Hacettepe University Graduate School Of Social Sciences

Department of Economics

REAL BUSINESS CYCLE MODELS IN EMERGING ECONOMIES

Oğuz Kaan KARAKOYUN

Ph. D. Dissertation

Ankara, 2024

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The jury finds that Oğuz Kaan Karakoyun has on the date of 03/06/2024 successfully passed the defense examination and approves his Ph. D. Dissertation titled “Real Business Cycle Models In Emerging Economies”.

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Oğuz Kaan KARAKOYUN

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ABSTRACT

KARAKOYUN, Oğuz Kaan. *Real Business Cycle Models in Emerging Economies*, Ph. D. Dissertation, Ankara, 2024.

Emerging Market Economies (EMEs) exhibit different economic dynamics compared to developed markets. While several EMEs have strong growth due to their trade surplus, most of them rely on imported inputs for their production processes and face a significant amount of foreign debt. This thesis seeks to address two crucial research questions concerning the distinctive characteristics of EMEs. The primary objective is to investigate the origins and transmission mechanisms behind economic fluctuations in an EME characterized by a trade deficit and substantial foreign debt. The other objective is to identify the fundamental attributes of EMEs that rely on imported inputs, taking into account different sectors.

Türkiye is an appropriate subject for the study because it has consistent trade deficits and a significant amount of foreign debt. In Chapter 1, we employ both a dynamic stochastic general equilibrium (DSGE) model and the Bayesian estimation technique using the Turkish data. The results indicate that Türkiye exhibits a higher degree of sensitivity to growth shocks. Furthermore, analyzing the fluctuations of the trade balance to output ratio reveals that country premium and domestic spending shock processes, both in the medium and long terms, account for a substantial portion of its fluctuations. The most significant finding is the model's ability to accurately capture the fluctuations in Türkiye's crisis periods (1994, 2001, and 2009).

Over time, the production of final goods has become more reliant on imported inputs. The reasoning behind this situation led to the creation of a conceptual framework in Chapter 2, which includes imported inputs as a factor of production and distinguishes between different sectors. To the best of our knowledge, there is a scarcity of literature that combines imported inputs in production processes and sector differentiation within a theoretical model. The model's findings indicate that there is an inverse relationship between non-tradable goods sector and the macroeconomic variables associated with international trade. Moreover, country premium shock holds the highest significance in elucidating the macroeconomic fluctuations.

Keywords
Emerging Market Economy, Business Cycles, Dynamic Stochastic General Equilibrium, Bayesian Estimation

ÖZET

KARAKOYUN, Oğuz Kaan. *Yükselen Ekonomilerde Reel İş Çevrimi Modelleri*, Doktora Tezi, Ankara, 2024.

Yükselen Piyasa Ekonomileri (EME), gelişmiş piyasalara kıyasla daha farklı ekonomik dinamikler sergilemektedir. Bazı EME'ler ticaret fazlaları nedeniyle güçlü bir büyüme kaydederken, çoğu üretim süreçlerinde ithal girdilere bağımlı ve önemli düzeyde dış borçla karşı karşıyadır. Bu tez, EME'lerin ayırt edici özelliklerini dikkate alarak iki önemli araştırma sorusunu ele almayı amaçlamaktadır. Temel amaç, ticaret açığı ve önemli miktarda dış borçla karakterize edilen bir EME'deki ekonomik dalgalanmaların kökenlerini ve aktarım mekanizmalarını araştırmaktır. Diğer amaç ise farklı sektörleri dikkate alarak, üretimleri ithal girdilere dayalı olan EME'lerin temel özelliklerini belirlemektir.

Türkiye, istikrarlı ticaret açıkları ve önemli miktarda dış borcu olması nedeniyle bu çalışma için uygun bir öznedir. Bölüm 1'de hem dinamik stokastik genel denge (DSGE) modelini hem de Türkiye verilerini kullanan Bayesyen tahmin tekniğini kullanıyoruz. Sonuçlar, Türkiye'nin büyüme şoklarına karşı yüksek düzeyde hassasiyet gösterdiğine işaret etmektedir. Ayrıca ticaret dengesinin çıktıya oranındaki dalgalanmalar incelendiğinde, hem orta hem de uzun vadede ülke primi ve yerel harcama şoku süreçlerinin dalgalanmaların önemli bir kısmını oluşturduğu görülmektedir. En önemli bulgu, modelin Türkiye'nin 1994, 2001 ve 2009 kriz dönemlerindeki dalgalanmalarını doğru bir şekilde yakalayabilmesidir.

Zamanla, nihai mal üretimi ithal girdilere daha bağımlı hale gelmektedir. Bu durumun ardındaki mantık, Bölüm 2'de ithal girdileri üretim faktörü olarak içeren ve farklı sektörler arasında ayrım yapan kavramsal bir çerçevenin oluşturulmasına yol açmıştır. Bildiğimiz kadarıyla, üretim süreçlerindeki ithal girdileri ve sektör farklılıklarını teorik bir model çerçevesinde birleştiren literatür eksikliği bulunmaktadır. Modelin bulguları, ticarete konu olmayan mallar sektörü ile uluslararası ticaretle ilişkili makroekonomik değişkenler arasında ters yönlü bir ilişki olduğunu göstermektedir. Ayrıca, makroekonomik değişkenlerdeki dalgalanmaların aydınlatılmasında ülke primi şoku en açıklayıcı şok sürecidir.

Anahtar Sözcükler
Yükselen Piyasa Ekonomisi, İş Çevrimleri, Dinamik Stokastik Genel Denge, Bayesyen Tahminleme

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LIST OF ABBREVIATIONS

AR	Autoregressive Process
BC	Business Cycles
BIRF	Bayesian Impulse Response Functions
BML	Bayesian Maximum Likelihood Estimating
CAY	Current Account to Output Ratio
CDS	Credit Default Swap
DSGE	Dynamic Stochastic General Equilibrium
EME	Emerging Market Economy
EME-RBC	Emerging Market Economies - Real Business Cycles
EMEs	Emerging Market Economies
FOCs	First Order Conditions
GDP	Gross Domestic Product
GHH	Greenwood Hercowitz Huffman Preference
GMM	Generalized Method of Moments
GNI	Gross National Income
HP	Hodrick-Prescott
IMF	the International Monetary Fund
IRF	Impulse Response Functions
LOP	Law of One Price
MCMC	Markov Chain Monte Carlo
ML	Maximum Likelihood
OECD	the Organisation for Economic Co-operation and Development
OLS	Ordinary Least Squares
PPP	Purchasing Power Parity
PWT	Penn World Table
RBC	Real Business Cycles
SOE	Small Open Economy
SS	Steady State
TBY	Trade Balance to Output Ratio
TUIK	Turkish Statistical Institute
US	the United States
VAR	Vector Autoregression
WB	World Bank
WBD	World Bank Database

INTRODUCTION

"*The good thing about science is that it's true whether or not you believe in it.*"

- Neil deGrasse Tyson

Macroeconomic research has traditionally placed significant emphasis on the analysis of business cycles, which are the recurrent fluctuations in economic activity marked by periods of expansion and contraction. Gaining a comprehensive understanding of the fundamental factors that cause these variations is of the utmost significance for policymakers, economists, and market participants alike. This understanding offers valuable insights into the mechanisms behind economic growth, unemployment, inflation, and financial stability. The Real Business Cycle (RBC) theory, a major framework in macroeconomics, provides a theoretical perspective for analyzing the origins and transmission mechanisms of business cycles.[1]

Emerging Market Economies (EMEs) are essential contributors to the global economy since they stimulate development, foster innovation, and provide investment opportunities. Nevertheless, these countries frequently have distinctive obstacles such as trade deficits and foreign debt, which can have a substantial influence on their economic performance and stability. In this thesis, Chapter 1 seeks to analyze the fluctuations in economic activity in EMEs that are characterized by both negative trade balances and external debt, with a specific focus on the case of Türkiye.

In essence, the primary question driving Chapter 1's investigation is: What are the mechanisms underlying the fluctuations in economic activity in EMEs that exhibit both a trade deficit and foreign debt, with a specific focus on the case of Türkiye? This research question aims to explore the complex interplay between trade imbalances, foreign debt, and economic fluctuations in the Turkish economy.

Türkiye is a suitable subject for the study because it is a notable EME with persistent trade deficits and a significant amount of foreign debt. Through an analysis of Türkiye's experience, our objective is to acquire valuable knowledge on general trends and dynamics that could be applicable to other EMEs encountering comparable difficulties.

[1] See Stockman (1988).

Chapter 1 provides significant advancements in macroeconomic modeling, specifically within the framework of EMEs. Initially, Chapter 1 introduces a modified Dynamic Stochastic General Equilibrium (DSGE) model, specifically tailored to accurately depict the various economic dynamics of Türkiye. This study improves the representation of Türkiye's economic conditions by incorporating trade deficits and foreign debt into the model, leading to a more comprehensive and precise analysis compared to previous models.

Furthermore, Chapter 1 presents innovative and current estimation results, addressing a significant deficiency in the current body of research. Currently, there is a dearth of research that employs data from Türkiye to compute a DSGE model. Our study findings demonstrate that growth shocks are a crucial factor in driving economic fluctuations in Türkiye. These findings offer policymakers useful information that can guide their decision-making process. The focus on Türkiye, along with the concurrent analysis of trade imbalances and foreign debt, indicates significant advancement in the use and assessment of DSGE models for EMEs.

Over time, growing globalization and technological advancements have altered countries' industrial structures. The production of final goods is increasingly dependent on both domestic resources and imported inputs. This rationale led to the establishment of a theoretical framework in Chapter 2, which incorporates imported inputs as a production factor and sector differentiation. As far as we know, there is a dearth of existing literature that incorporates both imported inputs into production processes and sector differentiation within a theoretical model.

Integrating imported goods into production processes is essential due to the substantial amount of imported inputs in EMEs. By incorporating imported inputs into the model, the domestic economy forms a connection with the global economy, not only through the final goods but also through the use of inputs. Thus, we illustrate the influence of fluctuations in global prices and interest rates on domestic production through different transmission mechanisms. Moreover, it is feasible to accurately examine the shock dynamics that may occur in imported input prices. Furthermore, this method enables the expansion and improved understanding of the various channels through which changes in the external environment, such as shifts in interest rates and price levels, can impact the domestic economy.

Chapter 2 of the thesis aims to examine the economic dynamics of EMEs affected by imported inputs and sector differentiation, with a particular emphasis on the non-tradable and tradable goods sectors. Chapter 2 also conducts an examination of the non-tradable and tradable goods sectors, comparing their characteristics and performance. Chapter 2 aims to explore EMEs' economic structure, investigating how fluctuations across different sectors and the utilization of imported inputs influence their performance. The study attempts to analyze the impact of non-tradable and tradable goods sectors on different parts of the economy.

Integrating imported inputs into the production function of an EME's DSGE model significantly improves the model's realism and analytical capabilities. EMEs often have robust ties to global value chains, relying on imported intermediate goods and raw materials to conduct their production processes. By incorporating imported inputs, the model achieves a more accurate depiction of the actual price framework and interdependencies within the economy, highlighting the impacts of fluctuations in exchange rates and disturbances in the global supply chain on domestic output.

This inclusion also facilitates a comprehensive analysis of trade policies, such as tariffs and trade agreements, and their influence on economic activity. Moreover, it enhances our comprehension of how exogenous disruptions, such as changes in worldwide demand and fluctuations in commodity prices, propagate throughout the economy. The inclusion of imported inputs enhances the evaluation of monetary and fiscal policies by highlighting their impact on production costs and inflation. To summarize, this modification improves the accuracy of macroeconomic predictions and the effectiveness of policy simulations, boosting the DSGE model's value as a tool for policymakers in EMEs.

Prior to discussing the approaches employed in both Chapters 1 and 2, it would be beneficial to provide some background information on the RBC theory. The fundamental premise of the RBC theory is that fluctuations in overall economic activity are predominantly caused by external disturbances to technology or productivity, rather than by changes in monetary policy or other nominal factors.[2] The RBC theory, created by Finn Kydland and Edward Prescott in the early 1980s, diverges from classic Keynesian methods of macroeconomic research. The RBC theory focuses on the influence of aggregate demand and nominal rigidities on stimulating business cycles.[3]

The RBC theory differs from traditional Keynesian macroeconomic models by its

[2]See King et al. (1988) and Hansen (1985).
[3]See Gali (1999), McCollum (1999) and Kydland and Prescott (1990).

reliance on microeconomic principles rather than ad hoc aggregate behavioral assumptions.[4] The RBC models presume agents to possess forward-looking skills and rationality,[5] enabling them to make optimal decisions that aim to maximize their utility or profit, while taking into account budgetary and technological constraints. This microeconomic foundation allows for a thorough examination of the consequences of different policy regimes and institutional arrangements.

Another notable feature of the RBC theory is the postulation of adaptable prices and wages. In the RBC models, prices and wages exhibit high flexibility, promptly adapting to variations in supply and demand conditions, thereby guaranteeing the equilibrium of markets and the efficiency of resource allocation.[6] This assumption is in direct opposition to the Keynesian models, which emphasize the significant impact of nominal rigidities, such as rigid prices and wages, on causing fluctuations in the business cycles.

The work of Lucas (1977) is a significant and influential contribution to the field of macroeconomic theory. This work presents fundamental ideas such as rational expectations and endogenous fluctuations, which fundamentally alter economists' understanding and examination of the dynamics of business cycles. These concepts form the foundation of the RBC theory.

Kydland and Prescott (1982) focus on the concept of "time to build," which denotes the delay between making investment decisions and finalizing capital goods, as a pioneering work of the RBC theory. They demonstrate that their model is capable of reproducing important empirical patterns observed in business cycles. These patterns include the enduring nature of output fluctuations, as well as the relationship between investment and output. Additional novel studies on the topic include those by Christiano et al. (1999), Eichenbaum (1995), Galí (1999), and Long and Plosser (1983).

In contrast to the traditional approach, Hodrick and Prescott (1997) employ a method that divides the time series into two distinct components: cycle and trend. The Hodrick-Prescott (HP) filter, or other detrending techniques, have gained widespread recognition for the analysis of time series data in business cycle studies since their 1997 publication.

[4]See Tobin (1992).
[5]See Gottschalk (2005).
[6]See Ball et al. (1988).

The origins of the RBC theory can be traced back to the analysis of complex industrialized economies, but its application is not limited to these particular contexts. There has been an increasing interest in utilizing RBC models for EMEs because of their dependence on international trade and capital movements. These economies encounter different problems and prospects in handling changes in the business cycles, such as susceptibility to exogenous shocks, restricted policy independence, and structural vulnerabilities.[7]

Applying the RBC theory to EMEs involves numerous complicated factors to consider. This statement encourages a thorough analysis of the degree to which the fundamental assumptions of the RBC theory continue to hold true, especially considering the existence of international connections and trade openness. Furthermore, the inclusion of global factors, such as fluctuations in currency rates and movements of capital, in the RBC models prompts important inquiries on the consequences for comprehending the complexities of business cycle dynamics.

Moreover, policymakers in EMEs encounter the difficult responsibility of managing the compromises between the goals of maintaining stability within the country and the limitations imposed by external factors. In order to achieve economic resilience and sustainability, it is imperative to efficiently manage the competing priorities at hand. This thesis, from a different point of view, aims to address these issues by employing two distinct models across two separate chapters.

A trade deficit arises when a country's imports exceed its exports, leading to a net outflow of goods and services. Türkiye's ongoing trade deficits have generated worries about the long-term sustainability of its economic development. Chapter 1 will examine the role of trade deficits in the fluctuation of Türkiye's business cycles, impacting important economic variables including the Gross Domestic Product (GDP) growth, investment growth, and consumption growth.

Foreign debt refers to the total financial obligations that a country has to repay to international lenders. Türkiye accumulates a substantial amount of foreign debt over time,[8] raising concerns about its ability to repay the loan and its susceptibility to external shocks. Chapter 1 will analyze the effects of foreign debt on Türkiye's business cycles, investigating how debt dynamics interact with other macroeconomic factors to influence economic performance.

[7] See Neumeyer and Perri (2005), Uribe and Yue (2006), Aguiar and Gopinath (2007) and Garcia-Cicco et al. (2010).

[8] Türkiye's external debt to GDP ratio was 51% in 2022, according to the World Bank dataset.

Ultimately, comprehending the intricacies of economic fluctuations in EMEs such as Türkiye is of utmost importance for policymakers, investors, and researchers who aim to navigate the complexities of global economic patterns. The primary objective of Chapter 1 is to provide insight into the difficulties and potential advantages that EMEs encounter in a world that is becoming more interconnected. This will be achieved by analyzing the relationship between trade deficits, foreign debt, and economic fluctuations.

Chapter 1 uses a DSGE model as a methodology to focus on the Turkish economy. The existing body of literature encompasses a multitude of empirical and theoretical investigations pertaining to EMEs, including Argentina and Mexico. Specifically, there is a scarcity of studies that utilize the estimation approach with Turkish data. This is a novel contribution to the limited body of research on this topic.

Chapter 1 builds the model based on the work of Garcia-Cicco et al. (2010). The country premium shock in the model has been altered, in contrast to the initial study on the Argentinian economy. The Turkish economy's past trade deficit prompts an adjustment in the level of long-term external borrowing to equalize the trade balance. In summary, we have adapted the model to accommodate the coexistence of external debt and the trade deficit.

The majority of the model parameters are calibrated using relevant literature and parameter values derived from the original study. Using annual Turkish data, we calibrate the other parameters, such as the proportion of government expenditures in the GDP and the ratio of long-term external debt to GDP. The calibration process utilizes two datasets, the Penn World Table (PWT) and the World Bank Dataset (WBD), from 1950 to 2019.

We then proceed with the model estimation process. We employ the Bayesian estimation method (BML) as the chosen approach to estimate the non-observable parameters from the data, including the persistency and volatility parameters of the shock processes. The estimation results align with the previous investigations documented in the existing literature.

Chapter 1 also examines the growth experiences of selected EMEs, namely Argentina and Mexico, and Türkiye during the past seven decades. Based on the data, it is evident that Türkiye experiences significant volatility when it experiences relatively high growth. This condition implies that the growth shocks have a greater impact on Türkiye than on Argentina. Chapter 1 examines this particular implication. Additionally, we analyze the model findings using Impulse Response Function (IRF) analysis and the conditional variance decomposition.

We identify the role of growth and technology shocks in explaining fluctuations in output growth. Furthermore, we find that both growth and country premium shock processes have a substantial role in explaining the fluctuations of the trade balance to output ratio. To perform a more comprehensive inquiry, we examine the impact of the domestic crises that occurred in Türkiye in 1994 and 2001, as well as the global financial crisis of 2008, on the country.

In Chapter 1, the estimation approach reveals the connection between the shock variables, which are the technology, growth, and country premium shocks, and the selected variables, which are output growth and the trade balance to output ratio, during the years of crisis of Türkiye. We closely observe the three-year period before and after these three crises, which reach their peak intensity in the designated year zero. The shock variables derived from the model accurately portray Türkiye's economic conditions during years of crisis. These findings represent the most significant contribution of Chapter 1 to the literature.

In Chapter 2, the main objective is to introduce a benchmark model that incorporates imported inputs and sector differentiation while also accurately representing the distinctive structure of EMEs. Chapter 2 constructs a DSGE model, which includes households contributing labor and capital to various sectors and firms producing final goods using labor, capital, and imported inputs. Furthermore, borrowing from external sources and importing inputs creates a connection with the rest of the world. Hence, there is an opportunity to analyze the impacts of fluctuations in exchange rates that link the domestic economy with the global markets.

Sector differentiation refers to the existence of different sectors within the economy, each with its own set of characteristics and dynamics. Within EMEs, the non-tradable goods sector generally includes industries that largely serve the domestic market, including retail, construction, and services. Conversely, the tradable goods sector encompasses industries engaged in global trade, such as agriculture and manufacturing. Comprehending the complex nature of these industries is crucial for assessing their impact on economic growth.

Imported inputs are essential in the production process of both the non-tradable and tradable goods sectors in EMEs. The inputs might consist of raw materials, intermediate goods, and capital equipment, which are crucial for sustaining competitiveness and efficiency. Nevertheless, EMEs' dependence on imported inputs also makes them vulnerable to other risks, including supply chain disruptions, volatility in exchange rates, and trade barriers. These risks have the potential to impact their economic stability.

In contrast to contemporary works, the model incorporates exogenous foreign price shocks. This shock process refers to sudden changes that might happen in the prices of tradable goods in international marketplaces. It is crucial for EMEs that lack the authority to set global prices to analyze the impacts of this shock process. Furthermore, the model includes exogenous shocks to the price levels of imported inputs, which distinguishes it from the existing literature. We calibrate the model's parameters following the relevant literature, and we also compute the model's steady state solutions. We compare the obtained results with data from Türkiye as an indicator of an EME. Finally, we apply IRFs and variance decomposition analyses to examine the model results.

We dedicate the final section of Chapter 2 to performing robustness tests. Given the impact of external circumstances on the domestic economy, we employ various scenarios to determine the foreign interest rate. We analyze the IRFs for each scenario, where the interest rate is defined as debt-elastic, income-elastic, and exogenously given. The findings remain mostly unaffected by changes in interest rate definitions.

Ultimately, we validate the model outcomes by arbitrarily selecting shock persistency parameters across multiple levels. Changing the persistency parameters has no impact on the model outcomes, despite alterations in the response values of the chosen variables to the shock processes and the duration of the shock processes' influence.

To summarize, this thesis seeks to address the existing gap in the literature regarding two significant issues. Initially, we analyze the origins and aspects of economic fluctuations in Türkiye or a similar EME with characteristics resembling those of Türkiye, such as a negative balance of trade and indebtedness to foreign entities. Next, we examine the impact of utilizing imported inputs in the production processes of an EME with sector differentiation. In addition to these two significant foundational contributions, we present novel shock processes, such as foreign price and imported input prices shock processes.

The thesis is organized in the following manner. Chapter 1 presents a DSGE model that has been constructed in alignment with the economic structure of Türkiye. Chapter 1 introduces the model parameter calibration and the estimation approaches. The findings will be analyzed using the second moments, IRFs, and the conditional variance decomposition analyses. We also compare the growth experiences of Türkiye and some selected EMEs such as Argentina and Mexico over the past 70 years by dividing them into sub-periods. Finally, we analyze the fluctuations in output growth and the trade balance to output ratio throughout the crisis periods of 1994, 2001, and 2008, as well as the shock processes derived from the model.

Chapter 2 presents a DSGE model that incorporates both non-tradable and tradable goods sectors. Furthermore, the production of these sectors involves the utilization of imported inputs. Next, we focus on the calibration of the parameters and the subsequent analyses of the obtained results. Furthermore, Chapter 2 incorporates a range of rigorous tests to assess the robustness of the findings. Ultimately, the final chapter is the concluding remarks of the thesis.

CHAPTER 1

UNDERSTANDING REAL BUSINESS CYCLES IN TÜRKİYE

1.1. INTRODUCTION

Emerging market economies (EMEs) are vital to the global economy, but their distinct features present difficulties for conventional macroeconomic analysis. Their openness to engage in international trade makes them vulnerable to variations in worldwide demand, unexpected changes in trade conditions, and the movement of capital, all of which can have a substantial impact on domestic economic activity.[9] Furthermore, their limited capacity to implement autonomous monetary and fiscal measures renders them susceptible to external disturbances and requires a reassessment of conventional macroeconomic frameworks.[10]

The literature started analyzing EMEs in the early 1990s and later compared them to developed countries. Mendoza (1991), Correia et al. (1995), and Agenor et al. (2000) are notable examples of pioneering studies in the field. Mendoza's (1991) model accurately reflects the observed positive relationship between savings and investment, despite the complete mobility of financial capital and the countercyclical fluctuations in external trade. The findings indicate that fluctuations in "terms-of-trade" have a significant impact, explaining approximately 50% of the observed fluctuations in GDP.

Correia et al. (1995) demonstrate that a simple type of time-separable preferences can accurately explain the cyclical fluctuations in the components of the national income account identity, as well as the countercyclical nature of the trade balance. Agenor et al. (2000) demonstrate numerous similarities in macroeconomic fluctuations between EMEs and advanced economies, such as the correlation of real wages with business cycles and the inverse relationship between government expenditures and economic fluctuations. However, there are also notable distinctions, such as the inverse relationship between the velocity of monetary aggregates and macroeconomic fluctuations of output.

[9] See Kose (2002).

[10] See Bauducco and Caprioli (2014) and Gali and Monacelli (2005).

Researchers are conducting a significant number of investigations to examine the origins of fluctuations in EMEs. Changes in global interest rate or global price level directly impact EMEs. Blankenau et al. (2001) claim that real interest rate shocks have the ability to account for approximately 33% of the fluctuations in output and over 50% of the fluctuations in net foreign assets and net exports. Kose (2002) also finds that changes in global prices are a major contributor to fluctuations in economic activity in EMEs.

In general, early studies about EMEs lack financial rigidity. Furthermore, they have neglected to demonstrate numerous stylized phenomena evident in the data, such as the significant fluctuations in consumption and the negative correlation between GDP with the trade balance. Since the early 2000s, there has been a substantial increase in the number of successful studies reflecting the features of actual data.

Neumeyer and Perri (2005) assert that global interest rates display a countercyclical pattern and serve as a leading indicator of the economic cycle. Nevertheless, Uribe and Yue (2006) have criticized Neumeyer and Perri's study's assumption that the United States (US) interest rate and the country spread follow a first-order and bivariate autoregressive process. Their primary finding indicates that the US interest rate shocks contribute to approximately 20% of the fluctuations in the overall economic activity of EMEs.

