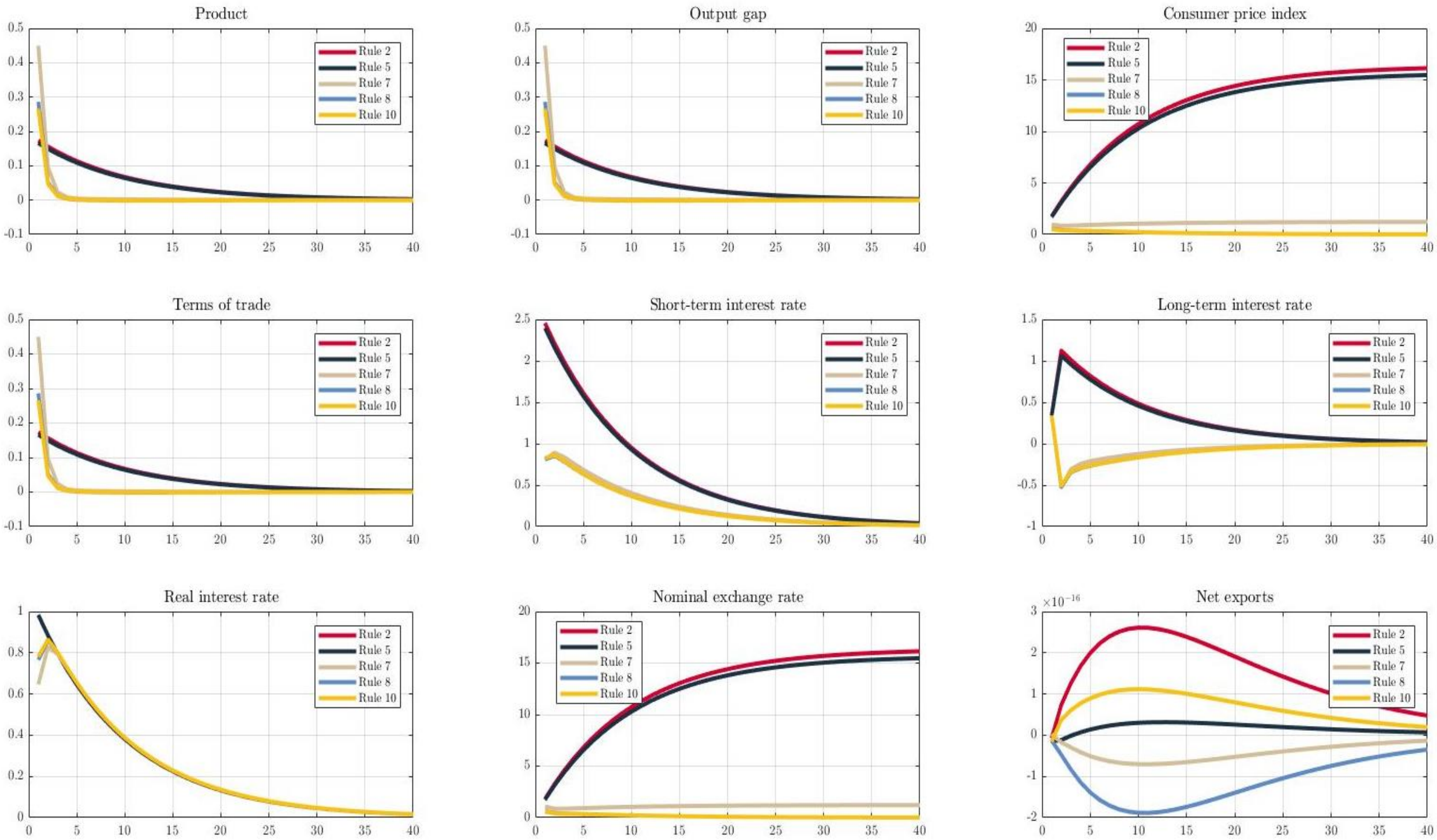



*Figure 42.* International interest rate shock