According to Aguiar and Gopinath's (2007) assertion, the main cause of fluctuations in EMEs is shocks to long-term economic growth, as opposed to short-term variations around a stable trend. In the literature, this argument is commonly known as *"the cycle is the trend"*. However, Garcia-Cicco et al. (2010) construct an extended model that incorporates financial frictions to demonstrate that the long-term Argentinian data does not support Aguiar and Gopinath's (2007) findings. Besides, their findings corroborate Uribe and Yue's (2006) research.

Chang and Fernandez (2013) argue that trend shocks are insignificant in elucidating macroeconomic fluctuations. Their model explains overall changes by emphasizing the significant impact of financial frictions on typical transitory productivity shocks, whereas trend shocks have a minimal effect. Boz et al. (2012) corroborate the findings of Chang and Fernandez (2013), but their theory is based on learning effects rather than the financial frictions. Both studies use data from Mexico, but for different time periods.

A significant amount of research in the literature is dedicated to studying EMEs and their business cycles. Scholars have conducted numerous important studies, particularly focusing on countries such as Argentina and Mexico. Currently, Türkiye, often regarded as one of the most important EMEs, lacks a comprehensive study of its business cycles.

Researchers have conducted studies such as Alp et al. (2012), Alper (2002), Cebi (2012), Tastan and Asik (2014), and Yuksel (2013) to analyze the business cycles in relation to the Turkish economy. This chapter distinguishes itself from previous research by presenting an extended theoretical framework, utilizing long-term data for the estimations, and providing a more comprehensive explanation of economic fluctuations by incorporating financial frictions into widely accepted models.

This chapter focuses on identifying the key factors that cause fluctuations in economic activity in EMEs, which are characterized by both trade deficits and foreign debt. To investigate this issue, we perform a case study on Türkiye. The objective of this research question is to investigate the intricate relationship between trade imbalances, foreign debt, and economic fluctuations in the Turkish economy. Türkiye is an appropriate subject for the study due to its status as an EME characterized by consistent trade deficits and a substantial level of foreign debt. Our goal in examining Türkiye's experience is to gain important insights into overall patterns and dynamics that may be relevant to other EMEs facing similar challenges.

The objective of this study is to examine the long-term business cycles in Türkiye by employing the Financial Frictions Model established by Garcia-Cicco et al. (2010) using the DSGE methodology. The inclusion of financial frictions offers a more compelling explanation for the factors that drive economic activity and enables an examination of their significance. Financial frictions are significant factors in the occurrence of fluctuations. Moreover, the financial frictions model provides a more comprehensive explanation for the fluctuations when compared to the baseline models. The constructed model redefines the connection between domestic and world interest rates, resulting in a negative trade balance. Section 1.2. presents the details of the model.

This chapter makes significant contributions to the field of macroeconomic modeling, particularly in the context of EMEs. Firstly, it presents a modified DSGE model that is specifically designed to accurately represent the different economic dynamics of Türkiye. This research enhances the portrayal of Türkiye's economic environment by including both trade deficits and foreign debt in the model, resulting in a more comprehensive and accurate analysis compared to prior models.

Furthermore, this chapter provides novel and up-to-date estimation findings, filling a notable gap in the existing research. As far as we know, there is a lack of research that calculates a DSGE model using data from Türkiye. The results of our study indicate that growth shocks play a vital role in causing economic fluctuations in Türkiye. These findings provide policymakers with valuable insights that can inform their decision-making process. The emphasis on Türkiye, combined with the simultaneous examination of trade deficits and foreign debt, signifies notable progress in the implementation and estimation of DSGE models for EMEs.

In this study, we conduct a historical comparison of the growth rates of Türkiye and selected EMEs, Argentina and Mexico. We obtain intriguing findings in the comparison by utilizing data spanning a substantial duration of around 70 years. While the 70-year average output growth and volatility of output growth exhibit similarities, we identify notable distinctions across different time periods. As an illustration, Argentina, which had a comparatively higher rate of economic growth during the 1990s, experienced a period of significant economic decline due to the crisis it faced from 1998 to 2002. When comparing the volatilities of the economic boom and crisis periods of Argentina, they exhibit significant similarities.

Given the disparities in growth rates among Argentina, Mexico, and Türkiye, our study specifically examines the impacts of Türkiye's domestic economic crises in 1994 and 2001, as well as the global financial crisis of 2008. During the crisis years, we examined the correlation between the shock variables derived from the model and several macroeconomic variables. We discover that negative growth shocks are a significant factor in Türkiye's economic collapse. Furthermore, the research revealed that during times of crisis, the foreign trade deficit considerably decreased due to the negative growth shocks.

Furthermore, the estimation process determines the model parameters using extensive historical yearly data specifically collected from Türkiye from 1950 to 2019. The data is sourced from the Penn World Table (PWT) dataset. The variables selected for estimation are the output growth (g_Y), the consumption growth (g_C), the investment growth (g_I), and the trade balance to output ratio (tby). We estimate the model parameters using the Bayesian estimation method. The estimation results align with the relevant literature. The estimated parameters, derived from Turkish data, provide a novel contribution to the existing literature. In addition, we conduct the Impulse Response Functions (IRFs) analysis and the conditional variance decomposition analysis based on the parameters obtained through the Bayesian estimation technique.

A shock process is persistent if its effects take a longer time to dissipate. We discover that the persistency of growth shocks in Türkiye is quite significant compared to Argentina and Mexico. Accordingly, growth shocks have a greater impact on nearly all macroeconomic indicators, especially in the long-term. Furthermore, there is a similarity between the persistency parameter of technology shock in Argentina, Mexico, and Türkiye. The model results corroborate the findings of Aguiar and Gopinath's (2007) investigation.

The study's key findings indicate that the model accurately represents the data in relation to the second moments. The order of the volatilities of the selected variables is $\sigma_{tby} < \sigma_{g_I} < \sigma_{g_C} < \sigma_{g_Y}$ in accordance with the Turkish data. In addition, the relative volatilities obtained from the model are consistent with the data. Moreover, the correlation coefficients of the variables exhibit compatibility between the data and the model results. While the correlation coefficients of g_Y with g_C and g_I are positive, the correlation coefficient of g_Y with tby is negative.

The findings of the IRFs align with the prevailing macroeconomic expected outcomes. The positive technology and the positive growth shocks have a positive impact on g_Y, g_C, and g_I; nevertheless, the consequences of these shocks vary. Like Garcia-Cicco et al.'s (2010) research, the country premium shock significantly affects the fluctuations of tby. Nevertheless, the country premium shock does not exert a substantial influence on g_I.

Technology shocks have a more significant impact on the output growth and consumption growth variables in the short run through conditional variance decomposition, while growth shocks have a stronger effect in the medium and long terms. The Turkish data, unlike the Argentinian study, suggests that the intertemporal preference shock does not significantly influence the volatilities of the variables. However, in terms of the fluctuations of tby, the domestic spending shock appears to be especially significant in the context of Türkiye. One of the primary factors contributing to this phenomenon is the comparatively greater government expenditures to GDP ratio observed in Türkiye compared to Argentina.

The following section of the study offers an in-depth analysis of the employed model. In Section 1.3. and 1.4., the analysis includes the utilization of the data, the process of calibration, and the outcomes of estimation. Section 1.5. investigates the results of IRFs in relation to several shock processes. Also, in Section 1.5., the results obtained in the original investigation are compared with the results obtained in this study specifically for Türkiye via conditional variance decomposition analysis. Section 1.6. includes discussions that specifically focus on the model's findings and data. We initially focus on the periods of crisis in Türkiye. This section presents a comparative analysis of the data and the shock variables in different crisis periods. Section 1.6. also analyzes the historical growth rates of Türkiye and selected EMEs, Argentina and Mexico, by categorizing them into several sub-periods. In this section, we will also discuss what the model teaches us about Türkiye's economic dynamics. Finally, the concluding remarks are presented in Section 1.7.

1.2. MODEL

This section presents the constructed model. In the current economic environment, only final goods are available. The production of these goods is contingent upon the availability of both labor and capital. The production function is the following expression:

$$Y_t = a_t K_t^{\alpha} (X_t h_t)^{1-\alpha} \tag{1}$$

where the capital's share of output $\alpha \in (0, 1)$. Y_t, K_t, and h_t are output, capital, and labor respectively. Furthermore, a_t and X_t are productivity processes.

While the variable a_t represents the temporary technological shock, the variable X_t represents the permanent effects of the technological shock on productivity. To facilitate illustration and calibration, different notations are employed to represent shocks to the "level of productivity" (a_t) and the "growth of productivity" (X_t). Throughout the entire chapter, we represent variables with a trend in equilibrium with uppercase letters, and variables without a trend in equilibrium with lowercase letters.

In the context of natural logarithms, it is presumed that a_t corresponds to a first-order autoregressive process (AR(1)):

$$\ln a_t = \rho_a \ln a_{t-1} + \epsilon_t^a; \quad \epsilon_t^a \sim N(0, \sigma_a^2) \tag{2}$$

X_t is nonstationary. Let $g_t = \frac{X_t}{X_{t-1}}$ represents X_t's gross growth rate. The realizations of g_t are often referred to as "growth" shocks due to the fact that they represent the stochastic trend in productivity. g_t follows an AR(1) process:

$$\ln\left(\frac{g_t}{\bar{g}}\right) = \rho_g \ln\left(\frac{g_{t-1}}{\bar{g}}\right) + \epsilon_t^g; \quad \epsilon_t^g \sim N(0, \sigma_g^2) \tag{3}$$

where $\bar{g}$ represents the deterministic gross productivity growth rate. The parameters $\rho_a, \rho_g \in [0, 1)$ are the persistency parameters of the shock processes. Also, the parameters $\sigma_a, \sigma_g > 0$ are the volatilities of the shock processes.

The household's budget constraint is as follows:

$$Y_t + \frac{D_{t+1}}{1 + r_t} = C_t + S_t + I_t + D_t + \frac{\phi}{2}\Big(\frac{K_{t+1}}{K_t} - \bar{g}\Big)^2 K_t \tag{4}$$

where r_t represents the domestic interest rate and the variable D_{t+1} represents the amount of external debt obtained during period t. Also, C_t, I_t, and S_t are consumption, investment, and domestic spending, respectively. The last expression is the capital adjustment cost. ϕ is the capital adjustment cost parameter.

To clarify, S_t stands for unanticipated government expenditures. In the context of AR(1), the variable S_t signifies the exogenous stochastic domestic spending shock process:

$$\ln\left(\frac{s_t}{\bar{s}}\right) = \rho_s \ln\left(\frac{s_{t-1}}{\bar{s}}\right) + \epsilon_t^s; \quad \epsilon_t^s \sim N(0, \sigma_s^2) \tag{5}$$

where $s_t = \frac{S_t}{X_{t-1}}$ and the parameter $\bar{s}$ denotes the long-term share of public spending to GDP. The parameter $\rho_s \in [0, 1)$ and $\sigma_s > 0$ are the persistency parameter and the volatility of the shock process respectively.

The following expression shows the law of motion of capital:

$$K_{t+1} = I_t + (1 - \delta)K_t \tag{6}$$

where $\delta \in (0, 1)$ is depreciation rate.

The household desires to maximize the following lifetime utility function by choosing consumption, labor, capital, and debt stock:

$$\max_{\{C_t,h_t,K_{t+1},D_{t+1}\}} E_0 \sum_{t=0}^{\infty} \beta^t v_t \frac{(C_t - \theta\omega^{-1}X_{t-1}h_t^{\omega})^{1-\gamma} - 1}{1-\gamma} \tag{7}$$

where β, θ, ω, and γ are the discount factor, labor coefficient in the utility function, exponent of labor in the utility function, and intertemporal elasticity of substitution, respectively.

In Equation 7, v_t is the intertemporal preference shock process. It is also exogenous and follows AR(1):

$$\ln v_t = \rho_v \ln v_{t-1} + \epsilon_t^v; \quad \epsilon_t^v \sim N(0, \sigma_v^2) \tag{8}$$

where the parameter $\rho_v \in [0, 1)$ and $\sigma_v > 0$ are the persistency parameter and the volatility of the shock process respectively.

We assume that this EME faces a debt elastic interest rate premium to be consistent with the related lirature (as in Aguiar and Gopinath (2007)):

$$r_t = r^* + e^{\mu_t - 1} - 1 + \psi\left(e^{\frac{D_t}{X_{t-1}} - \bar{d}} - 1\right) \tag{9}$$

where r^*, μ, ψ and $\bar{d}$ are the global interest rate, country premium shock, the debt elasticity of the interest rate and the long-term debt level respectively. The original study defines the $\bar{d}$ parameter as the long-term ratio of trade balance to GDP. At the long-term equilibrium level, this assumption guarantees that the country can maintain external debt when experiencing a foreign trade surplus, and have a creditor from the outside world (negative external debt) when facing a foreign trade deficit. In the economic model of Türkiye, which features a trade deficit and external debt simultaneously, $\bar{d}$ represents the long-term equilibrium external debt level and it can be shown as $\bar{d} = \tilde{d}Y^{ss}$, where $\tilde{d}$ and Y^{ss} represent the long-term debt to GDP ratio and the steady state level of output, as described in the Schmitt-Grohe and Uribe's (2003) research.

Furthermore, the country premium shock process, μ_t, is exogenous and follows AR(1) as well:

$$\ln \mu_t = \rho_\mu \ln \mu_{t-1} + \epsilon_t^\mu; \quad \epsilon_t^\mu \sim N(0, \sigma_\mu^2) \tag{10}$$

where the parameter $\rho_\mu \in [0, 1)$ and $\sigma_\mu > 0$ are the persistency parameter and the volatility of the shock process respectively.

Eventually, the household maximizes Equation 7 subject to Equations 1, 4, and 6 by assuming as given the initial conditions, D_0 and K_0 and the shock processes, a_t, g_t, s_t, v_t, and μ_t. Also, no-ponzi condition must hold to obtain the deterministic steady state as follows:

$$\lim_{T\to+\infty} E_t \frac{D_{t+T}}{\prod_{i=0}^{T}(1+r_i)} \leq 0 \tag{11}$$

By log-linearizing the resource constraints and the first order conditions around the deterministic steady state, we numerically solve the normalized model. The uniqueness of the equilibrium is established based on the presumption of the first-order approximation. Furthermore, the steady state conditions of the model are presented in Appendix 1.

1.3. DATA AND CALIBRATION

The unit of time is the year in this study. While some parameters are calibrated from the relevant literature, others are calibrated using data from Türkiye. Table 1 shows the calibrated parameters from the literature.

In the relevant literature, the capital share in the production function (α) is assumed to be 0.32. Furthermore, a value of $\theta = 2.24$ guarantees that households dedicate 20% of their time to labor in the long-term. The value of $\omega = 1.6$ ensures that the labor supply elasticity ($\frac{1}{\omega-1}$) equals 1.7, which is commonly used in the literature (as in Mendoza (1991)).

Table 1: The Calibrated Parameters from the Relevant Literature

Description	**Symbol**	**Value**
Capital elasticity of the production	α	0.32
Labor coefficient in utility	θ	2.24
Exponent of labor in utility	ω	1.60
Intertemporal elasticity of substitution	γ	0.30
Capital depreciation rate	δ	12.55%
Discount factor	β	0.98

Following the research of Garcia-Cicco et al. (2010), the capital depreciation rate is determined at 3% quarterly, and 12.55% annually. The intertemporal elasticity of substitution is assumed to be 0.3 for Türkiye, in line with the findings of Havranek et al. (2015). Finally, we set the discount factor at 0.995 quarterly, and 0.98 annually, in accordance with Chang et al. (2015) and Brzoza-Brzezina et al. (2013).

We decide to use the PWT dataset, widely recognized as a highly significant and reliable source for the research of Türkiye's historical data. The PWT data is a compilation of national-accounts data created and managed by scientists at the University of California, Davis, and the Groningen Growth Development Centre of the University of Groningen.

The PWT dataset's purpose is to quantify the real GDP across different countries and track its changes over time. The updates incorporate additional countries, currently totaling 183, as well as statistics spanning from 1950 to 2019. In addition, the updates include information on capital, productivity, employment, and some other significant macroeconomic variables. We also utilize the World Bank Dataset (WBD) to adjust other parameters missing from the PWT dataset. The WBD spans from 1970 to 2022.

We calibrate various model parameters by using the steady state equilibrium solutions of the model and the long-term annual data from Türkiye. PWT data provides the real GDP at constant PPPs (purchasing power parity) in 2017 US$. The dataset also provides the ratios of government spending, investment, consumption, capital stock, and other macroeconomic variables to output, allowing for easy computation of the required variables in the same unit as the real GDP.

By simultaneously employing the data with the steady state solutions of the model, we use (i) external debt stock (D) to GDP (Y) ratio to obtain the parameter $\tilde{d}$; and (ii) the government spending (G) to GDP ratio to determine the parameter $\bar{s}$. The calibrated parameters using the data are displayed in Table 2.

Table 2: The Calibrated Parameters Using the Turkish Data

Description	**Symbol**	**Data**	**Value**
External debt to output ratio	$\tilde{d}$	$\frac{D}{Y}$	38.14%
Share of public spending in GDP	$\bar{s}$	$\frac{G}{Y}$	18.64%

Note: *The author generates the results using annual data for Türkiye from 1950 to 2022. Y, D, and G represent GDP, external debt stock, and government spending data for Türkiye.*

1.4. ESTIMATION

We use the Bayesian maximum likelihood estimation method (BML) and the data from Türkiye to estimate variables that are unobservable and difficult to accurately calibrate in the model. The literature prefers the maximum likelihood (ML) method for model estimation due to its advantages over other methods. It is possible to estimate certain model equations with the generalized method of moments (GMM) and the impulse-response matching methods. The ML estimation, on the other hand, is a system-based estimation method. All model equations are estimated collectively. Furthermore, this method offers the essential metrics for comparing models.

The BML approach offers some additional benefits compared to the ML estimating method. The classical ML estimator treats the parameters as fixed but unknown values. It calculates the ML estimator by maximizing the likelihood function using the observed values of the variables. The BML technique assumes that the parameters are stochastic variables for which there exists a priori information. Finally, the BML method allows for the inclusion of measurement errors while also considering the potential dangers of model identification.

The estimation is based on Turkish data spanning 1950 to 2019. We derive the real GDP data on a per capita basis by dividing it by the total population, which eliminates the effect of population size. The scale effect is also eliminated by applying the natural logarithm to the obtained numbers. The output growth rate is calculated based on the obtained values. We also apply this strategy to investment and consumption data. We divide net exports by GDP for each year to calculate the trade balance to GDP ratio.

We use the growth of investment (g_I), the growth of consumption (g_C), the growth of output (g_Y), and the trade balance to output ratio (tby) data for the estimation. Table 3 provides the summary statistics for these variables.

During our analysis of comprehensive Turkish data, we saw the 2001 economic crisis as a significant milestone in the country's history. The 2001 Turkish economic crisis was a severe financial crisis that resulted in the devaluation of the Turkish lira and an enormous drop in the stock market. This crisis was caused by long-standing political and economic problems that had been suffering Türkiye for several years.

Table 3 displays the lowest and highest values of each selected variable, along with the average and standard deviation, across two different time periods: the pre-2001 crisis period and the post-2001 crisis period. The last two rows show the average and standard deviation over the entire period.

Türkiye's economic growth throughout the period leading up to the crisis, which encompassed the 1980s and 1990s, relied significantly on foreign investment. The fiscal capabilities of the Turkish government and banking sectors were inadequate to support significant economic growth. The government, already struggling with substantial budget deficits, partially sustained them by issuing large volumes of high-interest bonds to Turkish banks. The government was able to prevent a temporary default on the bonds due to the continuous increase in inflation. As a result, Turkish banks started to primarily participate in these high-yield bonds.[11]

Table 3: Summary Statistics of the Selected Variables (in Percent)

Period	**Statistics**	g_Y	g_C	g_I	*tby*
	Min	-12.01	-16.11	-43.78	-5.96
1951-2001	Max	18.68	21.20	41.94	-0.41
	Avg	2.54	2.20	2.59	-1.81
	Std	6.29	6.78	15.63	1.31
	Min	-3.96	-3.67	-27.96	-10.21
2002-2019	Max	12.16	11.71	31.89	-2.71
	Avg	4.25	3.15	7.93	-6.84
	Std	5.04	4.26	15.27	1.96
1951-2019	Avg	2.99	2.45	3.98	-3.12
	Std	6.03	6.24	15.71	2.67

Note: *Min, Max, Avg, and Std represents minimum, maximum, average and standard deviation, respectively. The outcomes are computed by the author using Turkish data from 1950 to 2019 from the PWT dataset.*

Furthermore, the presence of political uncertainty in Türkiye would likely lead foreign countries to exercise significant caution when considering any investment initiatives. As a result of the crisis in 2001, the investment growth had a contraction of 43.78%. According to the data, this rate is the most significant decline in the

[11] See Özatay and Sak (2002).

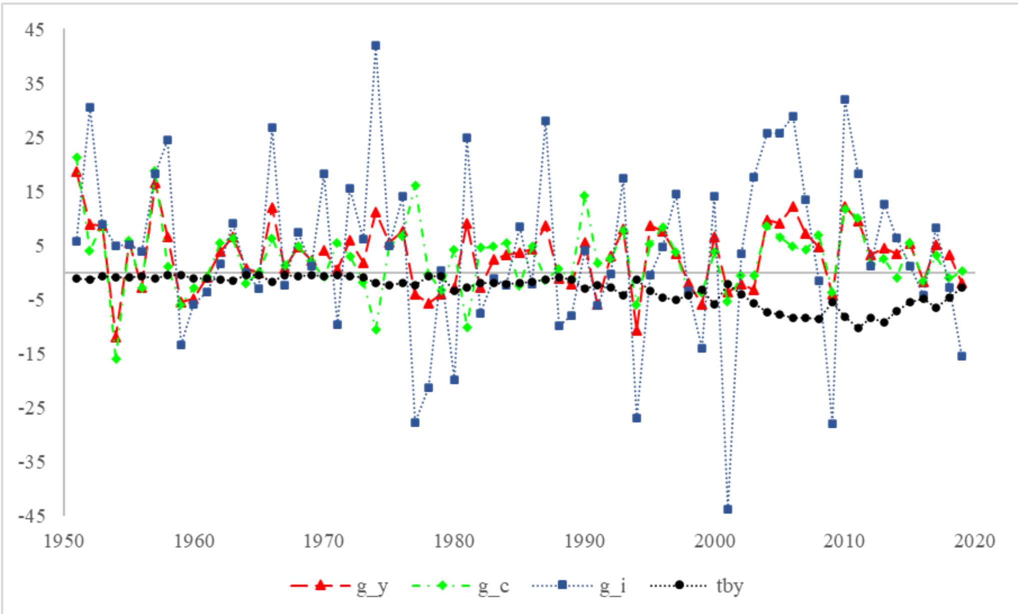
history of the country. Simultaneously, there was a decrease of 3.57% in the output growth and a decrease of 5.35% in the consumption growth.

When comparing the 50-year long-term averages prior to the 2001 crisis with the period following 2001, significant disparities become apparent. The average rate of the output growth over the span of about 50 years was 2.54%, whereas the average rate in the period after 2001 was 4.25%. Additionally, there is a slight rise in the average rate of the consumption growth.

Moreover, the most important rate increases are those related to the g_I and *tby*. The average rate of g_I increases roughly threefold, while *tby* increases almost fourfold in the post-2001 era. Türkiye, a country with a historical trade deficit, has experienced a notable escalation in its trade deficit since 2002.

Upon analyzing the volatilities over these specific time periods, it is evident that there is no substantial change in the volatility of investment growth. The decline in volatility is observed in both the output growth and the consumption growth. However, *tby* demonstrates a rise in volatility from 1.31 to 1.96.

Figure 1: Historical Data of Türkiye: 1951-2019 (in Percent)



Note: *g_y, g_c, g_i and tby represent the output growth, the consumption growth, the investment growth, and the trade balance to output ratio, respectively. The x- and y-axes show the year and the percentage values, respectively.*

Figure 1 shows the values of these variables from 1951 to 2019. The figure clearly demonstrates the immediate occurrence of volatility in investment growth (the blue line). The significant increase in the trade deficit after 2001 is readily apparent (the black line). Another notable issue in the figure is the close connection between the output growth and the consumption growth (the red and green lines).

Table 4 shows the key statistics about prior and posterior distributions. For the prior distributions of shock persistency parameters ρ_g, ρ_a, ρ_v, ρ_μ, and ρ_s, the beta distribution is chosen because it is commonly used in the relevant literature. Additionally, the beta distribution ranges from 0 to 1 in accordance with the definition of the persistency parameters.

The inverse gamma distribution is commonly used for modeling the volatilities of shock processes, σ_g, σ_a, σ_v, σ_μ, and σ_s. Also, the inverse gamma distribution is defined only for positive real values, just like the volatility parameters. Initially, we select a broad range and substantial variance to calculate the mean values of the prior distributions. The estimation procedure involves iteratively substituting the estimated values with mean values to improve accuracy.

Given the lack of precise predictions for the characteristics of the productivity growth, the interest rate debt elasticity, and the capital adjustment cost parameters, we prefer a uniform distribution for these parameters. This economy experiences a trade deficit if its productivity growth rate exceeds 1.03. The model must have a value below around 1.10 to satisfy the Blanchard-Kahn conditions.[12] Thus, the value of $\bar{g}$ is selected to fall between the range of 1.03 to 1.10. In addition, the capital adjustment cost and the interest rate debt elasticity parameters are selected from a significantly broader range, $\phi \in [0, 50]$ and $\psi \in [0, 20]$ than the ranges of the other parameter values.

We use a Markov Chain Monte Carlo (MCMC) chain with two million iterations to determine the posterior statistics. We eliminate the first million iterations during this process. In addition, the upper bound of the prior distributions for the standard deviations of measurement errors pertaining to the observed variables (σ_Y^{me}, σ_C^{me}, σ_I^{me}, and σ_{tby}^{me}) is set at 25% of the variance of the relevant historical data.

[12]Blanchard and Kahn (1980) established certain criteria for a solution's existence and uniqueness, which can be easily verified by examining eigenvalues calculated at the model's equilibrium. The model's solution is unique when the number of unstable eigenvectors in the system (the number of eigenvalues greater than 1) matches the number of forward-looking (control) variables.

Table 4: Prior and Posterior Distributions

	Prior Distribution			Posterior Distribution		
Parameter	**Distribution**	**Mean**	**Std**	**Mean**	**5%**	**95%**
g	Uniform	1.065	0.02	1.0899	1.0889	1.0910
ρ_g	Beta	0.9	0.02	0.9807	0.9792	0.9819
ρ_a	Beta	0.8	0.02	0.8353	0.8092	0.8615
ρ_v	Beta	0.3	0.02	0.3007	0.2678	0.3337
ρ_μ	Beta	0.6	0.02	0.6018	0.5692	0.6350
ρ_s	Beta	0.4	0.02	0.4429	0.4086	0.4772
σ_g	Inv. Gamma	0.03	2	0.0413	0.0349	0.0475
σ_a	Inv. Gamma	0.03	2	0.0354	0.0300	0.0406
σ_v	Inv. Gamma	0.50	2	0.3086	0.1278	0.4975
σ_μ	Inv. Gamma	0.03	2	0.0792	0.0647	0.0931
σ_s	Inv. Gamma	0.05	2	0.1908	0.1623	0.2180
ϕ	Uniform	25	14.43	24.451	18.158	30.437
ψ	Uniform	10	5.77	6.989	2.079	12.431
σ_Y^{me}	Uniform	0.008	0.0043	0.0141	0.0129	0.0151
σ_C^{me}	Uniform	0.008	0.0045	0.0128	0.0089	0.0156
σ_I^{me}	Uniform	0.020	0.0113	0.0381	0.0367	0.0393
σ_{tby}^{me}	Uniform	0.003	0.0019	0.0024	0.0001	0.0047

Note: *Std represents the standard deviations of the distributions. The lower and upper boundaries of Highest Posterior Density (HPD) intervals are* 5% *and* 95%*, respectively.*

We perform various diagnostic tests prior to analyzing the estimation results. The identification test is the first diagnostic test. We utilize the identification test to verify the accurate identification of all intended parameters for the estimation process.[13] Figure 30 in Appendix 1 shows the identification test results.

The range of identification strength is from 0 to ∞. Using a logarithmic scale, the domain is now restricted to the interval $(-\infty,\infty)$. Values ranging from 0 to 1 exhibit negative logarithmic values in terms of identification strength. A value of 0 in the level is shown as $-\infty$ on the graph, which is why no bar is displayed since $-\infty$

[13] See Qu and Tkachenko (2012) and Iskrev (2010).

cannot be plotted. Therefore, since all parameters intended for estimation in the model are non-zero, we can infer that they are all identifiable.

More precisely, $\bar{g}$ is the most strongly identified parameter. Following $\bar{g}$, ρ_g, and ρ_a are more strongly identified than the other parameters. The figure also illustrates the degree to which the prior distribution mean (blue bars) and variance (yellow bars) influence the parameter determination.

Brooks and Gelman (1998) created MCMC univariate and multivariate diagnostic tests. When the number of Monte Carlo chain exceeds one, we can calculate these tests. These tests can be calculated in this study because the estimation procedure relies on five Monte Carlo chains. Figure 31 in Appendix 1 displays the multivariate MCMC convergence diagnostics. Figures 32 to Figure 36 in Appendix 1 also display the univariate MCMC convergence diagnostics.

In Figure 31, the first figure (interval) uses the Brooks and Gelman convergence test for the 80% interval, the second figure (m2) for the variance, and the third figure (m3) for the third moment. The blue line reflects combined samples from all chains, while the red line represents values from an individual chain. We anticipate the two lines to stabilize horizontally and approach each other if the chains converge. Thus, the estimated model successfully passes the multivariate and univariate MCMC convergence tests.

Finally, the Metropolis-Hastings (MH) algorithm employs the selection of favorable candidates from the simulation-generated distributions around the mode to form the posterior distributions. At this stage, the acceptance ratio determines the appropriate candidates. The common consensus in the literature is that this ratio should be within the range of 20% to 40%, with the ideal target being around 33%.[14] In the model estimation, the acceptance ratios for each chain are as follows: 32.20% for the first chain, 32.38% for the second chain, 32.30% for the third chain, 32.23% for the fourth chain, and 32.33% for the fifth chain.

The estimation results are generally consistent with the findings in the existing literature. All parameters yielded a mean value that is not equal to zero. Upon examination of the persistency parameters, it is evident that the parameters of the technology and the growth shocks (ρ_a and ρ_g) exhibit more persistent processes compared to the other shock processes.

[14]See Roberts et al. (1997) and Neal (2011).

It is important to note that the persistency of intertemporal preference and the domestic spending shock processes (ρ_v and ρ_s) are quite smaller than the other shock processes. The estimated parameters ϕ and ψ are also compatible with the existing literature. Lastly, the posterior means of the measurement errors are close to the minimum levels, and they account for less than 2% of the volatilities of the observed variables.

1.5. MAIN RESULTS

In this section, the second moments of the constructed model and Turkish data are compared. Additionally, we present the impulse response functions (IRFs) of the selected variables to the shock processes and the conditional variance decomposition table.

1.5.1. Second Moments

Table 5 shows some statistics about the model and data. The selected variables are investment growth (g_I), consumption growth (g_C), output growth (g_Y), and the trade balance to GDP ratio (tby), as previously stated. The dataset consists of yearly data spanning from 1950 to 2019. Table 5 also displays the relative volatilities of the selected variables. The statistics show that the main characteristics of the model and data are compatible, namely the magnitude and ordering of second moments, comparable relative volatilities, and the signs of the correlation coefficients.

While the model demonstrates a slightly higher level of volatility in the selected variables compared to the observations derived from the data, the corresponding amounts of volatility in the variables are consistent between the model and the data. In short, $\sigma_{tby} < \sigma_Y < \sigma_C < \sigma_I$ for both the data and the model, where σ denotes the standard deviation of any variable.

Furthermore, the volatility of g_C relative to g_Y is consistent across the data and the model. The relative volatility of g_I to g_Y is higher, as the data suggest. Ultimately, the data and model both indicate that the relative volatility of tby to g_Y is less than 1. However, the model suggests that this volatility is much lower.

Moreover, the model and data exhibit consistent relationships between the selected variables and the output growth. For instance, while the correlation coefficient between tby and g_Y ($corr(tby, g_Y)$) equals to -14.01% in the model, it equals to -25.99% in the data. We also observe comparable correlation coefficients between the output growth and both the consumption and investment growth.

Furthermore, the correlation coefficients between the trade balance to output ratio and the other variables within the model align with the actual data. Both the model and the data exhibit negative correlation coefficients between tby and the other variables. Thus, the estimation findings accurately reflect the main characteristics of the data.

Table 5: Second Moments of Data and Model (in Percent)

Statistics	**Variables**				**Relative Volatility**		
	g_Y	g_C	g_I	tby	$\frac{\sigma_C}{\sigma_Y}$	$\frac{\sigma_I}{\sigma_Y}$	$\frac{\sigma_{tby}}{\sigma_Y}$
Standard Deviations							
Model	23.41	24.12	30.46	7.08	1.03	1.30	0.30
Data	6.03	6.24	15.71	2.67	1.03	2.61	0.44
Correlation with g_Y							
Model		94.30	81.17	-14.01			
Data		60.64	73.09	-25.99			
Correlation with tby							
Model	-14.01	-3.82	-22.57				
Data	-25.99	-19.18	-24.22				

Note: *g_Y, g_I, g_C, and tby are output growth, investment growth, consumption growth, and the trade balance to GDP ratio, respectively. The three columns on the right display the relative volatilities. The outcomes are computed by the author.*

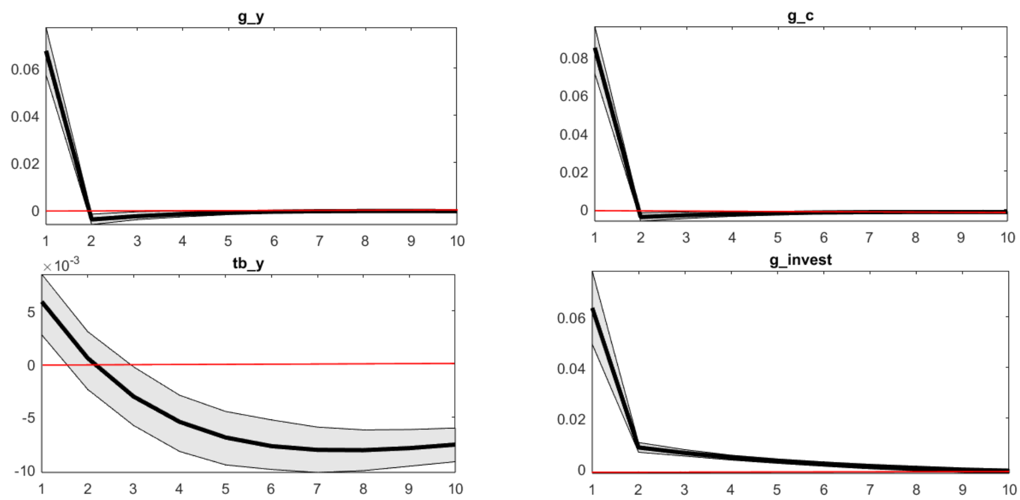
1.5.2. Impulse Response Functions

The IRFs analysis have used to closely examine the impact of shocks on the variables. The IRFs depict the expected path of endogenous variables when subjected to a shock of one standard deviation at time $t = 0$. Figure 2 to Figure 6 show the Bayesian Impulse Response Functions (BIRFs) of the selected variables to the shock processes.

The solid black lines in BIRF figures depict the path of variables. The solid red lines represent the deterministic steady state. The y-axis represents the percentage deviation from the deterministic steady state level and the x-axis is the period of time following the occurrence of a shock, which is set to 10 periods of time. tb_y, g_invest, g_c, and g_y represent the trade balance to GDP ratio, investment growth, consumption growth, and output growth, respectively. Lastly, the figures exhibit a 90% confidence interval.

Figure 2 displays the BIRFs of the selected variables to the positive technology shock. When the shock occurs, consumption, output, and investment growth increase by around 8%, 6%, and 6%, respectively. The positive technological shock has a favorable impact on these variables, causing them to rise as expected. Following the initial increases, each variable eventually reaches the steady state level.

Figure 2: BIRFs of the Selected Variables to the Technology Shock (a_t)



Note: *The solid black and red lines display the path of variables and the deterministic steady state values. The x- and y-axes represent the period of time following the occurrence of a shock and the percentage deviation from the deterministic steady state level.*

The positive technology shock has a positive impact on *tby* during the initial phase. A positive technological shock, characterized by increased productivity using the same resources, results in a lower level of foreign borrowing. Over time, the requirement for external borrowing increases as a result of enhanced production, and the ratio decreases below its long-term equilibrium level, but the change in *tby* is negligible. It persists at a level lower than its long-term level for an extended period of time. Eventually, the ratio converges to its steady state level.

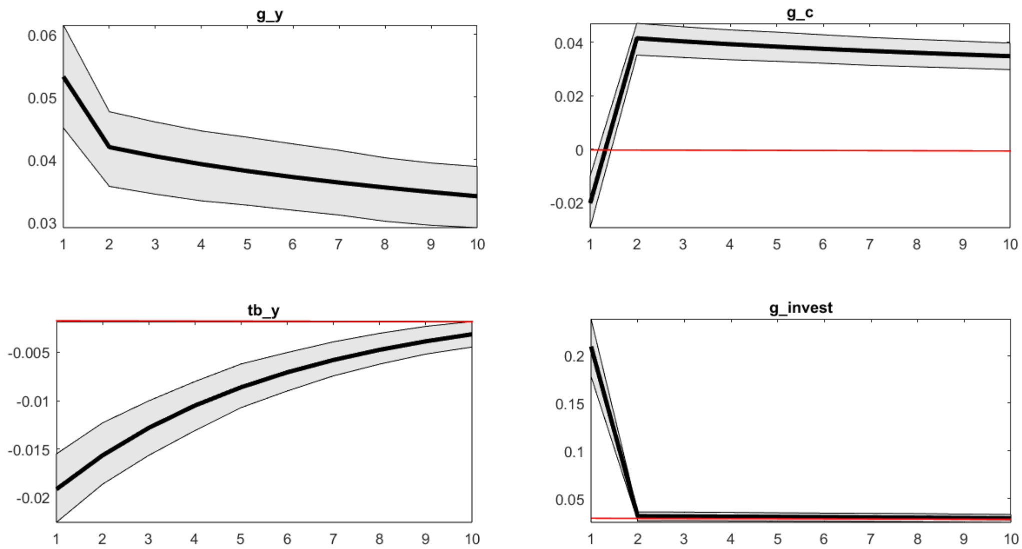
Figure 3 displays the BIRFs of the selected variables to the positive growth shock.

Growth and technological shocks have comparable effects on the variables. With the occurrence of a growth shock, g_Y and the g_I increase by around 5%, and 20%, respectively. In response to the growth shock, g_I outpaces g_Y.

The growth shock impacts g_C with a time lag. During the shock, consumption growth initially drops below the long-term equilibrium level of 2% due to a huge increase in investment growth. Nevertheless, it then rises instantly and stays above the long-term equilibrium level over an extended period of time.

Nevertheless, the growth shock slightly decreases *tby* by around 2%. The reason for this phenomenon is an increase in demand for accessing external resources as a result of the accelerated growth rates. Following the initial movements, each variable eventually reaches the steady state level at a variety of time periods.

Figure 3: BIRFs of the Selected Variables to the Growth Shock (g_t)

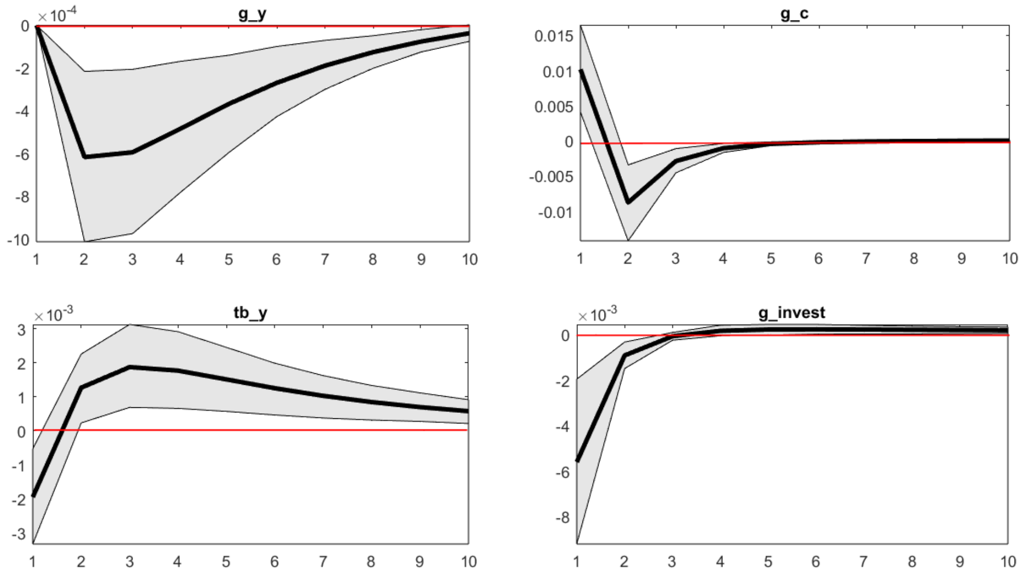


Note: *The solid black and red lines display the path of variables and the deterministic steady state values. The x- and y-axes represent the period of time following the occurrence of a shock and the percentage deviation from the deterministic steady state level.*

Figure 4 shows the BIRFs of the selected variables to the positive intertemporal preference shock. An intertemporal preference shock refers to a sudden shift that alters the connection between present and future consumption by affecting the subjective discount rate.

Positive intertemporal preference shocks elevate the value of present consumption and utility, leading to an increase in the consumption growth. In order to attain this level of spending, households boost their borrowing volume, leading to a reduction in *tby*.

Figure 4: BIRFs of the Selected Variables to the Preference Shock



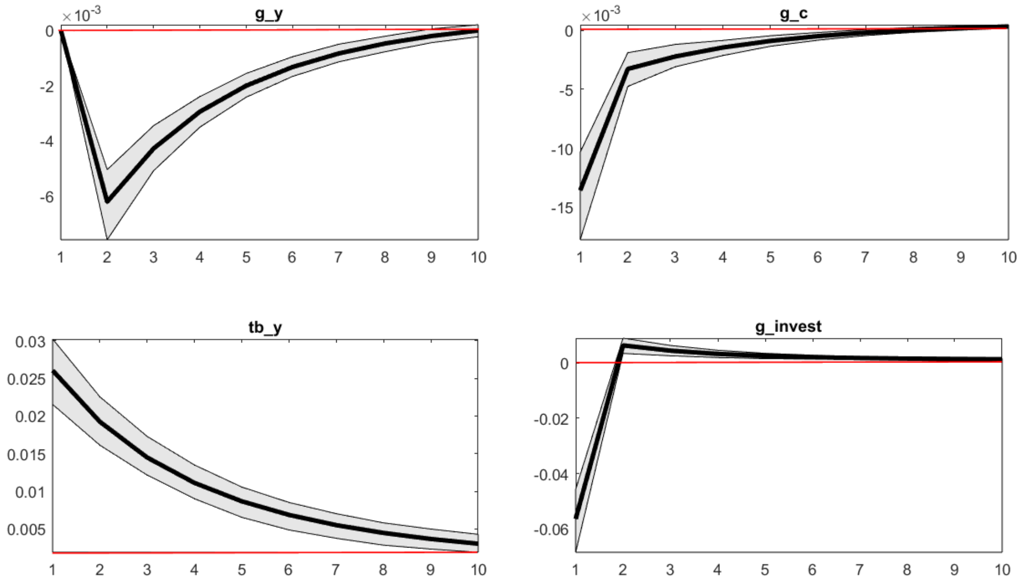
Note: *The solid black and red lines display the path of variables and the deterministic steady state values. The x- and y-axes represent the period of time following the occurrence of a shock and the percentage deviation from the deterministic steady state level.*

Moreover, households offset the rise in consumption by decreasing their investments when the shock happens. A decline in investments results in a subsequent decrease in the growth rate of output during the subsequent period (referred to as period 2). Lastly, the impact of the preference shock is minimal when examining the values on the y-axis.

The BIRFs of the selected variables to the negative country premium shock are displayed in Figure 5. The negative country risk premium shock can be assessed by observing an escalation in the country's Credit Default Swap (CDS) rates, resulting in an increase in borrowing costs.

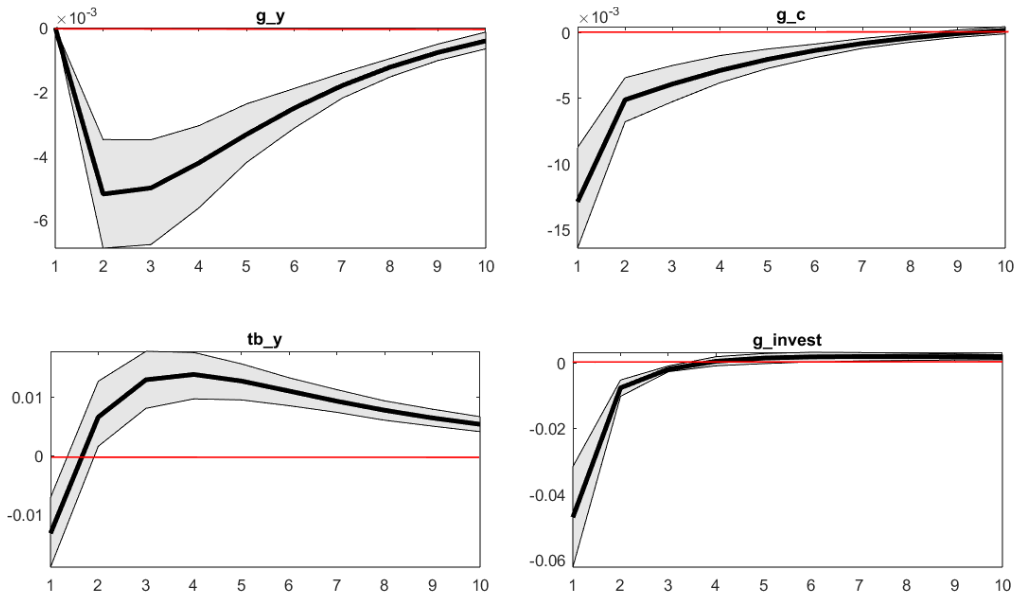
When a country experiences a negative country premium shock, its ability to borrow money from foreign sources decreases and as a result, its trade balance improves. Conversely, households experiencing a decline in resources decrease their consumption, investment, and thus, their ability to produce. As a result, the shock has a negative effect on the growth of investment, the growth of consumption and the output growth. Following the first reaction, the variables partially regain their stability and ultimately converge towards their long-term equilibrium levels.

Figure 5: BIRFs of the Selected Variables to the Contry Premium Shock



Note: *The solid black and red lines display the path of variables and the deterministic steady state values. The x- and y-axes represent the period of time following the occurrence of a shock and the percentage deviation from the deterministic steady state level.*

Figure 6: BIRFs of the Selected Variables to the Domestic Spending Shock



Note: *The solid black and red lines display the path of variables and the deterministic steady state values. The x- and y-axes represent the period of time following the occurrence of a shock and the percentage deviation from the deterministic steady state level.*

Lastly, Figure 6 shows the BIRFs of the selected variables to the positive domestic spending shock. Based on the observed deviation amounts, it is evident that domestic spending shock has a negligible impact on the fluctuations of g_Y and g_C. However, the domestic spending shock has a particularly significant impact on investments. The increase in domestic spending crowds out investments and causes investment growth to decline by around 4%. After four periods, the investment growth fully recovers and stabilizes at the long-term equilibrium level.

The decline in g_I, g_C and the output growth leads to a moderate increase in the requirement for external borrowing, while also resulting in a deterioration in *tby* during the initial phase. Subsequently, there is a decline in external borrowing and the ratio remains above its long-term equilibrium level for a prolonged duration.

1.5.3. Conditional Variance Decomposition

We share the conditional variance decomposition tables of the model across various time horizons to discuss the impact of shock processes on the selected variables of Türkiye in different time periods.

Variance decomposition analysis quantifies the extent to which exogenous shocks account for the predicted error variance of a specific variable. This strategy allows for the separation of the significance and impact of various types of shocks on macroeconomic fluctuations. Essentially, this method divides the impact of each shock process on business cycle fluctuations into ratios.

The conditional variance decomposition findings from model simulations are shown in Table 6, considering the short-term (1 period), the medium-term (5 periods), and the long-term (10 periods) effects. The original study for Argentina shows that growth shocks alone are insufficient to explain fluctuations in macroeconomic variables. However, the results of our study in Türkiye challenge this argument. This investigation confirms the widely debated topic of "*the cycle is the trend*" in the literature.

Upon analyzing the short-term consequences, it appears that 61.1% of the volatility in the output growth is attributed to the technology shock, while 38.9% is attributed to the growth shock. The technological shock accounts for nearly all the fluctuations in g_C. The growth shock primarily accounts for the volatility in g_I. *tby* indicates that 28.9% of the volatility is attributed to the growth shock, 53.6% to the country premium shock, and 14.2% to the domestic spending shock in the short-term.

Table 6: Conditional Variance Decomposition

	g_Y	g_C	g_I	tby
Period 1				
Technology Shock	61.1	88.3	7.7	2.9
Growth Shock	38.9	5.7	81.9	28.9
Intertemporal Preference Shock	0.0	1.5	0.1	0.4
Country Premium Shock	0.0	2.4	6.1	53.6
Domestic Spending Shock	0.0	2.2	4.3	14.2
Period 5				
Technology Shock	32.7	49.0	7.4	4.1
Growth Shock	66.2	46.5	82.7	28.9
Intertemporal Preference Shock	0.0	1.5	0.1	0.5
Country Premium Shock	0.5	1.4	5.8	43.2
Domestic Spending Shock	0.6	1.6	4.1	23.3
Period 10				
Technology Shock	22.6	34.1	6.8	10.6
Growth Shock	76.6	62.8	83.9	25.9
Intertemporal Preference Shock	0.0	1.0	0.1	0.5
Country Premium Shock	0.4	1.0	5.4	36.8
Domestic Spending Shock	0.5	1.1	3.9	26.2

Note: *g_Y, g_I, g_C, and tby are the output growth, the investment growth, the consumption growth, and the trade balance to output ratio, respectively. The author computes the outcomes. The table expresses the values as percentages.*

When analyzing the medium-term consequences, the ability of the technological shock to account for fluctuations in the consumption growth and the output growth is notably diminished. The technological shock's explanatory power on the volatilities in g_I and tby remains modest in the medium-term.