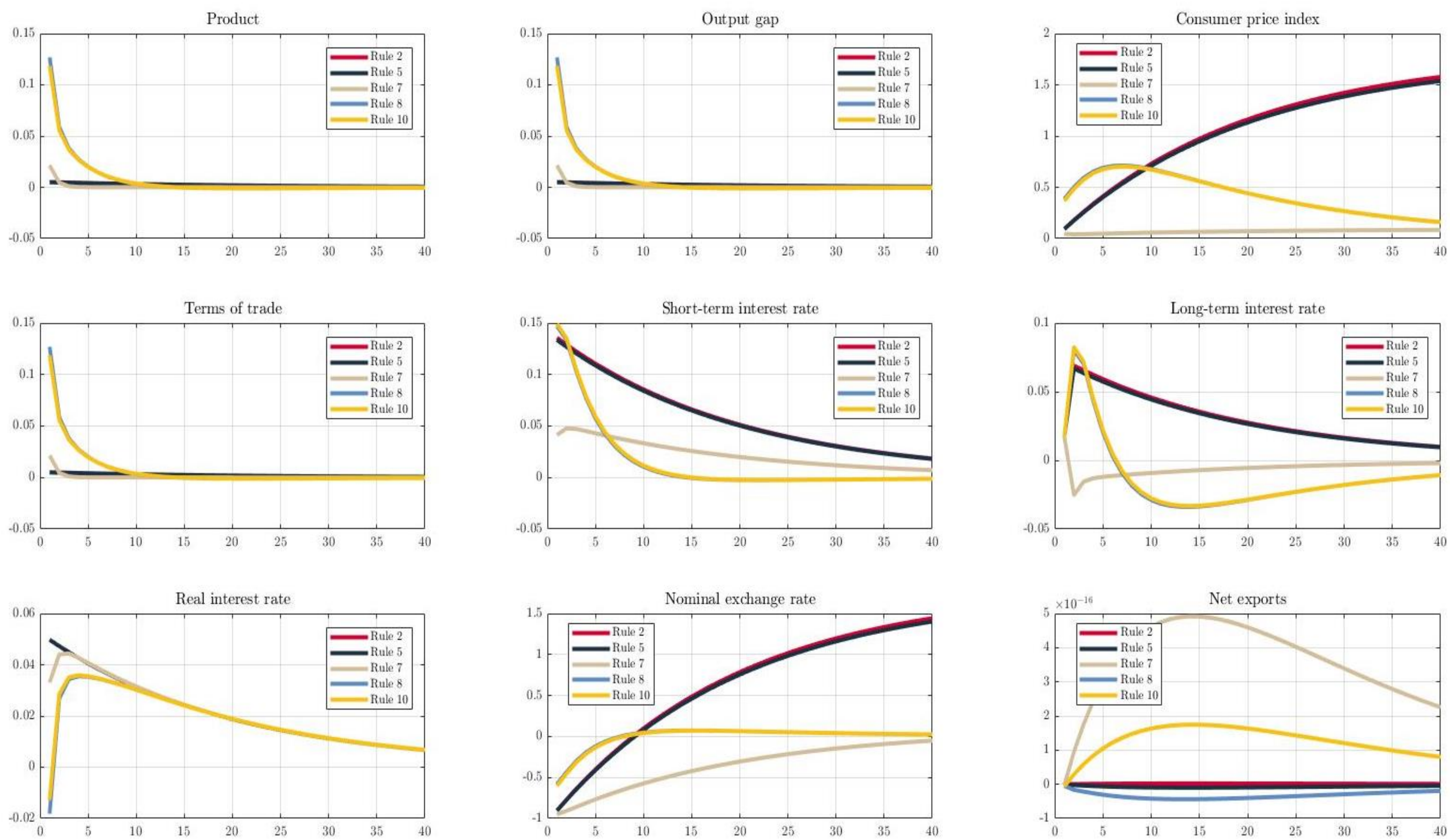



*Figure 43*. World price level shock

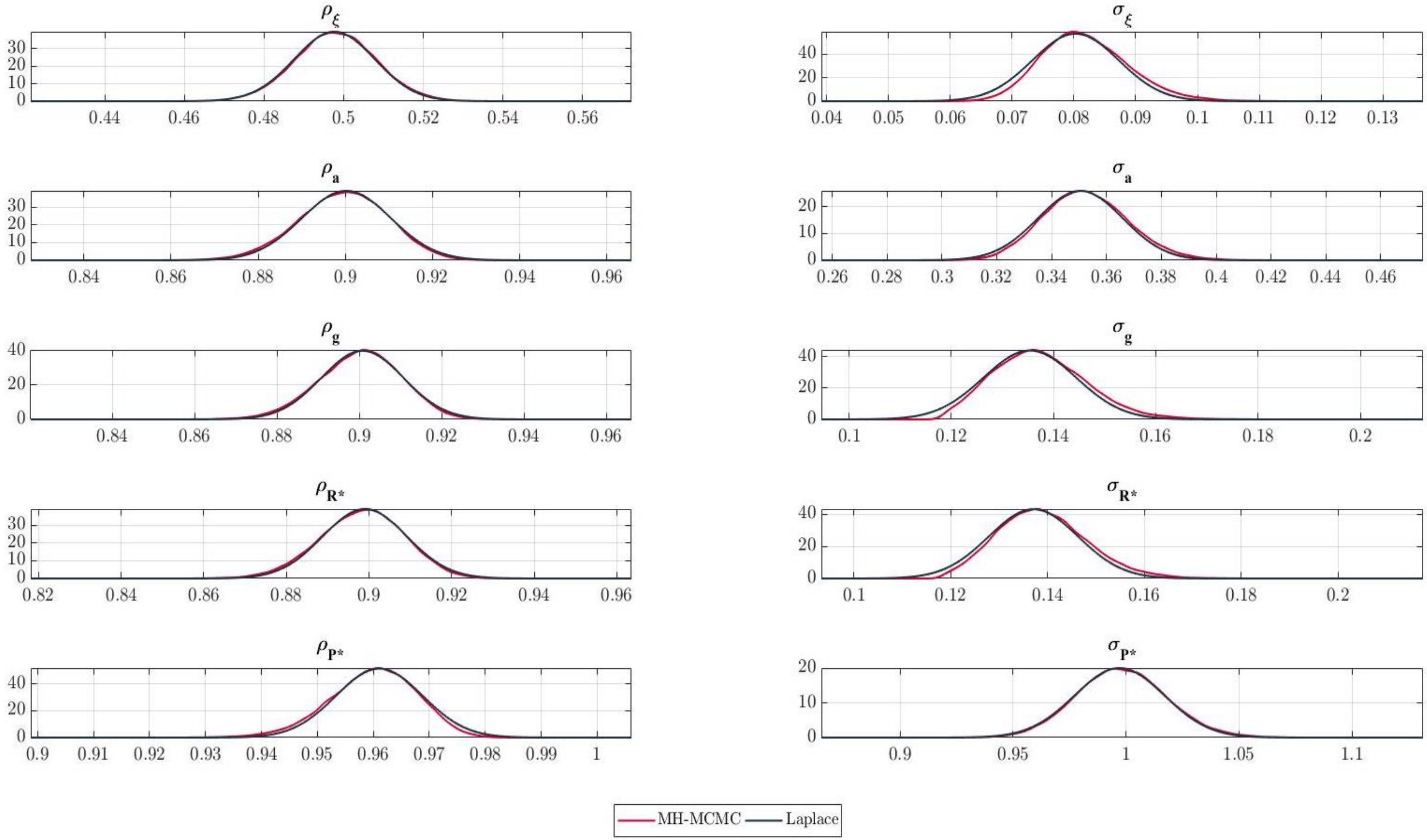



*Figure 44.* Comparison between RWMH-MCMC algrotihm and Laplace approximation