The growth shock has the greatest explanatory power for the fluctuations of most of the selected variables in the medium term. More precisely, the growth shock accounts for 66.2% of the output growth volatility, 46.5% of the consumption growth volatility, 82.7% of the investment growth volatility, and, finally, 28.9% of the volatility in tby, respectively.

In the medium term, the explanatory power of the intertemporal preference shock is negligible. The country premium shock remains a significant factor in explaining a substantial portion of the volatility in *tby*. Upon examination, the domestic spending shock accounts for 23.3% of the volatility in *tby*, but is deemed insignificant in explaining other selected variables.

On the other hand, the growth shocks are responsible for most of the volatility in g_Y, g_C, and g_I over the long term, with percentages of 76.6%, 62.8%, and 83.9%, respectively. This discovery aligns with Aguiar and Gopinath's (2007) theory that emphasizes "*the cycle is the trend*", a concept well explored in the literature. In an EME such as Türkiye, the fluctuations in most variables can be mostly attributed to the growth shocks.

The technology shock explains 22.6% of g_Y volatility, 34.1% of g_C volatility, 6.8% of g_I volatility, and 10.6% of *tby* volatility in the long term. Also, the impact of intertemporal preference, country premium, and domestic spending shock processes on the volatility in g_I, g_C, and g_Y are negligible.

Besides, 36.8% of the volatility in *tby* is attributed to the country premium shock, whereas 26.2% is attributed to the domestic spending shock in the long term. The results indicate that the explanatory ability of the country premium shock is less than what the Argentinian study suggests. Also, the explanatory power of the domestic spending shock is greater in the context of *tby* volatility compared to the Argentinian sample. The primary explanation for this situation is the higher percentage of long-term government spending in GDP in Türkiye.

To sum up, several key factors contribute to the diminishing explanatory power of shock processes, such as technology, over time. Firstly, the nature of the shock process itself is inherently temporary, meaning its effects are not long-lasting. Additionally, the persistency parameter associated with technology shocks is lower compared to growth shocks, further contributing to their decreasing explanatory power. Finally, agents with forward-looking expectations tend to react less to technological shocks that they are aware are temporary in nature.

1.6. DISCUSSION

This section includes observations that specifically focus on the model's findings and data. We will initially focus on Türkiye's significant historical periods of crisis. For this analysis, we have selected the economic crises that occurred in the years 1994, 2001, and 2009. Next, we will provide a concise comparison between Türkiye and a few selected EMEs. Lastly, we will incorporate a concise discussion section regarding the proportion of fluctuations in Türkiye that originate from internal factors versus foreign factors.

1.6.1. Türkiye's Crisis Experiences

Based on the analysis of long term data, it is determined that numerous shock processes have a significant impact on Türkiye. In this subsection, we will examine the dynamics of the output growth (g_Y) and the trade balance to output ratio (tby) variables during crisis periods using the shock variables derived from the employed model.

There is widespread recognition that Türkiye experienced severe domestic crises in 1994 and 2001. Following that, the global financial crisis that commenced in 2008 had an impact on numerous EMEs, including the Turkish economy. This subsection of the study provides a concise analysis of the causes and consequences of these crises. We then conduct an analysis of the model's functioning during times of crisis, specifically focusing on the variables of g_Y and tby.

A combination of factors, including elevated inflation, substantial fiscal deficits, and political instability, initiated the 1994 crisis in Türkiye. A significant devaluation of the Turkish lira initiated the crisis, leading to a serious imbalance in payments and a decline in foreign investors' trust. The government enacted a sequence of stabilization measures, such as currency devaluation and increases in interest rates, in order to restore stability to the economy. The crisis exposed the weaknesses of Türkiye's economy and prompted substantial structural reforms in the following years.

The 2001 crisis was one of Türkiye's most severe economic crises to date. The event was triggered by a banking crisis, unmanageable amounts of government debt, and difficulties obtaining external financing. The crisis resulted in a significant devaluation of the Turkish lira, a substantial increase in inflation, and numerous bankruptcies. The International Monetary Fund (IMF) compelled the government to implement a comprehensive economic program to stabilize the economy. The IMF program encompassed fiscal austerity measures, banking sector reforms, and privatization endeavors. Although the crisis resulted in substantial economic difficulties, it also facilitated crucial structural reforms designed to enhance macroeconomic stability and budgetary discipline.

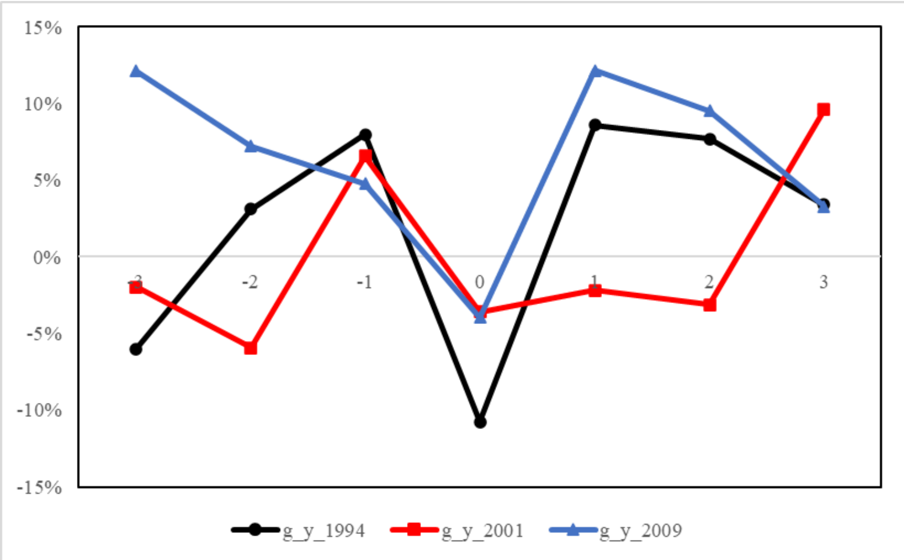
The global financial crisis significantly impacted Türkiye's economy, albeit with less severe damage than the crises of 1994 and 2001. The crisis resulted in a significant decrease in worldwide demand, reduced external investments, and increased investor caution about taking risks.

Also, Türkiye experienced a deceleration in economic expansion, an increase in unemployment, and instability in the financial markets. Nevertheless, the country's comparatively stable macroeconomic foundations and cautious policy measures played a role in lessening the effects of the crisis. The Turkish government enacted stimulus measures, such as augmenting public expenditure and implementing monetary relaxation, to bolster economic activity. Furthermore, Türkiye benefited from its diverse export portfolio and strong relationships with EMEs, which mitigated the effects of the global economic downturn.

According to the preceding section, growth and technology shock processes account for the majority of output growth fluctuations. Similarly, we find that country premium and growth shock processes contribute substantially to fluctuations in tby. Consequently, we select three shock processes in total. Subsequently, we analyze the fluctuations of shock processes across the crisis periods of 1994, 2001, and 2009. We chose 2009 because it was the year when the global financial crisis had the greatest impact on Türkiye. We adjust the crisis year to $t = 0$ and are displaying three years before and following the crisis year. Initially, Figure 7 displays the output growth trajectory, whereas Figure 8 illustrates the results related to tby.

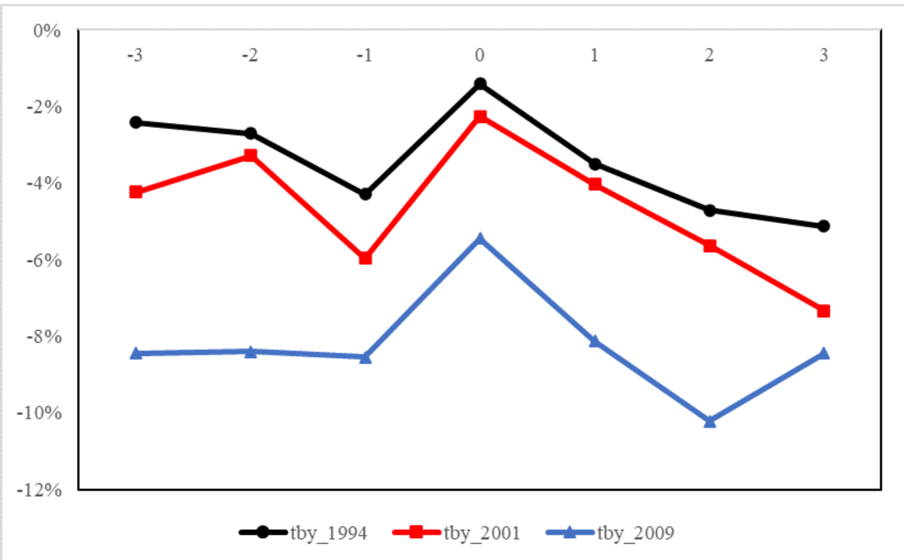
According to Figure 7, the output growth rate drops dramatically during crisis years. Output growth, which was about almost 5% before the crisis in all three periods, fell by 10.75%, 3.57%, and 3.96% in the crisis years of 1994, 2001, and 2009, respectively. The economy, which rebounded quickly after the 1994 and 2009 crises, was unable to replicate its achievements following the 2001 catastrophe. The terrible consequences of the 2001 crisis persisted for several years. In 2004, the Turkish economy recovered in terms of output growth after the devastating effects of the 2001 crisis.

Figure 7: The Trajectory of Output Growth in Türkiye During the Years of Crisis



Note: *The solid black, red, and blue lines display the output growth of the 1994, 2001, and 2009 crisis periods, respectively. We adjust the crisis year to* $t = 0$ *and are displaying three years before and following the crisis year. We obtain the data from the PWT dataset.*

Figure 8: The Trajectory of the Trade Balance to Output Ratio of Türkiye During the Years of Crisis



Note: *The solid black, red, and blue lines display the trade balance to output ratio of the 1994, 2001, and 2009 crisis periods, respectively. We adjust the crisis year to* $t = 0$ *and are displaying three years before and following the crisis year. We obtain the data from the PWT dataset.*

Figure 8 depicts *tby*'s movements during crisis periods. Figure 8 shows that the country runs a trade deficit during all crisis periods. However, in all crisis years, the trade deficit decreases in parallel with the contraction in the economy. The trade deficit rose in the years following the crisis as the economy recovered, as economic growth is heavily dependent on imported goods.

Figure 8 also indicates that the trade deficit is increasingly expanding over time. The trade deficit remained between 2% and 4% in the 1990s and exceeded 6% during the global financial crisis period, except for the 2009 crisis year.

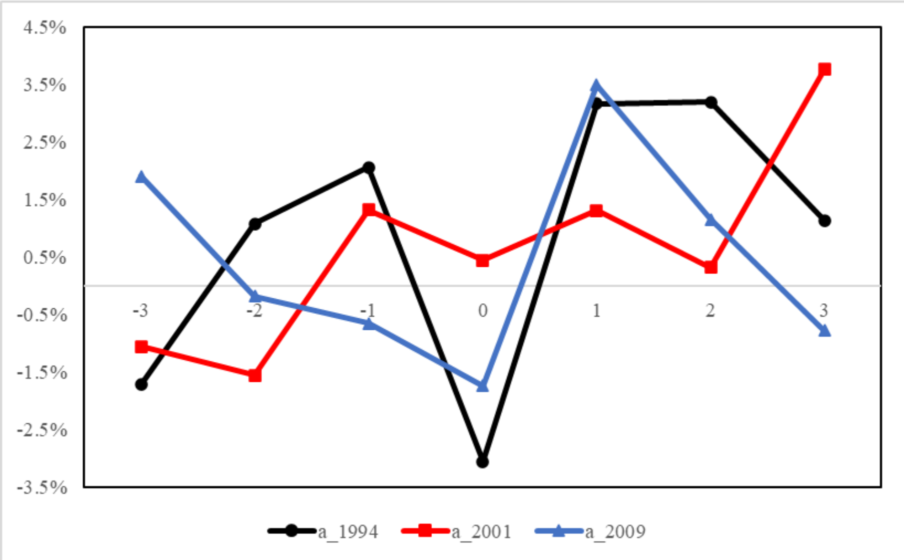
Figures 9, 10, and 11 display the movements of the most informative shock processes discovered using the variance decomposition analysis. These shock mechanisms refer to the technology (a_t) and growth (g_t) shocks that explain most of the volatility of g_Y, as well as the country premium (μ_t) and growth shocks that explain most of the volatility of tby.

The zero point on the graphs corresponds to the years 1994, 2001, and 2009, just like the graphs shown above. In addition, the y-axis represents the percentage deviation of the variables from the long-term equilibrium point. Put simply, the y-axis represents the percentage impact of the shock, including both negative and positive values. Hence, as the magnitude of the value increases, the shock's effect intensifies.

Upon examining the technology shock, it is evident from Figure 9 that it had negative values in the crises of 1994 and 2009 but had a positive value around zero during the 2001 crisis. Figure 10 illustrates that the growth shock had negative values during all crisis years. Furthermore, Figures 9 and 10 demonstrate that the values of both the variables a_t and g_t during the crisis years are lower compared to the years preceding and following the crisis year.

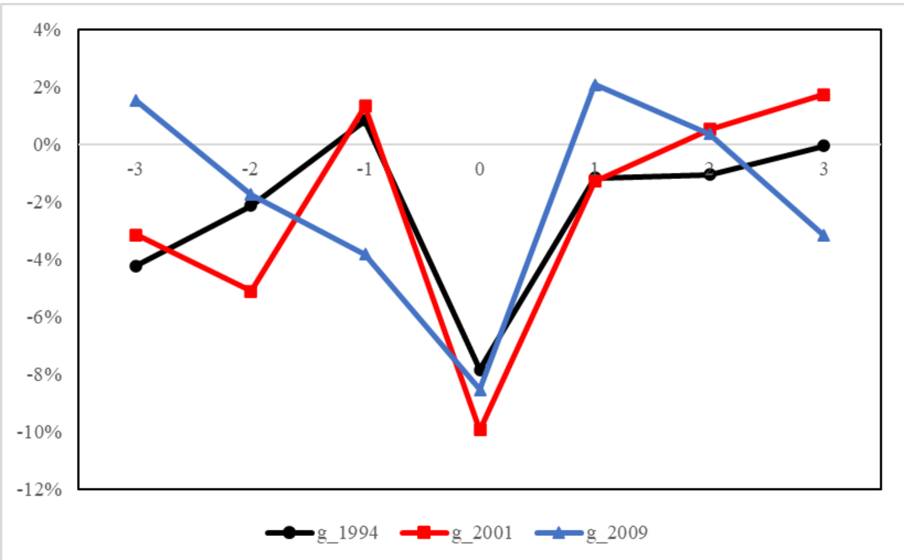
Combined analysis of Figures 9 and 10 suggests that the combination of growth and technology shocks significantly contributes to economic recession. For example, in 2001, the marginally beneficial influence of the positive technology shock partially mitigated the detrimental impact of the negative growth shock. Moreover, when examining the 1994 crisis, we observe a substantial rise in the economic downturn since both shocks exhibit negative and quite high magnitudes.

Figure 9: The Trajectory of the Technology Shock (a_t) During the Years of Crisis



Note: *The solid black, red, and blue lines display the technology shock (a_t) of the 1994, 2001, and 2009 crisis periods, respectively. We adjust the crisis year to $t = 0$ and are displaying three years before and following the crisis year. The y-axis represents the variable's percentage deviation from the steady state level.*

Figure 10: The Trajectory of the Growth Shock (g_t) During the Years of Crisis

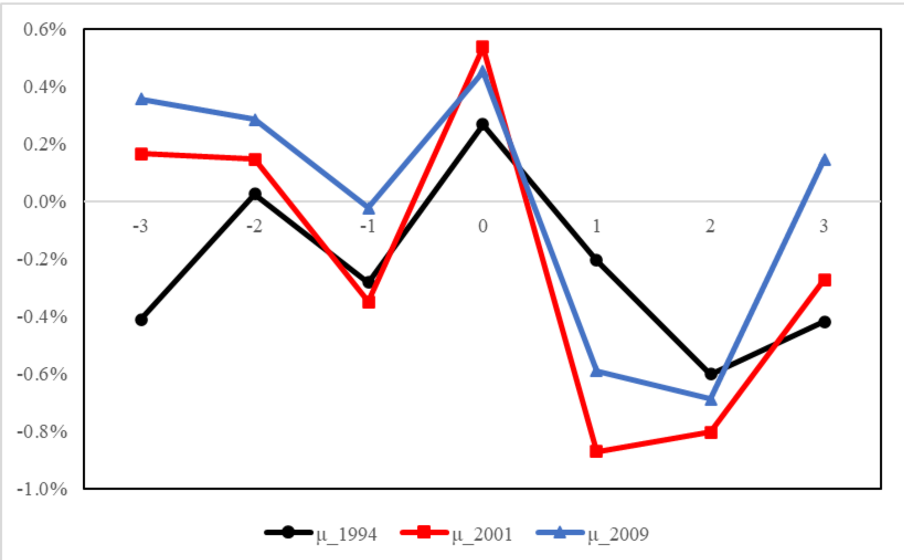


Note: *The solid black, red, and blue lines display the growth shock (g_t) of the 1994, 2001, and 2009 crisis periods, respectively. We adjust the crisis year to $t = 0$ and are displaying three years before and following the crisis year. The y-axis represents the variable's percentage deviation from the steady state level.*

After analyzing the *tby* variable and the growth shocks, Figures 8 and 10, a clear inverse relationship becomes apparent. Quantitative evidence suggests that growth shocks have a detrimental impact during periods of severe economic distress. During this period, *tby* reaches its peak. The country's external borrowing requirement falls as its production declines due to the contracting economy, but the value of the *tby* variable grows. In short, all of the shock variables derived from the model are quite consistent with the Turkish data.

Figure 11 represents the country premium shock process. The country premium shock's absolute value is frequently lower than that of technology and growth shocks. If this variable takes positive values, it indicates the occurrence of a negative country premium shock process, followed by a rise in external borrowing costs. Otherwise, negative values indicate a decrease in interest rates.

Figure 11: The Trajectory of the Country Premium Shock (μ_t) During the Years of Crisis



Note: *The solid black, red, and blue lines display the country premium shock (μ_t) of the 1994, 2001, and 2009 crisis periods, respectively. We adjust the crisis year to $t = 0$ and are displaying three years before and following the crisis year. The y-axis represents the variable's percentage deviation from the steady state level.*

We observe that immediately following the crisis years, the value of the country premium shock turned negative (decreasing in borrowing costs). Furthermore, the favorable tendency persists into the following year. Upon closer examination of the crisis years, it becomes evident that the country premium shock is both positive and the highest when compared to the periods prior to and afterwards. The decline in international trade during the most severe years of the crisis and the emergence of a decreasing risk appetite among foreign investors following the economy's contraction are the causes of this phenomenon.

To summarize, g_Y and tby consistently behave in the opposite manner during all periods of crisis. During periods of crisis, there is a decline in g_Y and an increase in tby. When analyzing shock variables, the origins of different circumstances change. While negative technology and growth shocks in the 1994 crisis led to a more than 10% decrease in output growth, a positive technology shock counterbalanced the negative growth shock in the 2001 crisis.

Furthermore, the country premium shock exhibited negative values in the years following the crisis, which is a noteworthy finding. This suggests that the risk premium of a country after a crisis has decreased, and the positive outlook persists in the following years.

1.6.2. Türkiye And Emerging Markets Comparison

In this section, we will initially analyze long-term data and uncover the similarities and disparities between Türkiye and some selected EMEs, namely Argentina and Mexico. We selected the economies of Argentina and Mexico due to their notable similarities to Türkiye. Subsequently, we will analyze the model's outcomes and compare them to those of other studies.

1.6.2.1. Data Facts

This subsection contains a concise analysis of the economies of Argentina, Mexico, and Türkiye. Figure 12 shows the log-linear quadratic trends and business cycles for Argentina, Mexico, and Türkiye. The black lines on the left subfigures in Figure 12 display the natural logarithm of per capita income for Argentina, Mexico, and Türkiye, spanning from 1950 to 2019. The dashed red lines indicate log-linear quadratic trends[15] for all countries. In addition, the right subfigures depict their business cycles.

[15] The log-linear quadratic trend can be expressed as $y_t = a + bt + ct^2 + \epsilon_t$. In the equation, y_t represents the natural logarithm of real GDP per capita. t represents the independent variable of time. The phrase $y_s = a + bt + ct^2$ reflects the long-term trend, known as the secular trend, whereas the expression $y_c = \epsilon_t$ indicates the cyclical component. Henceforth, we can employ the terms y_s and y_c to denote the secular trend and cyclical component of y_t, respectively. The Ordinary Least Squares (OLS) method can be used to estimate the parameters a, b, and c in the secular trend equation.

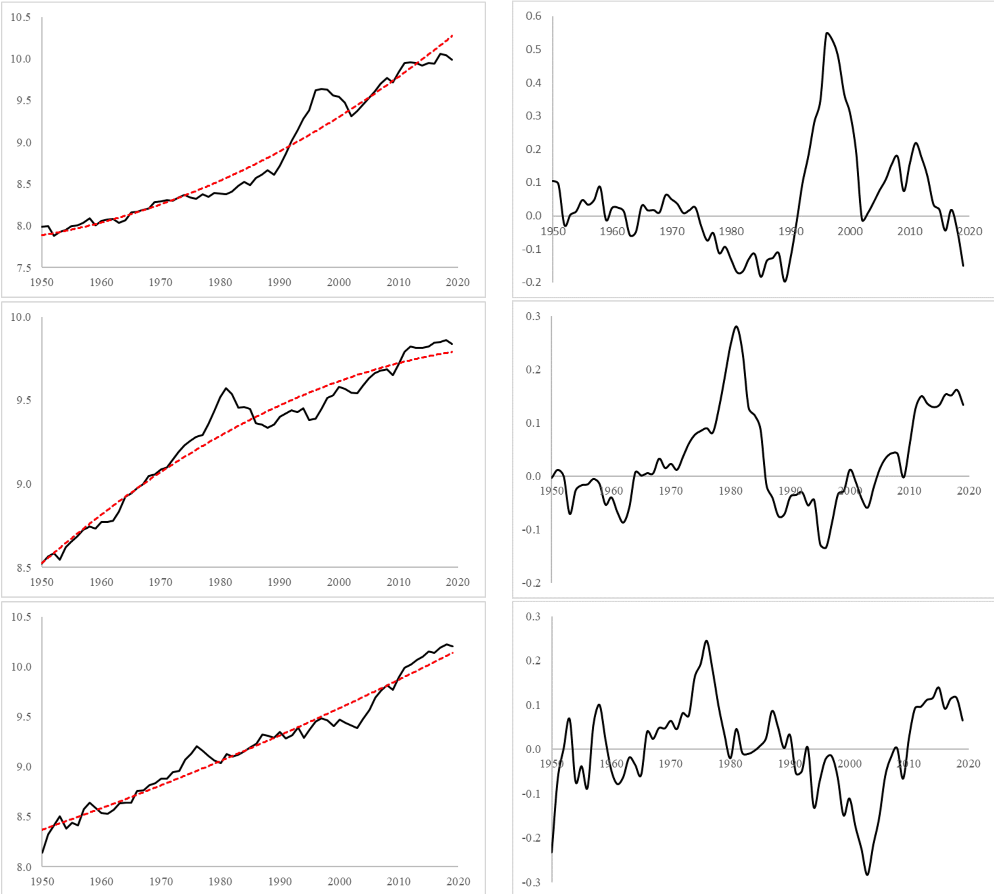
Figure 12: Log-linear Quadratic Trends and Business Cycles for Argentina, Mexico, and Türkiye

(a) Quadratic Trend **(b)** Business Cycles

Argentina

Mexico

Türkiye



Note: *The figures on the left show quadratic trends, and those on the right show business cycles for Argentina, Mexico, and Türkiye. In the left subfigures, the black lines represent the natural logarithm of per capita income. The red dashed lines illustrate the log-linear quadratic trend. The right subfigures depict the business cycles, the cyclical component of the data. The PWT database serves as the source of the data. The calculations belong to the author.*

Figure 12 illustrates that all economies deviate from their long-term trends at different time periods. For instance, although the Argentinian economy had strong development during the 1990s, it failed to meet the expected growth rate due to the economic crises that occurred subsequently. The significant economic downturn that Türkiye experienced during the 2001 crisis is easily noticeable in the figure.

After analyzing the individual growth performances of countries' per capita incomes, it becomes evident that Argentina's development in the 1990s significantly exceeded its long-term trend. A significant economic crisis, namely the Great Depression of

Argentina, caused an economic downturn in the country from 1998 to 2002. It is evident that this contraction led to a resumption of growth in line with its long-term trend.

Upon examining Mexico, it becomes evident that it possesses the lowest level of volatility compared to the other two countries. Per capita income, which experienced a tremendous rise in the 1970s, has since returned to its long-term trend with only modest fluctuations.

Conversely, Türkiye has seen periods of rapid growth and recession at different time intervals compared to other countries. Türkiye experienced the greatest divergence from the long-term trend in 2001. All three countries clearly exhibit a positive trend. Nevertheless, it is feasible to discuss an increasing but diminishing trend for Mexico.

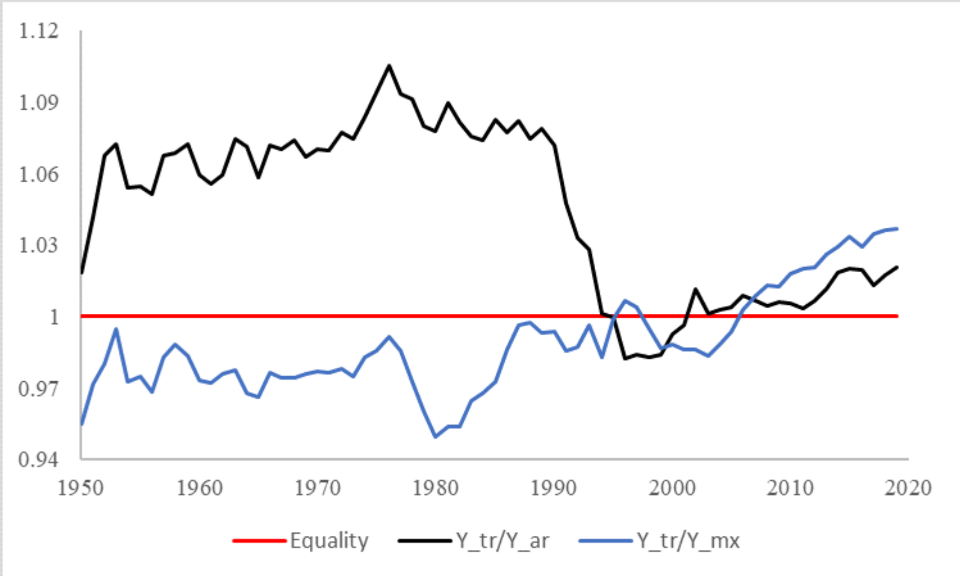
Figure 13 displays the ratios of Türkiye's per capita income to Argentina's per capita income and Türkiye's per capita income to Mexico's per capita income from 1950 to 2019. We utilize the PWT dataset to obtain this figure, as detailed in the estimation section. The real GDP data for all countries from 1950 to 2019 is initially adjusted for population by calculating it per capita. Next, we apply natural logarithms to smooth the data.

If the ratios in the figure exceed the red line, which is equal to 1, it indicates that Türkiye's per capita income surpasses that of Argentina and Mexico. Until 1995, Türkiye had a higher per capita income than Argentina. Then, Argentina outperformed Türkiye in terms of rapid economic expansion during the 1990s. This condition persisted until 2001, at which point both countries faced a crisis. From 2002 to 2019, Türkiye exceeded Argentina in per capita income.

Since 2006, Türkiye has consistently exceeded Mexico in terms of per capita income, with the exception of 1996 and 1997, when Türkiye had slightly higher per capita income in these years. Mexico, which previously held a leading position in terms of per capita income, has experienced a decline in its ranking due to its comparatively lower growth rates in recent years.

After examining the comparisons between Türkiye and Argentina, as well as Türkiye and Mexico, it becomes evident that the ratio of per capita income is approximately equal to 1. It is worth thoroughly examining the comparable per capita income performances of these three economies, despite their varied economic dynamics and geographical locations.

Figure 13: The Ratio of Türkiye's Real GDP Per Capita to That of Argentina and Mexico



Note: *The solid black, blue, and red lines display the ratio of real GDP per capita in Türkiye to real GDP per capita in Argentina (Y_tr/Y_ar), the ratio of real GDP per capita in Türkiye to real GDP per capita in Mexico (Y_tr/Y_mx), and the equality line. The x-axis indicates the year. The PWT database serves as the source of the data.*

These three countries with closely matched per capita income numbers exhibit variations in their economic dynamics. For instance, Argentina has a trade surplus due to its export-focused agricultural industry, while Türkiye relies on imported inputs for production and has a trade deficit. Mexico, like Türkiye, has a significant reliance on the service sector for employment and experiences a trade deficit. These three countries have witnessed different fluctuations at various times. To analyze these fluctuations more thoroughly, it is considered appropriate to segment the entire data period into different time periods. Table 7 displays the historical periods together with the average growth rates and the volatility of growth rates during those periods.

We decide to analyze the period from 1951 to 1974, which includes the post-World War II era and the global oil crisis in 1973, while considering the political and economic contexts of these selected EMEs. Türkiye has significantly higher per capita income growth on average during this period. Similarly, the growth rate in Mexico exceeds its historical average. In addition, substantial growth rates result in substantial volatility in growth for Türkiye.

The upcoming phase spans from 1975 to 1989. During this period, all countries implemented economic reforms and increasingly adopted neoliberal principles. This period includes the 1980 military coup in Türkiye and the debt crises in Latin American countries during the 1980s. All countries faced severe economic and political developments, resulting in growth rates considerably lower than their typical long-term averages. However, Türkiye has higher volatility than Argentina despite experiencing lower average growth rates. Despite its lowest growth performance, Mexico has the highest volatility in this period.

Table 7: Historical Growth Experiences for Türkiye, Argentina, and Mexico over Different Time Periods (in Percent)

Period	G_{TR}	G_{AR}	G_{MX}	σ_{TR}	σ_{AR}	σ_{MX}
1951-1974	3.89	1.58	2.95	6.93	4.55	2.75
1975-1989	1.45	1.60	0.83	5.00	4.31	5.14
1990-1997	2.45	11.31	1.77	7.10	6.09	3.96
1998-2002	-1.41	-6.66	1.99	4.73	6.04	3.79
2003-2015	5.69	4.94	2.11	5.09	5.67	3.20
2016-2019	1.16	1.00	0.42	3.63	7.27	2.08
1951-2019	2.99	2.90	1.91	6.08	6.72	3.65

Note: *G_{TR}, G_{AR}, , G_{MX}, σ_{TR}, σ_{AR}, and σ_{MX} are the per capita real GDP growth of Türkiye, the per capita real GDP growth of Argentina, the per capita real GDP growth of Mexico, the standard deviation in growth of Türkiye, the standard deviation in growth of Argentina, and the standard deviation in growth of Mexico, respectively. The PWT database serves as the source of the data. The outcomes are computed by the author. The values are in percentages.*

The 1990s were a time of significant fluctuations in growth rates for Türkiye. Despite increasing growth rates compared to the preceding decade, this period experienced the most volatility. After the 1980s debt crisis in Latin America, Argentina had significant economic development throughout the 1990s. Despite the strong growth rates, the volatility in growth rates was modest in Argentina compared to Türkiye in this period. Also, the Mexican Peso Crisis in 1994 hindered Mexico's potential for better economic growth. During this period, Mexico, which experienced growth that closely aligned with the long-term average, has the lowest level of volatility among all countries.

We analyze the years 1998–2002 separately because they were a time of crisis for Argentina and Türkiye. This era is known as the Great Depression in Argentina. Also, the financial crisis that occurred in Türkiye in 2001 is one of the most significant crises in the country's history. During this specific period, the economies of both countries shrank. The Argentinian economy is seeing a more significant downturn compared to the Turkish economy. Argentina, which matched Türkiye in per capita income throughout the 1990s, thereafter fell behind due to the significant economic downturn it faced. In spite of the poor economic times in Argentina and Türkiye, Mexico exhibited significant growth and maintained a stable performance with few fluctuations during this time period.

After 2002, Türkiye, Argentina, and Mexico's economies experienced higher and more stable growth. Argentina and Türkiye experienced approximately 5% growth in per capita income on average from 2003 to 2015, but their growth volatility, surprisingly, remained lower than their long-term volatility levels. While Mexico's growth rate is lower than that of the other two countries, it exceeds its own long-term growth, and the volatility falls below its own long-term volatility average.

All countries have experienced economic challenges since 2016. The Argentinian peso, after lifting limitations on the domestic exchange rate, has undergone its most significant decline since 2002. Argentina experienced a significant rise in inflation rates in 2016, which was closely linked to sharp fluctuations in the exchange rate, resulting in one of the highest inflation rates globally. Following the military coup attempt in 2016 and geopolitical developments, the Turkish economy, which is susceptible to external shocks, began to deteriorate. In recent years, Mexico has experienced weak economic growth as a result of protectionist policies implemented by the United States, its major trading partner. In the subsequent years, the economic decline in all countries continued to escalate. Post-2015, the average growth rates were dramatically lower than the historical averages.

The historical averages of the Argentinian and Turkish economies show similar average growth rates and volatilities. However, Mexico's growth and volatility averages are lower than the other two countries. All countries have experienced periods of tremendous growth and recession at various times for different reasons. Argentina has consistent growth volatility across several growth periods. For instance, although the growth patterns of the years $1990-1997$ and $1998-2002$ seem to be contrasting, the growth volatilities are in alignment for Argentina.

Similarly, Mexico's growth patterns appear to be different throughout the periods of $1951-1974$ and $2016-2019$, yet the levels of growth volatility are consistent. However, various growth periods result in varying levels of volatility for the Turkish and Mexican economies. During the same periods, the growth volatility in Türkiye differs significantly. Consequently, the stylized facts suggest that Türkiye responds more vigorously to growth shocks, like the model's claim.

1.6.2.2. Model Comparisons

In this subsection, we will compare the results of our investigation with those of Garcia-Cicco et al. (2010) and Aguiar and Gopinath (2007). Aguiar and Gopinath's study specifically examined the Mexican economy, while Garcia-Cicco et al. conducted a more comprehensive analysis of the Argentinian economy using an extended model. Table 8 shows the summary information about these studies. Table 9 displays the estimated values of the selected parameters in both studies and our own findings.

Table 8: Summary Information of the Studies Being Compared

	Research		
Information	**Aguiar and Gopinath (2007)**	**Garcia-Cicco et al. (2010)**	**Our Study**
Country	Mexico	Argentina	Türkiye
Data Frequency	Quarterly	Annually	Annually
Period	1980-2003	1900-2005	1950-2019
Technology Shock	√	√	√
Growth Shock	√	√	√
Preference Shock	–	√	√
Country Premium Shock	–	√	√
Domestic Spending Shock	–	√	√

Table 8 demonstrates that the Mexican study has a shorter duration compared to other investigations. In addition, unlike others, they utilized quarterly frequency data. Research conducted in Argentina and Türkiye spans a much longer timeframe. Although the Argentinian study covers a time frame of more than a hundred years, the data utilized in our study pertains to a more contemporary timeframe. It is worth noting that the studies on Argentina and Türkiye have more extensive versions, including intertemporal preference, country premium, and domestic spending shock processes.

Table 9 presents the estimation results from all three investigations. Because the Aguiar and Gopinath study focuses on growth and technological shocks, other parameters do not have assigned values. It is important to point out that Garcia-Cicco et al. and our research are extensive models that encompass country premium, intertemporal preference, and domestic spending shock processes.

Table 9: Comparisons of Different Model Results

Parameter	**Aguiar and Gopinath (2007)**	**Garcia-Cicco et al. (2010)**	**Our Study**
ρ_g	0.72	0.35	0.98
σ_g	0.011	0.007	0.041
ρ_a	0.94	0.87	0.84
σ_a	0.004	0.033	0.035
ρ_v	-	0.86	0.30
σ_v	-	0.51	0.31
ρ_μ	-	0.91	0.60
σ_μ	-	0.056	0.079
ρ_s	-	0.29	0.44
σ_s	-	0.015	0.191

Note: *Parameters that are not available are marked with a hyphen (-).*

Our study determines the highest value for the persistency of the growth shock ($\rho_g = 0.98$). Following that comes the Mexican research (0.72). In the Argentinian study, the value is significantly lower (0.35) compared to the other two studies. The numbers observed for shock persistency directly indicate the ability of the growth shock to account for the fluctuations. The growth shock is the primary factor explaining the fluctuations in both Turkish and Mexican studies. After examining the volatility parameters of growth shocks, we find that our study has the highest volatility parameter ($\sigma_g = 0.041$), while the volatility parameters of the other two studies are similar and lower (0.011 and 0.007, respectively).

After analyzing the technology shock process parameters, it becomes apparent that the persistency parameters are both high and similar to each other ($\rho_a = \{0.84,$

0.87, 0.94}, respectively). However, in the Mexican study, the technology shock's volatility parameter is significantly lower ($\sigma_a = 0.004$) compared to the others. The low volatility of the technology shock seen in the Mexican study suggests that the technology shock alone is not enough to account for the fluctuations. Nevertheless, the technology shock is the primary factor that explains the processes in the Argentinian economy. Our study reveals that the technology shock, although extremely powerful in explaining short-term fluctuations, is less influential than the growth shock in explaining long-term fluctuations.

When we look at the estimation results from the studies in Argentina and Türkiye that used the extended model, it is clear that the intertemporal preference and country premium shocks have higher persistency parameters in the Argentinian study ($\rho_v = 0.86$ and $\rho_\mu = 0.91$). This demonstrates that these two shock processes play a significant role in explaining Argentinian economic fluctuations.

In our investigation, the intertemporal preference persistency parameter is relatively low ($\rho_v = 0.30$). It is evident that the impact of the intertemporal preference shock is not significant in explaining the fluctuations in Türkiye. It's important to note that, despite its slightly lower amount ($\rho_\mu = 0.60$), the country premium shock significantly contributes to explaining the fluctuations in *tby* in Türkiye.

Our study found that the domestic spending shock's persistency and volatility parameters are higher ($\rho_s = 0.44$ and $\sigma_s = 0.191$). This implies that the domestic spending shock plays a more significant role in explaining fluctuations compared to the Argentinian study. In the medium and long run, the domestic spending shock accounts for around 25% of Türkiye's *tby* fluctuations.

1.6.3. Domestic and Foreign Shock Effects

DSGE models include several shock processes to describe unanticipated changes in economic conditions that cause macroeconomic variables to fluctuate. This study examines five specific shock processes: technology, growth, intertemporal preference, domestic spending, and the country premium shock processes. Out of these, the country premium shock is a foreign shock, while the rest are domestic shock processes.

Technology shocks are sudden and unexpected changes in the economy's productivity and output. Innovations, improvements in industrial techniques, or technological advancements can cause these shocks. Technology shocks play an important role in understanding Türkiye's fluctuations in output and consumption. The IRFs in our model indicate that technology shocks exert a substantial and enduring influence on g_Y and g_C. The variance decomposition analysis reveals that technological shocks play a significant role in causing short-term economic fluctuations in Türkiye.

Changes in the economy's core growth rate cause growth shocks. These shocks might originate from different sources, including demographic changes, policy reforms, or continual improvements in human capital. Our model demonstrates that growth shocks have a significant effect on economic variables, changing the overall growth of investment, output, and consumption. We emphasize the importance of variance decomposition in explaining long-term economic fluctuations in Türkiye.

Intertemporal preference shocks refer to changes in consumers' time preferences that affect their savings and expenditure decisions. Factors such as variations in consumer confidence, future expectations, or changes in cultural attitudes towards saving and consumption can cause these shocks. The intertemporal preference shocks have an immediate effect on consumption, as shown by the IRFs. Nevertheless, these shocks have a negligible impact on the fluctuations in the variables.

Domestic spending shocks are unanticipated changes in government expenditures. These shocks may be caused by fiscal policy decisions, changes in public investment, or unexpected government spending. Our model's IRFs suggest that domestic spending shocks have a modest effect on tby. The variance decomposition analysis reveals that these shocks have a substantial impact on the long-term economic fluctuations in tby.

Comparing these shocks, it becomes clear that domestic shocks, such as changes in technology, growth, intertemporal preference, and domestic spending, are the main factors responsible for Türkiye's economic volatility. However, the foreign country premium shock also has a significant impact, particularly on Türkiye's trade balance.

Policymakers should prioritize fostering technological advancement and maintaining sustainable long-term economic growth by implementing structural changes and making investments in human capital. Efficiently managing domestic spending can contribute to stabilizing fluctuations. Furthermore, ensuring economic stability and enhancing foreign investor trust are crucial in reducing the negative effects of country premium shocks.

Overall, the five shock processes incorporated in our DSGE model offer a comprehensive understanding of the determinants behind economic fluctuations in Türkiye. Understanding long-term trends and short-term dynamics requires a thorough analysis of domestic shocks, with a special focus on technology and growth shocks. Foreign-country premium shocks have significant implications for the financial system's stability. To gain a more comprehensive understanding of Türkiye's economic resilience, future research could examine the impact of shocks specific to different sectors and their transmission mechanisms.

1.7. CONCLUSION

There is an extensive amount of research in the field of economics that focuses on EMEs and their analysis of business cycles. This chapter specifically examines the primary determinants of economic fluctuations in EMEs, which have both trade deficits and foreign debt. We choose Türkiye as our focus country due to its particular characteristics.

Despite methodological differences, most research utilizing DSGE models primarily examines countries such as Argentina and Mexico. There is a lack of extensive research on Türkiye. To address this research gap, this study investigates the business cycles in Türkiye using the Financial Frictions Model of Garcia-Cicco et al. (2010), making slight modifications to their model.

We calibrate the observed model parameters and estimate the unobserved model parameters using the long-term Turkish data, employing the Bayesian estimation method. The model's observable parameters are calibrated using annual data from Türkiye spanning the years from 1950 to 2019. The Penn World Table (PWT) data and the World Bank Database (WBD) are the datasets used in this study. We use the datasets to determine model parameters such as the share of government expenditures in GDP and the ratio of external debt to GDP.

The Bayesian estimation method is used to estimate the persistency and volatility parameters of shock processes and, additionally, the parameters of capital adjustment, productivity growth, and interest rate debt elasticity that are not observable in the data. The estimated parameter values make an important contribution to the existing literature.

The calculation of the second moments, Impulse Response Functions (IRFs), and the conditional variance decomposition summarize the study's analyses. The model's second moments accurately replicate the data. The data indicates that the variables' volatilities follow the order $\sigma_{tby} < \sigma_Y < \sigma_C < \sigma_I$. The estimated model results align with this fact. The correlation coefficients between *tby* and the other variables are negative, according to the data. The model is also capable of accurately replicating this phenomenon.

Furthermore, the IRFs analysis investigates significant macroeconomic variables' paths, such as g_Y, g_I, g_C, and *tby*, in response to encountered shocks. Positive technology and growth shocks have a favorable impact on variables g_Y, g_I, and g_C. Nevertheless, the technological shock initially leads to an increase and then a decrease in *tby*. Moreover, *tby* increases in the event of a growth shock after the initial decline.

The intertemporal preference shock only boosts the consumption growth. In the case of the country premium shock, there is a reduction in external borrowing opportunities. As a result, there is an increase in *tby* and a fall in other variables. The effect of the domestic spending shock is rather constrained in terms of g_Y and g_C. Nevertheless, the domestic spending shock has a significant effect on the variables g_I and *tby*.

We also compare the acquired findings with those from Argentina. By employing the variance decomposition analysis, one may observe the distinctiveness of the dynamics between Türkiye and Argentina. The growth shock, which has little impact on explaining the fluctuations in Argentina, is shown to be substantial for Türkiye in all different timeframes. Moreover, the ability of the technology shock to account for fluctuations in g_I and *tby* is greater in the case of Türkiye.

In contrast to the results for Argentina, the country premium shock has less importance in explaining the fluctuations for Türkiye. Both studies indicate that the impact of the domestic spending shock on fluctuations is negligible in accordance with g_Y, g_I, and g_C. Nevertheless, the domestic spending shock can explain the one-quarter of volatility in *tby* for Türkiye.

Finally, we analyze the impact of shock processes and observe the fluctuations of particular variables during times of crisis. We select the crises that occurred in

1994, 2001, and 2009 as the designated crisis periods. Based on our findings, growth shocks have a substantial effect on both the growth of output and *tby*. Furthermore, the country premium shock has a substantial impact on *tby*, while the technology shock has a significant impact on g_Y.

Chapter 1 of the thesis provides a substantial advancement in our comprehension of the economic dynamics of EMEs, specifically focusing on countries that exhibit both trade deficits and foreign debt, such as Türkiye. By carefully analyzing the factors that cause changes in economic activity in these economies, we discover useful information about the complex relationship between trade deficits, external debt, and domestic economic conditions. This chapter offers a detailed understanding of the factors that cause economic fluctuations. It provides a sophisticated viewpoint on the strengths and weaknesses of EMEs' economic structures. This study lays the groundwork for future investigations and policy development.

By acknowledging the weaknesses identified in this analysis and implementing specific methods to address them, EMEs such as Türkiye can strengthen their ability to endure challenges and navigate a path towards long-term economic growth. The findings in Chapter 1 provide a substantial contribution to the broader discussion on the economic dynamics of EMEs. They influence policy decisions and promote inclusive growth in these rapidly changing economies.

Using the DSGE framework, we may look into how different policy regimes or macroeconomic shocks affect EMEs in the future. This would allow a more thorough analysis of policy trade-offs and transmission mechanisms. Future research could also investigate the resilience of the model's predictions to changes in parameterizations or structural assumptions. Sensitivity analysis could test the model's performance in various situations. Also, checking the DSGE model's predictions against real-world data and using econometric methods could help us understand how well it works and where it falls short when it comes to accurately describing the complicated nature of economic activity in EMEs.

CHAPTER 2

NON-TRADABLE GOODS AND IMPORTED INPUTS IN AN EMERGING MARKET ECONOMY

2.1. INTRODUCTION

The prevailing literature on classical Emerging Market Economies-Real Business Cycle (EME-RBC) models typically comprises two main agents: households and firms. Within these models, households generate revenue by providing their capital and labor, while firms utilize these factors of production to produce final goods. There exists a single final good in the economy that has the ability to be both exported and imported. Particularly, some of these models incorporate the concept of an external debt stock, where the household determines the amount to borrow in each period.[16]

It is unrealistic to assume that the economy produces only one good that is exchangeable internationally. Essentially, several goods in EMEs are classified as non-tradable goods. Non-tradable goods, by definition, are goods or services that lack producers and consumers in close proximity, have substantial logistics costs, or face trade restrictions such as tariffs or quotas.[17]

Goods or services subject to the constraints that prevent them from participating in international trade do not have their prices equalized in global marketplaces as tradable goods and services do. Put simply, the law of one price (LOP) does not apply to these goods.

The LOP principle assumes a market devoid of friction, characterized by the absence of transaction expenses, transportation costs, and legal constraints. Additionally, it assumes an equal currency exchange rate and the absence of price manipulation by either buyers or sellers. The principle of the LOP stems from the belief that the arbitrage opportunity will ultimately eliminate disparities in asset values across various geographical regions.

What factors influence the magnitude of the deviation from the LOP? This ques-

[16]See Garcia-Cicco et al. (2010) and Aguiar and Gopinath (2007).
[17]See Komiya (1967) and Jenkins et al. (2011).

tion is a commonly debated topic in the literature. In response to this question, Samuelson (1964) highlights the disparities in productivity between non-tradable and tradable goods. Crucini et al. (2005) assert that the tradeability of the good and the proportion of non-tradable inputs required for its production primarily influence the variation across goods in the LOP deviations.

In recent times, there has been the development of several models that involve the production of both non-tradable and tradable goods, as opposed to firms solely producing final goods. Classifying production into two distinct sectors allows for a clearer analysis and identification of the impacts of external shocks, such as exchange rate fluctuations, and domestic disturbances within the country.

It is essential to include non-tradable goods in DSGE models to adequately represent the economic dynamics of EMEs. Non-tradable goods and services make up a significant portion of these economies, reflecting a broad sectoral structure essential for accurate modeling. By including non-tradable goods, we can conduct a more accurate examination of inflation and pricing dynamics. This is because prices in non-tradable sectors sometimes demonstrate varying levels of inflexibility when compared to tradable sectors.[18]

Understanding the differentiation between sectors is crucial for comprehending how monetary and fiscal policies impact different sectors, which in turn allows for more precise and effective policy recommendations. Incorporating non-tradable goods into the analysis enhances the evaluation of exchange rate pass-through effects, which are generally less significant in the non-tradable goods sector. This improvement in model accuracy is especially crucial for EMEs, since external shocks, such as fluctuations in commodity prices and changes in global demand, have varying effects on the sectors involved in international trade and those that are not.

The idea of incorporating the non-tradable sector into macroeconomic models began to gain traction in the mid-1990s. Stockman and Tesar's (1995) model matches a lot of different aspects of production and consumption data. It also does a good job of recreating international correlations between aggregate output and consumption, as well as the counter-cyclical behavior of the trade balance and the current account compared to earlier research.

By definition, the domestic market alone influences the demand for non-tradable

[18]See Uribe and Schmitt-Grohê (2017).

goods, while both domestic and global markets influence the demand for tradable goods.[19] Mendoza (2002) asserts that differentiating sectors allows for a better analysis of economies with foreign debt, primarily denominated in foreign currencies. He explains that changes in exchange rates can quickly impact the pricing of tradable goods, whereas the prices of non-tradable goods may not be as affected and could remain much cheaper or more expensive, depending on the direction of the movement in the exchange rates.

Engel (1999) demonstrates that changes in the real exchange rates of tradable goods account for the majority of the variation in bilateral exchange rates. Conversely, fluctuations in the relative pricing of non-tradable goods may account for a modest portion of the observed variance. Nevertheless, Betts and Kehoe (2008) assert that the relative price of non-tradable goods and the real exchange rate exhibit comparable directional fluctuations. Moreover, a low variability of the real exchange rate diminishes the association between the relative price of non-tradable goods and the real exchange rate.

When analyzing EMEs, it is crucial to consider not only the division of the production structure into several sectors, but also the impact of the production factors. Globalization, along with the rapid advancements in technology, results in substantial transformations within the industrial systems, particularly in EMEs. The globalization of domestic production networks has led to the adoption of foreign production for certain inputs, which serves as a means to provide reliable access to cost-effective and superior resources.

Numerous studies demonstrate that utilizing imported inputs in the production process improves production efficiency[20] and the export capacity of a country.[21] Nevertheless, in countries that heavily rely on imported inputs, variations in exchange rates can have a significant impact on macroeconomic variables such as GDP growth, the current account deficit, and inflation, mostly through production and export channels. This scenario gave rise to the idea that production's reliance on imported inputs posed a challenge, prompting researchers to focus their attention on addressing this particular issue.[22]

[19] See Bianchi (2011).

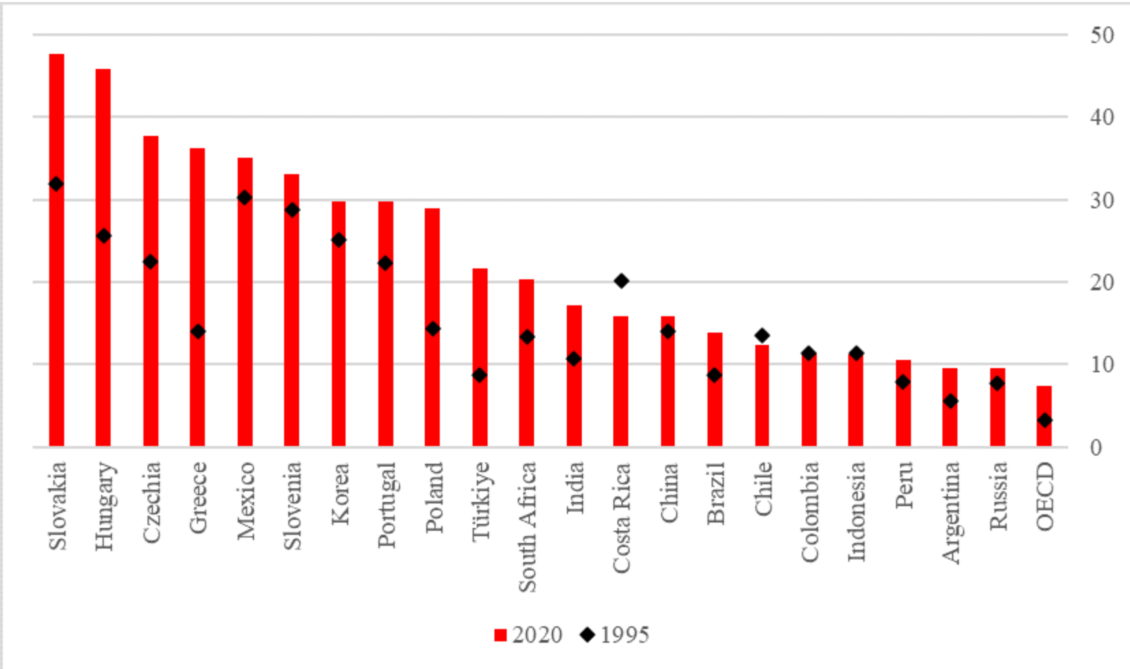
[20] See Halpern et al. (2015), Kasahara and Rodrigue (2008), Amiti and Konings (2007) and Topalova and Khandelwal (2011).

[21] See Bas and Strauss-Kahn (2014).

[22] See Liu and Qiu (2016), Erduman et al. (2020) and Boehm et al. (2020).

Figure 14 shows the import content of exports for the selected EMEs and the Organisation for Economic Co-operation and Development (OECD) average.[23] The import content of exports refers to the proportion of imported inputs in a country's total exports, indicating the degree to which a country relies on external inputs. The statistic is commonly known as the "foreign value-added share of gross exports." The calculation involves the division of the foreign value-added by the total gross exports, which is then expressed as a percentage.

Figure 14: Import Content of Exports for the Selected Countries



Note: *The data from 2020 is depicted in the red bar chart, while the data from 1995 is represented by the black dots. The x-axis represents the countries. The data source is the OECD Statistics on Trade in Value Added 2023 edition.*

Upon detailed examination of Figure 14, it becomes evident that the proportion of imported input utilization in the overall exports of nearly all countries has experienced an increase. Only Costa Rica and Chile exhibit a decline over time among the selected countries. Furthermore, it is worth noting that from 1995 to 2020, there has been a lack of substantial changes observed in countries such as Colombia and Indonesia. When examining the rates of imported input utilization, there are notable differences among countries. Eastern European countries such as Slovakia and Hungary have imported input usage rates exceeding 40%, whereas countries such as

[23] Appendix 2 provides the values and the list of selected countries.

Russia and Argentina have rates below 10%.

It is noteworthy that the rate in all selected countries is above the average rate of the OECD for both the years 1995 and 2020, with values of 3.2% and 7.4%, respectively. In Türkiye, the rates for 1995 and 2020 are 8.8% and 21.6%, respectively. This rise indicates a significant increase in Türkiye's reliance on foreign inputs over the past 25 years.

We have chosen to analyze Türkiye as a representative country in order to closely examine the significance of imported input usage for EMEs. After analyzing the official data from Türkiye during the first four months of 2024, it is evident that a significant portion of the imported goods consist of various intermediary goods used as inputs in production processes. Many industries use the most important imports as inputs, including mineral fuels, mineral oils, machinery, iron, steel, plastic, copper, rubber, seeds, and cereals.[24] Furthermore, the proportion of goods used as imported inputs in total imports is significant.

Given the significant quantity of imported inputs in EMEs, it is crucial to integrate these imported goods into the production processes. Incorporating imported inputs into theoretical models has numerous advantages. By incorporating imported inputs into the model, the domestic economy establishes a relationship with the global economy, not only through final goods but also through the use of inputs. Therefore, we demonstrate how potential fluctuations in worldwide pricing and interest rates affect domestic production. Furthermore, it is possible to more precisely observe the shock dynamics that may arise in imported input prices.

Furthermore, due to variations in pricing mechanisms across global marketplaces and among different goods, price shocks may occur at different times for each good. Hence, it is crucial to distinguish imported inputs in terms of factors of production and to separate sectors as extensively as feasible while formulating the production function of an EME.

Incorporating imported inputs into the production function of a DSGE model for an EME greatly improves the model's realism and analytical power. EMEs frequently have strong connections to global value chains, depending on imported intermediate goods and raw materials to carry out their production processes. By including imported inputs, the model achieves a more precise representation of the actual

[24]The Turkish Statistical Institute (TUIK) maintains the "Foreign Trade Statistics Imports of Intermediate Goods" database, from which we extract the data and product groups.

cost structure and interconnections within the economy, demonstrating the effects of exchange rate changes and disruptions in the global supply chain on domestic production.

This addition also enables a detailed examination of trade policies, such as tariffs and trade agreements, and their impact on economic activity. Furthermore, it improves our understanding of how external disturbances spread throughout the economy. The inclusion of imported inputs further improves the assessment of monetary and fiscal policies by demonstrating their impact on production costs and inflation. In summary, this adjustment improves macroeconomic forecast precision and policy simulation effectiveness, increasing the use of the DSGE model as a tool for policymakers in EMEs.

The objective of this study is to create a benchmark model that incorporates both non-tradable and tradable goods in an EME. Furthermore, we assume that these sectors utilize imported inputs alongside capital and labor. This chapter seeks to examine the economic structure of EMEs, specifically analyzing how fluctuations in various sectors and the use of imported inputs impact the economy's performance. The study aims to assess the influence of non-tradable and tradable goods sectors on various aspects of the economy.

Numerous EMEs rely on imported inputs in their production processes. This study seeks to enhance the existing literature through this extension. Despite EMEs not significantly influencing global prices and interest rates, we have enhanced the constructed model by incorporating exogenous shock processes from the prices of tradable goods and imported inputs from both sectors. One of the research's primary goals is to determine which shock processes are more effective in an EME with imported input dependence and a trade balance. Specifically, this analysis focuses on the volatility in GDP, the trade balance, and the current account balance.

Developing a hypothetical benchmark model that includes sector differentiation and the use of imported inputs will facilitate future research in a variety of fields. Compared to previous studies in the literature, the new model provides a more precise and distinct explanation of how foreign shocks impact the domestic economy and their transmission mechanisms. Chapter 2 has no primary goal of directly offering policy recommendations for a specific EME, but it is possible to estimate the model by selecting suitable EMEs that align with the research findings.

Analyzing EMEs' economic prosperity is dependent on two key factors: sectoral differentiation and the use of imported inputs. This study enhances our understanding of the challenges and opportunities that EMEs face in a globally interconnected economy by examining their influence on the non-tradable and tradable goods sectors. Hence, the study seeks to provide decision-makers and stakeholders with quantitative analysis and policy suggestions to enhance sustainable growth and resilience in EMEs.

We will specifically design a DSGE model for an EME in this study. The model incorporates both tradable and non-tradable goods sectors, utilizing imported inputs in production processes. The production of these sectors is aggregated by the final goods producer and provided to the economy as final goods. "The rest of the world" serves as an agent to illustrate the connection between the external world and the domestic economy. We will introduce the details of the model in the subsequent sections.

We calibrate the parameters of the constructed model by following the relevant literature. We first compute the steady state solutions, then proceed to compute the second moments of the selected variables. We compare the model's second moments with Türkiye's 2022 data to provide an illustrative example for EMEs. There is a substantial overlap between the findings of the model and the data. Furthermore, it is important to note that different production sectors exhibit notable fluctuations in their respective second moments. For instance, the non-tradable goods sector exhibits comparatively lower levels of fluctuations as compared to the other production sectors.

We then use the Impulse Response Functions (IRFs) for the analysis. The IRFs are individually analyzed for eight distinct shock mechanisms within the model. The primary observations indicate that each shock process exhibits variation across different sectors. Furthermore, the constructed model facilitates the examination of potential shocks in the foreign price level and imported input prices. Importantly, the fluctuations in imported input prices across various industries have a detrimental effect on the real exchange rate.

Ultimately, we conduct the analysis of variance decomposition. The variance decomposition is a statistical technique that quantifies the impact of individual shock processes on the volatility of the selected variables. We identify the country premium shock as the primary explanatory shock process for understanding the fluctuations of the variables. The final goods technology shock and the world (or foreign) price level shock processes are considered to be the most explanatory shock processes following the country premium shock.

Consistent with the findings of the variance decomposition analysis, we conduct some robustness tests on the selected shock processes. Analyzing the arbitrarily selected shock persistency parameters in the benchmark model yields consistent outcomes with the benchmark case at different levels. In addition, we analyze the outcomes of several models by modifying the concept of debt-elastic interest rate as specified in the model. Additional specifications, characterized by income-elastic and exogenous interest rates, produce outcomes that closely align with the benchmark model. Therefore, we might infer that the established theoretical model is robust and reliable.

The structure of this chapter is as follows. In Section 2.2., the environment and agents of the model are introduced. This section presents the household problem and discusses the types of firms and their optimization problems. The relationship between the rest of the world and the domestic economy is also explained in Section 2.2. Section 2.3. presents the parameter calibration of the model. In Section 2.4., the findings of the model are exhibited in detail through the second moments, IRFs, and the variance decomposition analysis. Section 2.5. presents some robustness tests. Finally, Section 2.6. provides the concluding remarks.

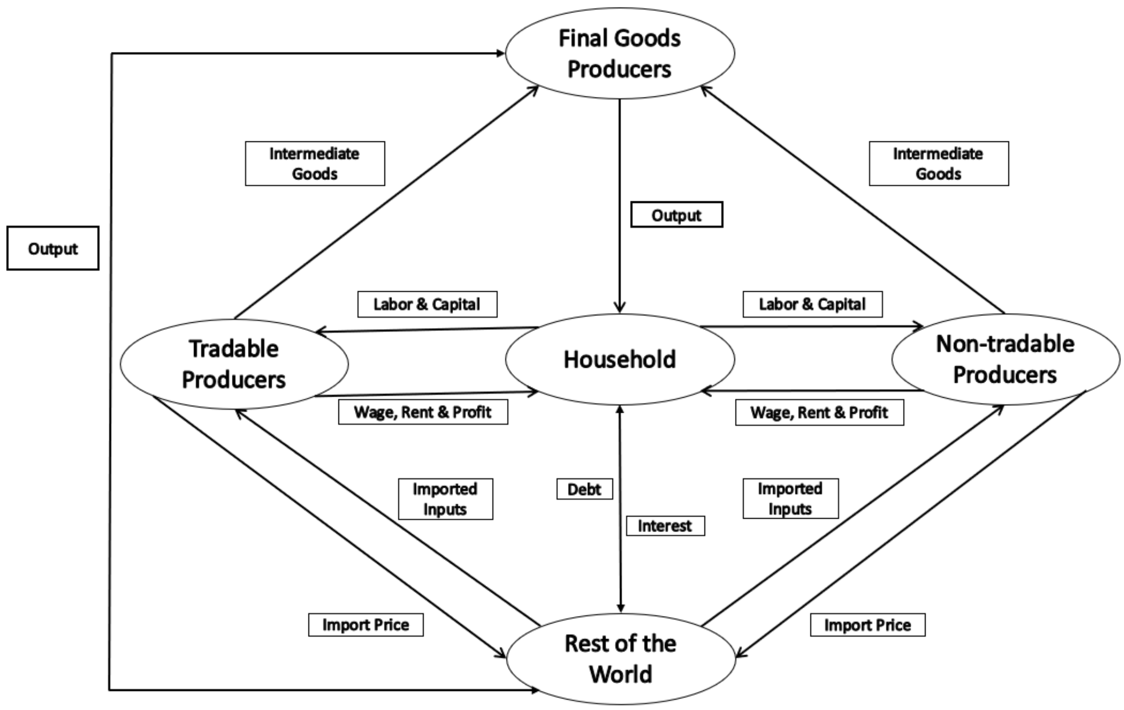
2.2. MODEL ECONOMY

2.2.1. Environment

We postulate the existence of three primary agents within this EME: households, firms, and the rest of the world. We categorize firms into three distinct groups: non-tradable, tradable, and final goods sectors. Figure 15 depicts the interrelationships among the agents.

Households aim to optimize their lifetime utility by consuming final goods and leisure time. Moreover, households allocate their labor and capital resources to both non-tradable and tradable goods sectors with the aim of obtaining remuneration in the form of wages and rental income from capital. Furthermore, households own all firms and receive a portion of the profits they generate.

Figure 15: Illustration of the Interrelationships of the Agents



The non-tradable and tradable goods sectors produce an intermediate good by using labor and capital. Also, these sectors rely on imported inputs for their production processes. This fundamental assumption is the essential factor that distinguishes this study from the existing literature.

We collectively employ intermediate goods as inputs in the production process of final goods. Given the current economic conditions, it is possible that households can acquire foreign borrowing in return for a certain interest payment.[25] Lastly, "the rest of the world" serves as an agent, exemplifying the interaction between the domestic economy and external economies.

This model assumes discrete time and identical agents for each problem. Therefore, we can concentrate on a representative agent for each problem. In the top-right corner, the symbols N, T, and F represent the non-tradable goods sector, the tradable goods sector, and the final goods producer, respectively. However, we have

[25] As discussed by Uribe and Schmitt-Grohe (2017).

no interest in the specifics of the domestic economy's interactions with the outside world. We are interested in the total sum of these interactions. In essence, we will investigate the model from the perspective of the domestic economy.

2.2.2. Decision Problems

2.2.2.1. Households

A representative household tries to maximize its lifetime utility. The utility function depends on consumption (c) and labors (h^N and h^T). This economy assumes the presence of two types of labor. Thus, there are two ways in which labor supply takes place: non-tradable and tradable goods production processes.

Because of technical advantages, such as becoming additively seperable and unconnectedness among c, h^N, and h^T, the utility function is assumed to be in the Greenwood-Hercowitz-Huffman (GHH) form as follows:

$$U(c_t, h_t^N, h_t^T) = \frac{G(c_t, h_t^N, h_t^T)^{1-\sigma} - 1}{1-\sigma} \tag{12}$$

$$G(c_t, h_t^N, h_t^T) = c_t - \frac{(h_t^N)^{\omega^N}}{\omega^N} - \frac{(h_t^T)^{\omega^T}}{\omega^T} \tag{13}$$

where ω^N, ω^T, and $\sigma > 0$. While ω^N and ω^T determine the wage elasticities of labor supply for non-tradable $\left(\frac{1}{\omega^N-1}\right)$ and tradable $\left(\frac{1}{\omega^T-1}\right)$ goods sectors respectively, $\sigma > 0$ is the risk aversion parameter.

The utility function is assumed to be continuous, concave and twice differentiable with $U_{c,t} \equiv \frac{\partial U(c_t,h_t^N,h_t^T)}{\partial c_t} > 0$, $U_{cc,t} \equiv \frac{\partial^2 U(c_t,h_t^N,h_t^T)}{\partial c_t^2} \leq 0$, $U_{h^N,t} \equiv \frac{\partial U(c_t,h_t^N,h_t^T)}{\partial (h_t^N)} < 0$, $U_{h^T,t} \equiv \frac{\partial U(c_t,h_t^T,h_t^T)}{\partial (h_t^T)} < 0$, $U_{h^N h^N,t} \equiv \frac{\partial^2 U(c_t,h_t^N,h_t^T)}{\partial (h_t^N)^2} \leq 0$, and $U_{h^T h^T,t} \equiv \frac{\partial^2 U(c_t,h_t^N,h_t^T)}{\partial (h_t^T)^2} \leq 0$ where $U_{c,t}$, $U_{h^N,t}$, and $U_{h^T,t}$ represent the first derivatives of the utility function with respect to c, h^N, and h^T at period t. Similarly, $U_{cc,t}$, $U_{h^N h^N,t}$, and $U_{h^T h^T,t}$ represent the second derivatives of utility function with respect to c, h^N, and h^T at period t.

The household's budget constraint is expressed as follows:

$$
\begin{aligned}
c_t + i_t^N + i_t^T + p_t^T d_t + \Phi_t^N + \Phi_t^T = w_t^N h_t^N + w_t^T h_t^T \\
+ u_t^N k_t^N + u_t^T k_t^T + p_t^T \frac{d_{t+1}}{1+r_t} + \Pi_t^N + \Pi_t^T
\end{aligned} \tag{14}
$$

In this constraint, i^N, i^T, p^T, d, Φ^N, Φ^T, k^N, k^T, w^N, w^T, u^N, u^T, r, Π^N, and Π^T represent investments in both sectors, the relative price of tradable goods, external debt stock, capital adjustment costs of both sectors, capital stocks in both sectors, wages in both sectors, rental incomes of capital in both sectors, the domestic interest rate, and profits of both sectors. Each expression of the budget constraint of the household is stated in terms of the final goods. Therefore, as debt stock is evaluated based on the tradable composite goods, the relative price of tradable goods, p_t^T, is assigned to this context in this equation.

The model's goal is to minimize sectoral transmission of production factors. To achieve this goal, we incorporate the labor supply into the utility function in a sector-specific manner, assuming that different parameters influence it. This specification allows for the imperfect substitution of labor across different sectors. Furthermore, we establish sector-specific capital adjustment costs to achieve the same goal. Therefore, it demonstrates that certain sectors restrict both capital and labor as inputs, and the transition between these sectors comes at a cost.

The literature commonly employs the concept of capital adjustment costs to mitigate excessive fluctuations in investments. It is widely acknowledged that net investments, whether positive or negative, incur a specific cost. The capital adjustment costs and the capital accumulation rules in each sector are as follows:

$$
\begin{aligned}
\Phi_t^N &= \frac{\phi^N}{2}(k_{t+1}^N - k_t^N)^2 \\
\Phi_t^T &= \frac{\phi^T}{2}(k_{t+1}^T - k_t^T)^2
\end{aligned} \tag{15}
$$

$$
\begin{aligned}
k_{t+1}^N &= i_t^N + (1-\delta^N)k_t^N \\
k_{t+1}^T &= i_t^T + (1-\delta^T)k_t^T
\end{aligned} \tag{16}
$$

where the depreciation rates $\delta^N, \delta^T \in (0,1)$ and the capital adjustment cost parameters $\phi^N, \phi^T > 0$.

The optimization problem of the representative household can be defined as follows:

$$\max_{\{c_t, h_t^N, h_t^T, k_{t+1}^N, k_{t+1}^T, d_{t+1}\}} E_0 \sum_{t=0}^{\infty} \beta^t v_t \frac{(c_t - \frac{(h_t^N)^{\omega^N}}{\omega^N} - \frac{(h_t^T)^{\omega^T}}{\omega^T})^{1-\sigma} - 1}{1-\sigma} \tag{17}$$

where $\beta \in (0,1)$ is the discount factor and v_t is the intertemporal preference shock process. This shock process is exogenous and follows a first-order autoregressive, AR(1), process:

$$\ln v_t = \rho_v \ln v_{t-1} + \epsilon_t^v, \quad \epsilon_t^v \sim N(0, \sigma_v^2) \tag{18}$$

where the parameters $\rho_v \in [0,1)$ and $\sigma_v > 0$ are the persistency parameter and the volatility of the intertemporal preference shock process, respectively.

The maximization problem of the household subject to the budget constraint is written as follows:

$$\begin{aligned} \mathcal{L} = \sum_{t=0}^{\infty} \beta^t \{ & [v_t U(c_t, h_t^N, h_t^T)] + \lambda_t [w_t^N h_t^N + w_t^T h_t^T + u_t^N k_t^N + u_t^T k_t^T \\ & + p_t^T \frac{d_{t+1}}{1+r_t} + \Pi_t^N + \Pi_t^T - c_t - i_t^N - i_t^T - p_t^T d_t - \Phi_t^N - \Phi_t^T] \} \end{aligned} \tag{19}$$

where λ_t is the lagrange multiplier. The problem's Lagrangian function can be reorganized in the following manner:

$$\begin{aligned} \mathcal{L} = \sum_{t=0}^{\infty} \beta^t \Bigg\{ & \Big[v_t \frac{(c_t - \frac{(h_t^N)^{\omega^N}}{\omega^N} - \frac{(h_t^T)^{\omega^T}}{\omega^T})^{1-\sigma} - 1}{1-\sigma} \Big] + \lambda_t \big[w_t^N h_t^N + w_t^T h_t^T \\ & + u_t^N k_t^N + u_t^T k_t^T + p_t^T \frac{d_{t+1}}{1+r_t} + \Pi_t^N + \Pi_t^T - c_t - k_{t+1}^N + (1-\delta^N) k_t^N \\ & - k_{t+1}^T + (1-\delta^T) k_t^T - p_t^T d_t - \frac{\phi^N}{2} (k_{t+1}^N - k_t^N)^2 - \frac{\phi^T}{2} (k_{t+1}^T - k_t^T)^2 \big] \Bigg\} \end{aligned} \tag{20}$$

The household decides his/her consumption (c_t), labor supplies (h_t^N, h_t^T), debt stock (d_{t+1}), and capitals (k_{t+1}^N, k_{t+1}^T). The First Order Conditions (FOCs) of the optimization problem with respect to c_t, h_t^N, h_t^T, d_{t+1}, k_{t+1}^N, and k_{t+1}^T in implicit forms are as follows:

$$v_t U_c(c_t, h_t^N, h_t^T) - \lambda_t = 0 \tag{21}$$

$$v_t U_{h^N}(c_t, h_t^N, h_t^T) + \lambda_t w_t^N = 0 \tag{22}$$

$$v_t U_{h^T}(C_t, h_t^N, h_t^T) + \lambda_t w_t^T = 0 \tag{23}$$

$$\lambda_t p_t^T = \beta(1 + r_t) E_t\{\lambda_{t+1} p_{t+1}^T\} \tag{24}$$

$$\beta E_t \Big\{ \lambda_{t+1}[1 + u_{t+1}^N - \delta^N + \Phi'(k_{t+2}^N - k_{t+1}^N)] \Big\} = \lambda_t[1 + \Phi'(k_{t+1}^N - k_t^N)] \tag{25}$$

$$\beta E_t \Big\{ \lambda_{t+1}[1 + u_{t+1}^T - \delta^T + \Phi'(k_{t+2}^T - k_{t+1}^T)] \Big\} = \lambda_t[1 + \Phi'(k_{t+1}^T - k_t^T)] \tag{26}$$

The explicit forms of these equations are as follows:

$$v_t \Big(c_t - \frac{(h_t^N)^{\omega^N}}{\omega^N} - \frac{(h_t^T)^{\omega^T}}{\omega^T} \Big)^{-\sigma} = \lambda_t \tag{27}$$

$$v_t \Big(c_t - \frac{(h_t^N)^{\omega^N}}{\omega^N} - \frac{(h_t^T)^{\omega^T}}{\omega^T} \Big)^{-\sigma} (h_t^N)^{\omega^N - 1} = \lambda_t w_t^N \tag{28}$$

$$v_t \Big(c_t - \frac{(h_t^N)^{\omega^N}}{\omega^N} - \frac{(h_t^T)^{\omega^T}}{\omega^T} \Big)^{-\sigma} (h_t^T)^{\omega^T - 1} = \lambda_t w_t^T \tag{29}$$

$$\lambda_t p_t^T = \beta(1 + r_t) \lambda_{t+1} p_{t+1}^T \tag{30}$$

$$\beta \lambda_{t+1}[1 + u_{t+1}^N - \delta^N + \phi^N(k_{t+2}^N - k_{t+1}^N)] = \lambda_t[1 + \phi^N(k_{t+1}^N - k_t^N)] \tag{31}$$

$$\beta \lambda_{t+1}[1 + u_{t+1}^T - \delta^T + \phi^T(k_{t+2}^T - k_{t+1}^T)] = \lambda_t[1 + \phi^T(k_{t+1}^T - k_t^T)] \tag{32}$$

$$\lim_{L \to +\infty} E_t \frac{p_{t+L}^T d_{t+L}}{\prod_{s=1}^{L}(1 + r_s)} = 0 \tag{33}$$

where Equation 33 shows the no-ponzi condition.

The FOCs indicate that we assume zero capital adjustment costs in the steady state equilibrium. Consequently, the rate of return on physical capital is solely determined by depreciation rates. Hence, when the rates of depreciation are identical, the rates of return on capital are also equivalent. However, this principle does not hold true for wages unless the parameters of ω^N and ω^T are both equal to 1.

Using Equations 27, 28, and 29 gives the following equations:

$$w_t^N = (h_t^N)^{\omega^N - 1} \tag{34}$$

$$w_t^T = (h_t^T)^{\omega^T - 1} \tag{35}$$

2.2.2.2. Firms

The literature on EME-RBC generally focuses on a single final good. This commodity is tradable on global marketplaces. This assumption is not realistic for EMEs. Several EMEs produce goods and services that are not easily transferable. Non-tradable goods are commodities that are not eligible for the international trade markets due to a variety of issues, such as trade barriers and high transportation expenses. Furthermore, sector differentiation helps to understand exchange rate pass-through and allows for independent analysis of the effects of external shocks on different sectors.

Based on these factors, we presume that there exist two sectors in this economy: non-tradable and tradable goods sectors. Additionally, the production of final goods utilizes both goods as inputs. The subsequent subsections will provide a comprehensive overview of firms classified into three distinct types. Furthermore, we focus on the representative firm for each specific problem, assuming identical firms within each sector.

2.2.2.2.1. Final Goods Producer

We assume perfect competition in the final goods sector and zero profit in each period. The representative final goods producer uses non-tradable and tradable goods as inputs. We assume the production function to be in Armington form, continuous, increasing, concave, and homogenous to degree one, following the relevant EME-RBC literature. The production function is defined as follows:

$$f_t = B(z_t^N, z_t^T) \tag{36}$$

$$f_t = a_t^F \left[\chi (z_t^N)^{1-\frac{1}{\xi}} + (1-\chi)(z_t^T)^{1-\frac{1}{\xi}} \right]^{\frac{1}{1-\frac{1}{\xi}}} \tag{37}$$

where f, z^N, and z^T denote final goods, non-tradable goods that are used in the production of final goods, and tradable goods that are used in the production of final goods. Also, $\chi \in (0,1)$ and $\xi > 0$ are expenditure share on non-tradable goods and elasticity of substitution between tradable and non-tradable goods. Here, a_t^F represents an exogenous stochastic final goods technology shock process following AR(1):

$$\ln a_t^F = \rho_F \ln a_{t-1}^F + \epsilon_t^F, \quad \epsilon_t^F \sim N(0, \sigma_F^2) \tag{38}$$

where the parameters $\rho_F \in [0, 1)$ and $\sigma_F > 0$ are the persistency and the volatility parameters of the final goods technology shock process, respectively.

The price of the final goods is assumed to be numeraire, and other goods' prices (the prices of tradable goods (p_t^T), non-tradable goods (p_t^N), imported input in non-tradable sector production (pm_t^N), and imported input in tradable sector production (pm_t^T)) are stated as relatively. Furthermore, in this model, the law of one price assumption remains valid. This means that foreign prices are equal to domestic prices. Section 2.2.3. provides a comprehensive analysis of the exchange rate and the real exchange rate concepts.

The profit function of the final producer is stated as follows:

$$\Pi_t^F = f_t - x_t p_t^T z_t^T - p_t^N z_t^N \tag{39}$$

where Π^F, p^N, and p^T are the profit and the relative prices of non-tradable goods, and tradable goods. Given that the price of tradable goods is decided by global markets, a new shock process has been added to Equation 39 as a further model extension. The variable x_t represents an exogenous stochastic shock process that may occur at the world price level. It can be called the world or foreign price shock process interchangeably throughout the chapter. It follows the AR(1) process as well:

$$\ln x_t = \rho_x \ln x_{t-1} + \epsilon_t^x, \quad \epsilon_t^x \sim N(0, \sigma_x^2) \tag{40}$$

where the parameters $\rho_x \in [0, 1)$ and $\sigma_x > 0$ are the persistency and the volatility parameters of the foreign price shock process, respectively.

The final goods producer choose z^N and z^T and we obtain the following FOCs in implicit forms:

$$B_N(z_t^N, z_t^T) = p_t^N \tag{41}$$

$$B_T(z_t^N, z_t^T) = x_t p_t^T \tag{42}$$

These FOCs can be written in explicit forms as follows:

$$p_t^N = a_t^F \chi (z_t^N)^{-\frac{1}{\xi}} \left[\chi (z_t^N)^{1-\frac{1}{\xi}} + (1-\chi)(z_t^T)^{1-\frac{1}{\xi}} \right]^{\frac{1}{\xi-1}} \tag{43}$$

$$x_t p_t^T = a_t^F (1-\chi)(z_t^T)^{-\frac{1}{\xi}} \left[\chi (z_t^N)^{1-\frac{1}{\xi}} + (1-\chi)(z_t^T)^{1-\frac{1}{\xi}} \right]^{\frac{1}{\xi-1}} \tag{44}$$

2.2.2.2.2. Non-tradable Goods Producer

The non-tradable goods sector produces goods that are only used inside the domestic economy, while tradable goods can be either exported or imported. The production function of the representative non-tradable goods producer depends on sector-specific labor, capital, and imported inputs.

The primary goal of this study is to incorporate imported inputs into the production process and identify the different outcomes that the extended model reveals compared to the existing literature. The production function is considered to be in Cobb-Douglas form and satisfies INADA conditions. Thus, we assume the following expression for the production function:

$$y_t^N = a_t^N f(k_t^N, h_t^N, m_t^N) \tag{45}$$

$$y_t^N = a_t^N (k_t^N)^{\alpha^N} (h_t^N)^{\theta^N} (m_t^N)^{1-\alpha^N-\theta^N} \tag{46}$$

where y_t^N, k_t^N, h_t^N, and m_t^N denote the output of non-tradable goods, sector specific-capital, sector-specific labor, and imported inputs that are used for non-tradable goods production. The parameters α^N and θ^N are the capital and labor shares of non-tradable goods production, respectively. The proportion of imported inputs in the production function can be represented as $1-\alpha^N-\theta^N$. Also, a_t^N is the exogenous stochastic non-tradable goods technology shock process following the AR(1):

$$\ln a_t^N = \rho_N \ln a_{t-1}^N + \epsilon_t^N, \quad \epsilon_t^N \sim N(0, \sigma_N^2) \tag{47}$$

where the parameters $\rho_N \in [0,1)$ and $\sigma_N > 0$ are the persistency and the volatility parameters of the non-tradable goods technology shock process, respectively.

We postulate the existence of a constraint on working capital, following Uribe and Yue (2006). The implicit assumption that firms must compensate employers' wages before their earnings underlies the significance of this constraint. In this way, the fluctuations in the costs of imported inputs in global markets directly affect the domestic economy's supply side. The working capital constraint is the following equation:

$$M_t^N \geq \eta^N w_t^N h_t^N \tag{48}$$

where the parameter η^N represents a value that defines the proportion of wages that firms should retain for non-tradable sectors. It is evident that a certain part of wage costs is retained in each period.

The profit function of the non-tradable sector can be represented by the following equation:

$$\Pi_t^N = p_t^N y_t^N - u_t^N k_t^N - w_t^N h_t^N - x_t^N pm_t^N m_t^N - (M_t^N - M_{t-1}^N) \tag{49}$$

where m^N, pm^N, and M^N are imported inputs, the relative price of imported input and the working capital.

The inclusion of an extra shock process has been added to Equation 49 as a further model extension due to the determination of the price of imported inputs (pm_t^N) in global marketplaces. The variable x_t^N represents the exogenous stochastic shock process that may occur in the price of imported inputs in the non-tradable production process. Also, it follows AR(1) process:

$$\ln x_t^N = \rho_{x^N} \ln x_{t-1}^N + \epsilon_t^{x^N}, \quad \epsilon_t^{x^N} \sim N(0, \sigma_{x^N}^2) \tag{50}$$

where the parameters $\rho_{x^N} \in [0,1)$ and $\sigma_{x^N} > 0$ are the persistency and the volatility parameters of the price of imported inputs in non-tradable sector shock process, respectively.

The representative firm tries to maximize its discounted lifetime profits by choosing k^N, h^N, m^N, and M^N:

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} \Pi_t^N + \gamma_t^N [M_t^N - \eta^N (w_t^N h_t^N)] \tag{51}$$

The FOCs in implicit forms are as follows:

$$u_t^N = p_t^N a_t^N y_k^N (k_t^N, h_t^N, m_t^N) \tag{52}$$

$$w_t^N (1 + \eta^N \gamma_t^N) = p_t^N a_t^N y_h^N (k_t^N, h_t^N, m_t^N) \tag{53}$$

$$x_t^N pm_t^N = p_t^N a_t^N y_m^N (k_t^N, h_t^N, m_t^N) \tag{54}$$

$$\lambda_t [1 - \gamma_t^N] = \beta E\{\lambda_{t+1}\} \tag{55}$$

where $y_k^N = \frac{\partial y_t^N}{\partial k_t^N}$, $y_h^N = \frac{\partial y_t^N}{\partial h_t^N}$ and $y_m^N = \frac{\partial y_t^N}{\partial m_t^N}$. The explicit forms of the FOCs are as follows:

$$u_t^N = p_t^N a_t^N \alpha^N (k_t^N)^{\alpha^N - 1} (h_t^N)^{\theta^N} (m_t^N)^{1-\alpha^N-\theta^N} \tag{56}$$

$$w_t^N (1 + \eta^N \gamma_t^N) = p_t^N a_t^N \theta^N (k_t^N)^{\alpha^N} (h_t^N)^{\theta^N - 1} (m_t^N)^{1-\alpha^N-\theta^N} \tag{57}$$

$$x_t^N pm_t^N = p_t^N a_t^N (1 - \alpha^N - \theta^N)(k_t^N)^{\alpha^N} (h_t^N)^{\theta^N} (m_t^N)^{-\alpha^N-\theta^N} \tag{58}$$

$$\lambda_t [1 - \gamma_t^N] = \beta \lambda_{t+1} \tag{59}$$

2.2.2.2.3. Tradable Goods Producer

Similar to the other sector, the tradable goods sector produces output by using sector-specific labor, sector-specific capital, and imported inputs. For EMEs, the international prices are given so that the prices of the tradable goods and imported inputs, which are p^T and pm^T, are exogenous variables for this economy. The production function of a representative tradable goods producer is as follows:

$$y_t^T = a_t^T f(k_t^T, h_t^T, m_t^T) \tag{60}$$

$$y_t^T = a_t^T (k_t^T)^{\alpha^T} (h_t^T)^{\theta^T} (m_t^T)^{1-\alpha^T-\theta^T} \tag{61}$$

where y_t^T, k_t^T, h_t^T, and m_t^T denote the output of tradable goods, sector specific-capital, sector-specific labor, and imported inputs that are used for tradable goods production. The parameters α^T and θ^T are capital share of tradable goods production and labor share of tradable goods production, respectively. The proportion of imported inputs in the production function can be represented as $1 - \alpha^T - \theta^T$. Also, a_t^T is the exogenous stochastic tradable goods technology shock process following the AR(1) process similar to the previous problem:

$$\ln a_t^T = \rho_T \ln a_{t-1}^T + \epsilon_t^T, \quad \epsilon_t^T \sim N(0, \sigma_T^2) \tag{62}$$

where the parameters $\rho_T \in [0, 1)$ and $\sigma_T > 0$ are the persistency and the volatility parameters of the tradable goods technology shock process, respectively.

The producer of tradable goods encounters a comparable constraint in working capital as follows:

$$M_t^T \geq \eta^T w_t^T h_t^T \tag{63}$$

where, similarly, the parameter η^T represents a value that defines the proportion of wages that firms should retain for tradable goods sectors.

The profit function of the tradable sector can be represented by the following equation:

$$\Pi_t^T = p_t^T y_t^T - u_t^T k_t^T - w_t^T h_t^T - x_t^T pm_t^T m_t^T - (M_t^T - M_{t-1}^T) \tag{64}$$

where m^T, pm^T, and M^T are imported inputs, the relative price of imported inputs, and the working capital.

An extra shock process has been added to Equation 64 following the same approach as in the other sector. The variable x_t^T represents the exogenous stochastic shock process that may occur in the price of imported inputs in the tradable goods production process. It also follows AR(1) process:

$$\ln x_t^T = \rho_{x^T} \ln x_{t-1}^T + \epsilon_t^{x^T}, \quad \epsilon_t^{x^T} \sim N(0, \sigma_{x^T}^2) \tag{65}$$

where the parameters $\rho_{x^T} \in [0, 1)$ and $\sigma_{x^T} > 0$ are the persistenc and the volatilityy parameters of the price of imported inputs in tradable sector shock process, respectively.

The representative firm tries to maximize its discounted lifetime profits by choosing k^T, h^T, m^T, and M^T:

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} \Pi_t^T + \gamma_t^T \left[M_t^T - \eta^T (w_t^T h_t^T) \right] \tag{66}$$

The FOCs in implicit forms are as follows:

$$u_t^T = p_t^T a_t^T y_k^T (k_t^T, h_t^T, m_t^T) \tag{67}$$

$$w_t^T (1 + \eta^T \gamma_t^T) = p_t^T a_t^T y_h^T (k_t^T, h_t^T, m_t^T) \tag{68}$$

$$x_t^T pm_t^T = p_t^T a_t^T y_m^T (k_t^T, h_t^T, m_t^T) \tag{69}$$

$$\lambda_t [1 - \gamma_t^T] = \beta E\{\lambda_{t+1}\} \tag{70}$$

where $y_k^T = \frac{\partial y_t^T}{\partial k_t^T}$, $y_h^T = \frac{\partial y_t^T}{\partial h_t^T}$ and $y_m^T = \frac{\partial y_t^T}{\partial m_t^T}$. The explicit forms of the FOCs are as follows:

$$u_t^T = p_t^T a_t^T \alpha^T (k_t^T)^{\alpha^T - 1} (h_t^T)^{\theta^T} (m_t^T)^{1 - \alpha^T - \theta^T} \tag{71}$$

$$w_t^T(1+\eta^T\gamma_t^T) = p_t^T a_t^T \theta^T (k_t^T)^{\alpha^T} (h_t^T)^{\theta^T-1} (m_t^T)^{1-\alpha^T-\theta^T} \tag{72}$$

$$x_t^T pm_t^T = p_t^T a_t^T (1-\alpha^T-\theta^T)(k_t^T)^{\alpha^T} (h_t^T)^{\theta^T} (m_t^T)^{-\alpha^T-\theta^T} \tag{73}$$

$$\lambda_t[1-\gamma_t^T] = \beta\lambda_{t+1} \tag{74}$$

Equations 59 and 74 demonstrate the equality of γ_t^N and γ_t^T.

2.2.3. Rest of the World

Since the economy under analysis is an EME, any shock process it experiences does not influence the dynamics of the external world. In contrast, external factors and mechanisms directly affect the domestic economy. In addition, as the model considers the external factors that influence the price of tradable commodities, which are the pricing of imported inputs and the world's interest rate, any changes in these variables can also impact the domestic economy. For the sake of this investigation, it is presumed that the interest rate premium of the country is sensitive to fluctuations in its debt levels:[26]

$$r_t = r^* + e^{\mu_t - 1} - 1 + \psi(e^{d_t - \bar{d}} - 1) \tag{75}$$

where r^*, $\bar{d}$, and μ are the world interest rate, the long-term (or equivalantly the steady state) debt level, and the country premium shock process, respectively. μ_t is exogenous and follows AR(1) process:

$$\ln\mu_t = \rho_\mu \ln\mu_{t-1} + \epsilon_t^\mu, \quad \epsilon_t^\mu \sim N(0,\sigma_\mu^2) \tag{76}$$

where the parameter $\rho_\mu \in [0,1)$ and $\sigma_\mu > 0$ are the persistency and the volatility parameters of the country premium shock process, respectively.

The world interest rate and the prices of tradable goods and imported inputs are given in this economy, as previously stated. The real exchange rate (RER), which refers to the relative prices of final consumption between countries, is a crucial variable that links the external world with the domestic economy. In general, RER can be defined as the following expression:

$$RER_t = \epsilon_t \frac{P_t^*}{P_t} \tag{77}$$

where P, P^*, and ϵ are the domestic price level, the global price level, and the

[26]As demonstrated in the study of Schmitt-Grohe and Uribe (2003).

nominal exchange rate. More specifically, a rise in the nominal exchange rate (ϵ) in this equation indicates the depreciation of the domestic currency compared to the foreign currency.

In order to obtain the RER in this model, to begin with, both price levels are divided by P_t^T, tradable goods' price level, in Equation 77. Then, we have the following equation:

$$RER_t = \frac{\epsilon_t \frac{P_t^*}{P_t^T}}{\frac{P_t}{P_t^T}} \tag{78}$$

Assuming that the LOP holds for tradable goods, $P_t^T = \epsilon_t P_t^{T*}$. Then, letting $p_t^T = \frac{P_t^T}{P_t}$ and $p_t^{T*} = \frac{P_t^*}{P_t^{T*}}$ denote the relative prices of consumption domestically and abroad. Lastly, p_t^{T*} is determined exogenously and it can be assumed as constant and normalized to unity. As a remainder, p_t^T is defined as the relative price of tradable goods in terms of final goods in the model. Then, the RER in this model can be found as follows:

$$RER_t = p_t^T \tag{79}$$

Consequently, the possibility of the domestic economy becoming more expensive (experiencing an appreciation in the real exchange rate) compared to other countries can only occur if the relative price of tradable goods decreases, and vice versa.

2.2.4. Market Clearing Conditions

We analyze the interactions between individuals to identify the general macroeconomic equilibrium once the individual behavior of each economic decision-maker has reached a steady state of equilibrium. Identifying the equilibrium state is significant for two primary reasons. Initially, due to the non-linear nature of the model, it is essential to create a linear approximation centered on a suitable point. The concept of steady state equilibrium is commonly regarded as an appropriate approximation point. Secondly, the deterministic equilibrium can roughly be defined as the average state of the model. Then, the model can incorporate observable values during the calibration process.

For non-tradable goods, the total demand and the total supply must equal each other. Otherwise, there is an inefficiency:

$$p_t^N y_t^N = p_t^N z_t^N \tag{80}$$

Tradable goods may experience a disparity between total demand and total supply. If the overall production exceeds the need, the surplus is exported to global markets. Conversely, if the production falls short of the demand, the goods can be imported from the rest of the world. In addition, the trade balance is adversely impacted by imported inputs from both sectors. Therefore, we can formulate the trade balance as follows:

$$tb_t = p_t^T (y_t^T - z_t^T) - pm_t^N m_t^N - pm_t^T m_t^T \tag{81}$$

where tb denotes the trade balance of the domestic economy. According to Equation 81, the trade balance can be either negative or positive. The equilibrium condition for the final goods market is as follows:

$$c_t + i_t^N + i_t^T + \Phi_t^N + \Phi_t^T = f_t \tag{82}$$

While the left-hand side of the equation pertains to the aggregate demand, the right-hand side of the equation pertains to the aggregate supply.

The current account is calculated by adding the net factor incomes and the trade balance. Currently, the only form of net factor incomes in the economy is the interest payments on external debt:

$$ca_t = tb_t - (interest\ payments)$$

$$ca_t = tb_t - p_t^T d_t r_t \tag{83}$$

When the household budget constraint, market equilibrium conditions for all three sectors, the firms' profit functions, and the assumption of zero economic profit for all companies are put together, it leads to the accumulation of the external debt as the following expression:

$$\frac{p_t^T d_{t+1}}{1 + r_t} = p_t^T d_t + tb_t \tag{84}$$

The behavior of the economy can be determined by the FOCs of the problems of households and firms, taking into account the initial values of debt and capital, d_0 and k_0, the given shock processes, ϵ_t^F, ϵ_t^N, ϵ_t^T, ϵ_t^v, ϵ_t^μ, ϵ_t^x, $\epsilon_t^{x^N}$, and $\epsilon_t^{x^T}$, and the no-Ponzi condition. Additionally, the steady state equilibrium conditions are indicated in Appendix 2.

2.3. CALIBRATION

We use emerging market economy models from the literature as a reference when determining the parameter values. The main purpose of the calibration is to preserve the crucial characteristics of EMEs to the greatest extent possible. In the model, a period represents a quarter. Table 10 presents the model's calibrated parameter values.

During the process of adjusting the parameter values, we refer to the literature and the steady state solutions. There are several models and estimations in the literature that utilize quarterly data. The capital depreciation rate of 3.5% is chosen based on the research conducted by Alp and Elekdag (2011). Since the primary objective of our study does not require variations in capital depreciation rates across various sectors, we adopt the same value for both sectors.

The parameters ω^N and ω^T, representing the degree to which the labor supply is responsive to the changes in wages, are selected as 2, consistent with the existing literature. The rationale for selecting identical parameters for ω^N and ω^T is analogous to the rationale for selecting identical depreciation rates. Surprisingly, the subsequent sections demonstrate that the wages vary in the steady-state equilibrium, despite the selection of the same parameter for ω^N and ω^T.

In García-Cicco et al.'s (2010) and Aguiar and Gopinath's (2007) studies, the value of the risk aversion parameter, σ, is selected as 2, while the parameter of interest rate sensitivity to indebtedness, ψ, is chosen as 0.001. Also, the literature provides a broad selection of capital adjustment cost parameters, ranging from 0.001 to 100. To establish this parameter, we check the model's second moments, aiming to ensure that the investment's volatility is not excessively high relative to the other variables'. We set the values for this investigation at 0.5 for both sectors.

Numerous studies commonly acknowledge the world interest rate to be 4%. When the value of r^* is set at 4% in the model, the corresponding value of β, the discount factor, is determined to be 0.9615. Based on the research conducted by Uribe and Schmitt-Grohé in 2017, the value of the ξ parameter, the elasticity of substitution between goods, is chosen to be 0.5. Also, the η values, the working capital share of wage payments for both sectors, are determined to be 1.2 based on the findings of Uribe and Yue (2006).

Table 10: Calibrated Parameters of the Model

Description	Symbol	Value
Sector N Capital Depreciation Rate	δ^N	0.035
Sector T Capital Depreciation Rate	δ^T	0.035
Utility Function Sectoral Labor Share in Sector N	ω^N	2
Utility Function Sectoral Labor Share in Sector T	ω^T	2
Risk Aversion	σ	2
Adjustment Cost Parameter for Sector N	ϕ^N	0.5
Adjustment Cost Parameter for Sector T	ϕ^T	0.5
Discount Factor	β	0.9615
World Interest Rate	r^*	0.04
Capital Share of Prodution in Sector N	α^N	0.19
Capital Share of Prodution in Sector T	α^T	0.24
Labor Share of Prodution in Sector N	θ^T	0.60
Labor Share of Prodution in Sector N	θ^N	0.76
Interest Rate Sensitivity to Indebtedness	ψ	0.001
Elasticity of Substitution	ξ	0.5
Expenditure Share on Non-tradables	χ	0.06
Working Capital Share of Wage Payments for Sector N	η^N	1.2
Working Capital Share of Wage Payments for Sector T	η^T	1.2
Terms of Trade $(\frac{p^T}{p^N})$ at SS	$\bar{p}$	1.5
Persistency of Final Goods Technology Shock	ρ_F	0.80
Persistency of Non-trad. Goods Technology Shock	ρ_N	0.80
Persistency of Trad. Goods Technology Shock	ρ_T	0.80
Persistency of Intertemporal Preference Shock	ρ_ν	0.80
Persistency of Country Premium Shock	ρ_μ	0.80
Persistency of Foreign Price Shock	ρ_x	0.80
Persistency of Imported Input Prices in Sector N Shock	ρ_{x^N}	0.80
Persistency of Imported Input Prices in Sector T Shock	ρ_{x^T}	0.80
Volatility of Final Goods Technology Shock	σ_F	0.01
Volatility of Non-trad. Goods Technology Shock	σ_N	0.01
Volatility of Trad. Goods Technology Shock	σ_T	0.01
Volatility of Intertemporal Preference Shock	σ_ν	0.01
Volatility of Country Premium Shock	σ_μ	0.01
Volatility of Foreign Price Shock	σ_x	0.01
Volatility of Imported Input Prices in Sector N Shock	σ_{x^N}	0.01
Volatility of Imported Input Prices in Sector T Shock	σ_{x^T}	0.01

The parameter χ denotes the proportion of non-tradable production in the country's overall production. In the literature, different values for χ are used. Upon analyzing the model solutions, it becomes evident that χ is one of the most influential parameters in the constructed model. If the value surpasses 38%, it becomes impossible to achieve steady state solutions, and the model enters the region of indeterminancy. According to multiple studies, it is recommended to aim for approximately 10% and select values around this value (Pengfei, 2021). After considering various factors, the benchmark model's appropriate parameter value is 6%.

We review the literature to determine the allocation of capital, labor, and imported inputs in production functions. In their studies on EMEs, Uribe and Yue (2006), and Aguiar and Gopinath (2007) selected a value of 0.32 for α^T. Therefore, the sole remaining factor of production, θ^T, is computed to be 0.68. Conversely, Uribe and Schmitt-Grohé (2017) argued that the proportion of capital in the non-tradable sector should be reduced and calculated it to be $\alpha^N = 0.22$. Therefore, the value of θ^N is 0.78. However, incorporating imported inputs into the model alters these parameters' values.

On the other hand, the existing empirical research mostly focuses on studies concerning the rates of imported inputs in the tradeble goods sector. According to Demir et al. (2023), the rate of imported inputs in production functions in a country similar to Türkiye is approximately 20%. We determine that the proportion of imported inputs in the tradable goods sector should exceed that in the nontradable goods sector based on the available information. $\alpha^N = 0.19$, $\alpha^T = 0.24$, $\theta^N = 0.76$, and $\theta^T = 0.60$ are assumed by reducing the share of production factors at similar rates. Consequently, the imported input rates are established at 5% $(1 - \alpha^N - \theta^N)$ and 16% $(1 - \alpha^T - \theta^T)$ in the non-tradable goods and the tradable goods sectors, respectively.

Due to the exogenous nature of p_t^T and being an EME, any fluctuations in p_t^T have a direct impact on p_t^N and cause it to shift, albeit with a delay. Although short-term price fluctuations may be significant, we anticipate that the ratio of prices will stabilize in the long run. Hence, we need to determine the ratio between these two relative prices in the long-run to acquire the solutions. The ratio for the benchmark model is assumed to be 1.5 following Uribe and Schmitt-Grohê (2017).

Lastly, we use the values of 0.80 and 0.01 for all of the persistency and the volatility parameters associated with the shock processes. Additionally, in Section 2.5., we will perform several robustness tests by changing the default values of the shock persistency parameters.

2.4. MAIN RESULTS

We solve the model numerically by linearizing the resource constraints and the FOCs around the deterministic steady state. The uniqueness of the equilibrium is established based on the assumption of the first-order approximation. Subsequently, we conduct numerical simulations to explore the fundamental characteristics of this EME.

This section presents the model findings and multiple analyses. Initially, we introduce some novel macroeconomic variables. Next, we compare the steady state solutions with actual data collected from Türkiye, chosen as a representative country from the EMEs. Then, the second moments of the model are investigated. We display the IRFs produced by the model for eight different shock processes. Consequently, we conclude the section by discussing the results of a variance decomposition analysis.

2.4.1. Steady State Solutions

The steady state (SS) solutions indicate that (*i*) the economy exports its tradable goods because domestic production is greater than the need ($y^T > z^T$); (*ii*) total imports, which include imported inputs, exceed total exports; and (*iii*) both trade balance and current account are in deficit. As a reminder, in the previous sections, we represented the prices of different goods in relation to the price of the final good. Currently, we specify some macroeconomic variables that account for changes in units and consider the impact of various prices. Initially, let us sequentially present the aggregate production equations:

$$YN_t = p_t^N y_t^N \tag{85}$$

$$YT_t = p_t^T y_t^T \tag{86}$$

$$YY_t = YN_t + YT_t \tag{87}$$

Equations 85, 86, and 87 show total non-tradable goods production (YN), total tradable goods production (YT), and the gross domestic product (YY) of this economy in terms of the price of final goods.

Additionally, total investments (II), total exports (XX), and total imports (MM) can be defined as the following expressions (assuming $y_t^T \geq z_t^T$):

$$II_t = i_t^N + i_t^T \tag{88}$$

$$XX_t = p_t^T(y_t^T - z_t^T) \tag{89}$$

$$MM_t = pm_t^N m_t^N + pm_t^T m_t^T \tag{90}$$

Once all these variables have been defined, we can display the trade balance to output ratio, *tby*, and the current account to output ratio, *cay*, in the following manner:

$$tby_t = \frac{tb_t}{YY_t} = \frac{XX_t - MM_t}{YY_t} \tag{91}$$

$$cay_t = \frac{ca_t}{YY_t} = \frac{XX_t - MM_t - p_t^T d_t r_t}{YY_t} \tag{92}$$

Table 11 displays a selected group of outcomes obtained from the model's steady state solutions. The ss expression located at the top-right of the variables denotes the steady state solution of each variable. Furthermore, the data column in Table 11 shows Türkiye's annual figures for 2022, sourced from the World Bank Database (WBD).

The model aligns certain findings with the data. The model determines that the ratio of total consumption to GDP is 76%. The figure for Türkiye in 2022 stands at 69%. Furthermore, the proportion of external debt stock to GDP stands at 43% in the model. Based on World Bank (WB) data, Türkiye's ratio of external debt stock to gross national income (GNI) stands at 51%.

The model and the data both validate the link where the investment to GDP ratio is lower than the exports to GDP ratio, which in turn is lower than the imports to GDP ratio ($\frac{II^{ss}}{YY^{ss}} < \frac{XX^{ss}}{YY^{ss}} < \frac{MM^{ss}}{YY^{ss}}$). While there may be differences in the size of these ratios, the values consistently exhibit a similar pattern in both the model and the data.

Table 11: Comparison between Steady State Solutions and Turkish Data

Variable	Model	Data
$\frac{c^{ss}}{YY^{ss}}$	76%	69%
$\frac{II^{ss}}{YY^{ss}}$	11%	35%
tby^{ss}	-1%	-4%
cay^{ss}	-2%	-5%
$\frac{d^{ss}}{YY^{ss}}$	43%	51%
$\frac{MM^{ss}}{YY^{ss}}$	14%	43%
$\frac{XX^{ss}}{YY^{ss}}$	13%	39%
$\frac{YN^{ss}}{YY^{ss}}$	15%	
$\frac{w_N^{ss}}{w_T^{ss}}$	47%	
RER^{ss}	0.73	

Note: *The model title signifies the outcomes of the model and these outcomes are computed by the author. The data column displays the 2022 data for Türkiye, which is acquired from World Bank Database. The ss expression located at the top-right of the variables denotes the steady state values.*

It has been demonstrated that there is a similarity between the current account deficit and the trade balance deficit in both the data and the model as well. *tby* is -1% in the model and -4% in the data from Türkiye. Similarly, *cay* is -2% in the model and -5% in the data. Expressively, these findings hold significant implications given the straightforwardness of the constructed model. To provide supplementary information, the table provides the ratio of total non-tradable goods to GDP, the sectoral wage rate, and the RER.

2.4.2. Second Moments Analysis

We also calculate the second moments of significant macroeconomic variables, YY, YT, YN, c, II, XX, MM, *tby*, *cay*, and RER, in addition to the steady state solutions. Given the presence of different sectors in the model, our objective is to investigate not only the GDP but also the production in each individual sector. Also, while we analyze *tby* and *cay*, our other intention is to assess total exports, XX, and total imports, MM, individually. Table 12 displays the standard deviations of these variables and their correlation coefficients with significant variables such as YY, YT, YN, and *tby*. In addition, the last row of Table 12 shows the autocorrelation coefficient of each variable.

It is a significant finding that there is a disparity in output volatility among different production sectors. The level of volatility in the non-tradable sector (2.55%) is considerably lower compared to the volatility observed in the tradable sector (8.85%). Furthermore, the fluctuations in production in the non-tradable goods sector are far lower than the fluctuations in the GDP (9.84%).

Table 12: Model Statistics

	YY	YT	YN	c	II	XX	MM	tby	cay	RER
Std. Dev.	9.84	8.85	2.55	5.14	8.42	10.32	1.49	8.57	9.08	1.82
Corr(YY,.)	1.00	0.97	0.50	0.91	0.31	0.20	0.97	0.08	0.27	0.51
Corr(YT,.)	0.97	1.00	0.26	0.78	0.06	0.44	0.98	0.32	0.50	0.59
Corr(YN,.)	0.50	0.26	1.00	0.77	0.97	-0.74	0.34	-0.82	-0.69	-0.08
Corr(tby,.)	0.08	0.32	-0.82	-0.30	-0.92	0.99	0.23	1.00	0.98	0.35
Autocorr.	0.94	0.93	0.71	0.93	0.70	0.72	0.93	0.70	0.73	0.77

Note: *The first row shows the standard deviation of each variable in percent. The following rows show correlation coefficients of YY, YT, YN, and tby with other variables. The last row shows the first-order autocorrelation coefficient of each variable. We perform the computations based on the simulation results.*

In EMEs, the level of consumption volatility is generally lower than the GDP volatility.[27] In the current economy, while there is a greater level of volatility in consumption (5.14%) compared to the non-tradable production sector's, its volatility is less than that of the tradable and final goods sectors.

Regarding the investment volatility (8.42%), comparable to the conditions in consumption, its volatility is higher than the non-tradable goods sector's but lower than the volatilities in the other sectors. Furthermore, consumption volatility is lower than investment volatility, which is consistent with the actual data.

When examining the variables associated with international trade, it can be observed that the volatilities of imports, *tby* and *cay*, which are 1.49%, 8.57%, and 9.08%, are lower than the volatility of the GDP (9.84%), as indicated by the data. Also, sector differentiation has facilitated the identification of differences in volatilities among these variables in various production sectors. However, the data cannot be

[27] See Uribe and Schmitt-Grohê (2017).

supported by the export volatility. The export volatility (10.32%) is higher than the volatilities of all production sectors, in contrast to the available data.

The correlation coefficients of the variables vary significantly across different production sectors, much like the standard deviation changes. Initially, it is worth noting that all sectors of production have positive relationships with one another. The strong correlation between YY and YT is noteworthy (0.97). The correlation coefficients between YN and other production sectors are slightly weaker, with $Corr(YY, YN) = 0.50$ and $Corr(YT, YN) = 0.26$, respectively.

The consumption correlation coefficients with all production sectors are positive, as expected. Although the correlation coefficients of investment and imports with all production sectors are also positive, there is diversity of values based on different sectors. More precisely, the investment exhibits a strong correlation with the non-tradable goods sector production ($Corr(II, YN) = 0.97$), whereas its correlation with the tradable goods sector production ($Corr(II, YT) = 0.06$) is insignificant. Imports, on the other hand, have a significant correlation with the tradable goods sector ($Corr(MM, YT) = 0.98$), but the correlation coefficient with the non-tradable goods sector ($Corr(MM, YN) = 0.34$) is slightly lower.

The noteworthy finding pertains to the diverse directional associations of various variables influenced by international trade, as per different sectors. Specifically, XX, *tby*, *cay*, and RER exhibit positive correlations with both the tradable and the final goods sectors. On the other hand, these variables have inverse correlations with the non-tradable goods sector production.

These findings indicate that variables influenced by trade openness and external circumstances can fluctuate in accordance with the current structure of the economy. Put simply, when the non-tradable goods sector's share in overall production in the country grows and the influence of this sector becomes stronger, it is possible for these variables to have negative correlation coefficients with the final goods sector. Indeed, there are discrepancies between the EMEs average and Türkiye's data regarding certain characteristics.[28] An influential factor contributing to this disparity can be attributed to the country's openness to trade and the proportion of non-tradable goods sector production in overall production.

Examining the correlation coefficients of *tby*, we observe conspicuous negative corre-

[28]See Uribe and Schmitt-Grohê (2017).

lations with consumption ($Corr(tby, c) = -0.30$) and investment ($Corr(tby, II) = -0.92$), thereby verifying the data. By definition, we expect *tby* to show a positive correlation with trade-related variables. The model also demonstrates this link. Lastly, all variables have positive autocorrelation coefficients, thereby confirming the data.

2.4.3. Impulse Response Functions

Using impulse response functions (IRFs), this section illustrates the impact of the shock processes implemented in the model on several macroeconomic variables. Each shock process is characterized by a magnitude of 1%. This implies that the exogenous shock variable fluctuates randomly by 1%. Therefore, the model describes certain shock processes as either positive or negative.

This approach involves monitoring the independent impact of a 1% shock administered to exogenous variables, specifically shock processes, on the path of endogenous variables. Just to be clear, the model consists of eight shock processes. The shock processes can be briefly referred to as the final goods technology (ϵ^F), non-tradable goods technology (ϵ^N), tradable goods technology (ϵ^T), the intertemporal preference (ϵ^v), the country premium (ϵ^μ), the foreign price (ϵ^x), the price of imported inputs in the non-tradable goods sector (ϵ^{x^N}), and the price of imported inputs in the tradable goods sector (ϵ^{x^T}).

Given the numerous variables in the constructed model, it is believed that it would be more advantageous to concentrate on certain specific variables. Therefore, we prioritize the variables related to various production sectors (YN, YT, and YY), overall consumption (c), total investment (II, and thus total capital), total labor supply (H), the current account to GDP ratio (cay), the trade balance to GDP ratio (tby), and the real exchange rate (RER). This approach allows for the investigation of all markets in this economy. Before initiating the analysis, we present the equation representing the overall labor supply as follows:

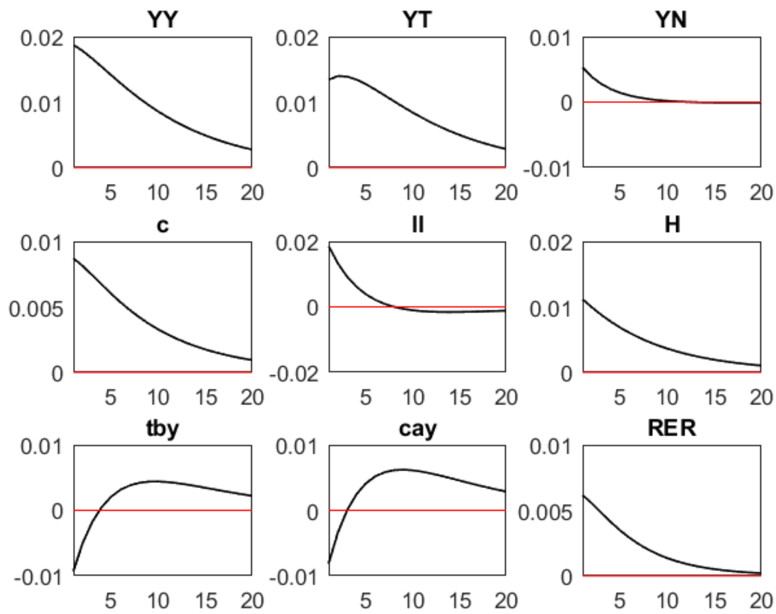
$$H_t = h_t^N + h_t^T \tag{93}$$

In short, the selected variables are YY, YT, YN, c, II, H, *tby*, *cay*, and RER. Now we can analyze all of the shock processes and their corresponding impacts.

2.4.3.1. Final Goods Technology Shock

Figure 16 shows the IRFs of the selected variables to the positive final goods technology shock. The x-axis in all figures represents the time period following the shock process, while the y-axis represents the percentage deviation from the steady-state value.

Figure 16: IRFs of the Variables to the Final Goods Technology Shock



Note: *The black and red lines show the path of the variable following the shock process and the steady state levels, respectively. The x- and y-axes represent the time period following the shock process and the percentage deviation from the steady state value, respectively.*

As anticipated, a positive shock in the production of final goods has a positive impact on all sectors of production. The rate of increase in YT seems to be greater than the rate of increase in YN.

Due to increases in all output sectors, there is a corresponding rise in both consumption and investment. The positive shock in final goods has also a favorable impact on the labor market, leading to an increase.

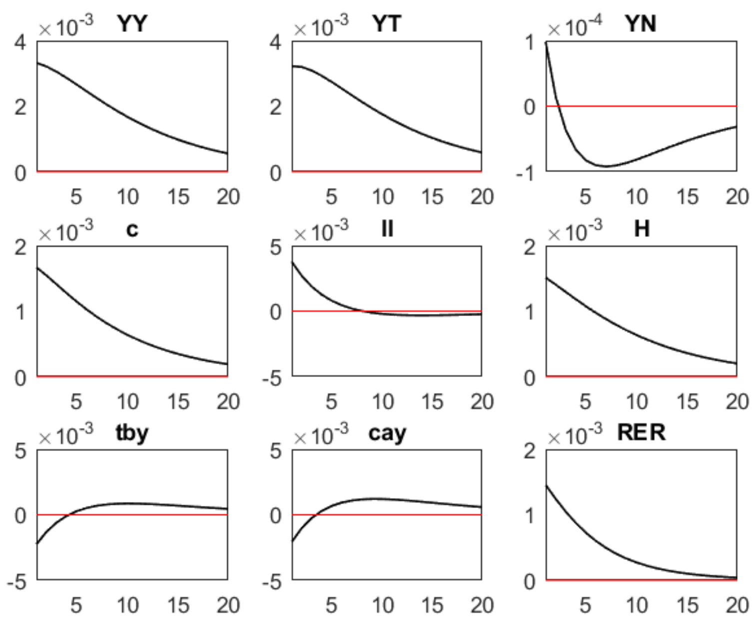
Households reduce their desire for external borrowing due to the increase in production sectors. Thus, the external debt diminishes over time. Consequently, despite the shock negatively impacting the early phase, both *tby* and *cay* show a noticeable enhancement. Furthermore, the final goods technology shock positively affects both *tby* and *cay*, maintaining values above their steady state values for an extended period.

Moreover, the increase in production in the sector that engages in international trade puts pressure on the nominal exchange rate, as it does not affect worldwide pricing. Consequently, there is a 0.5% rise in the RER when the shock occurs. Over time, the impact of the shock diminishes, and all factors, including the RER, converge towards their stable long-term equilibrium levels.

2.4.3.2. Non-Tradable Goods Technology Shock

Figure 17 shows the IRFs of the selected variables to the positive non-tradable goods technology shock. The first impact of the shock process results in a rise across all sectors of production, although these increases are significantly smaller compared to the shock in the production of final goods technology.

Figure 17: IRFs of the Variables to the Non-tradable Goods Technology Shock



Note: *The black and red lines show the path of the variable following the shock process and the steady state levels, respectively. The x- and y-axes represent the time period following the shock process and the percentage deviation from the steady state value, respectively.*

YY and YT gradually diminish and approach their steady state values, whereas

YN initially falls below the steady state value, then rises and eventually reaches the steady state value. The rise in GDP is followed by a simultaneous increase in both C and II.

Increasing overall production leads to a decrease in the necessity for external borrowing, like the shock process in the production of final goods. Thus, there is a noticeable enhancement in *tby* and *cay* over time.

The impact of this shock process on the labor market and the RER is comparable to the prior scenario, as depicted in the figures. Nevertheless, the alteration in both variables is negligible. Overall, there is no considerable alteration in the variables' divergence from the steady state equilibrium. We can conclude that this shock procedure has little impact on the fluctuations in the chosen variables.

2.4.3.3. Tradable Goods Technology Shock

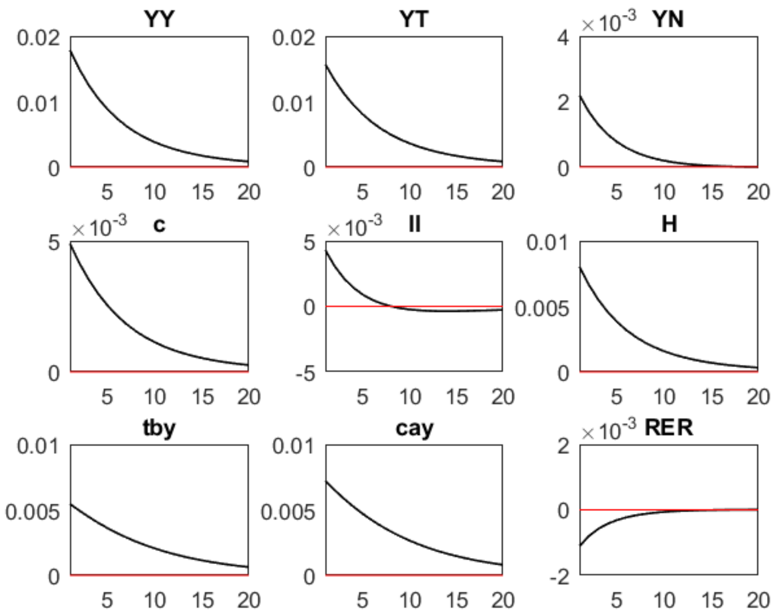
Figure 18 shows the IRFs of the variables to the positive tradable goods technology shock process. Regarding the production, we can notice a condition that is comparable to the impact of the final goods shock. Following the initial shock, there is a gradual increase in production across all sectors, eventually reaching their steady state values.

The increase in production across all sectors leads to a corresponding increase in employment within the labor market. Furthermore, consistent with the prior instances of shock processes, a rise in production leads to a corresponding increase in investment and consumption. Remarkably, the shock process in tradable goods production directly leads to an increase in *tby* and *cay*.

As a reminder, *tby* and *cay* initially declined and subsequently increased in other positive technology shock processes, but in this particular shock process, they have immediately surged. This is because positive technological progress in the tradable goods sector immediately eliminates the need for external borrowing. Moreover, a rise in tradable goods production results in a corresponding increase in exports and a positive enhancement in the *tby* and *cay* variables.

An additional significant finding pertains to the alteration in the RER. The country has witnessed a recovery in *tby* and *cay*, leading to foreign exchange inflows. Hence, the technology shock in the tradable sector leads to an appreciation of the economy's exchange rates for foreign transactions. In this case, the RER declines.

Figure 18: IRFs of the Variables to the Tradable Goods Technology Shock



Note: *The black and red lines show the path of the variable following the shock process and the steady state levels, respectively. The x- and y-axes represent the time period following the shock process and the percentage deviation from the steady state value, respectively.*

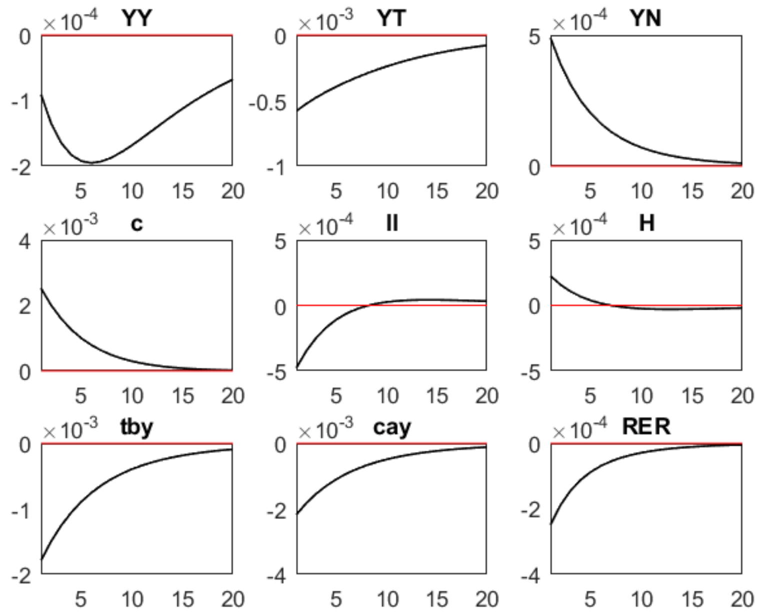
2.4.3.4. Intertemporal Preference Shock

An intertemporal preference shock is a sudden change that modifies the relationship between current and future consumption levels by impacting the subjective discount rate. Figure 19 shows the IRFs of the selected variables to the positive intertemporal preference shock.

An increase in consumption occurs when there is a positive preference shock, resulting in a higher utility value for present consumption. To achieve this level of consumption, households increase their external borrowing, resulting in a decrease in tby and cay. Also, as the current consumption level rises, households with less of a tendency to consider the future will reduce their investments.

Relying solely on external borrowing is not going to be enough to fulfill the increased demand in this economy. To meet this demand, the production of non-tradable goods is also on the rise. Furthermore, there is a higher supply of available labor in the non-tradable sector to satisfy the existing demand.

Figure 19: IRFs of the Variables to Intertemporal Preference Shock



Note: *The black and red lines show the path of the variable following the shock process and the steady state levels, respectively. The x- and y-axes represent the time period following the shock process and the percentage deviation from the steady state value, respectively.*

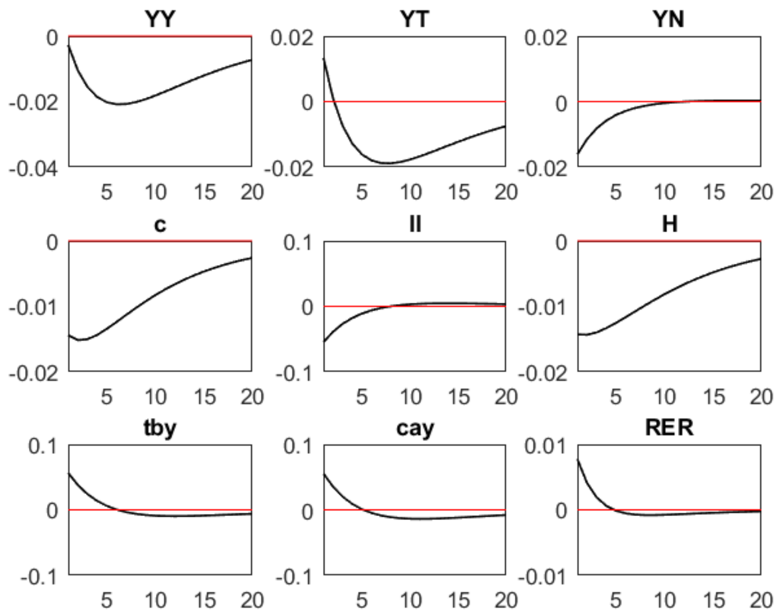
2.4.3.5. Country Premium Shock

Figure 20 shows the IRFs of the selected variables to the negative country premium shock. As will be shown in the following section, this particular shock process is the main source of the fluctuations in most of the selected variables.

A rise in a country's Credit Default Swap (CDS) rates, for example, indicates a negative country premium shock, resulting in higher external borrowing costs. In the current economic climate, characterized by a need to decrease the amount of external borrowing, *tby* and *cay* show improvement.

Reducing external borrowing also results in a decrease in the amount of capital flowing into the country. Consequently, a drop in borrowing leads to a decrease in foreign assets within the country and an increase in the RER, which means local currency depreciation.

Figure 20: IRFs of the Variables to Country Premium Shock



Note: *The black and red lines show the path of the variable following the shock process and the steady state levels, respectively. The x- and y-axes represent the time period following the shock process and the percentage deviation from the steady state value, respectively.*

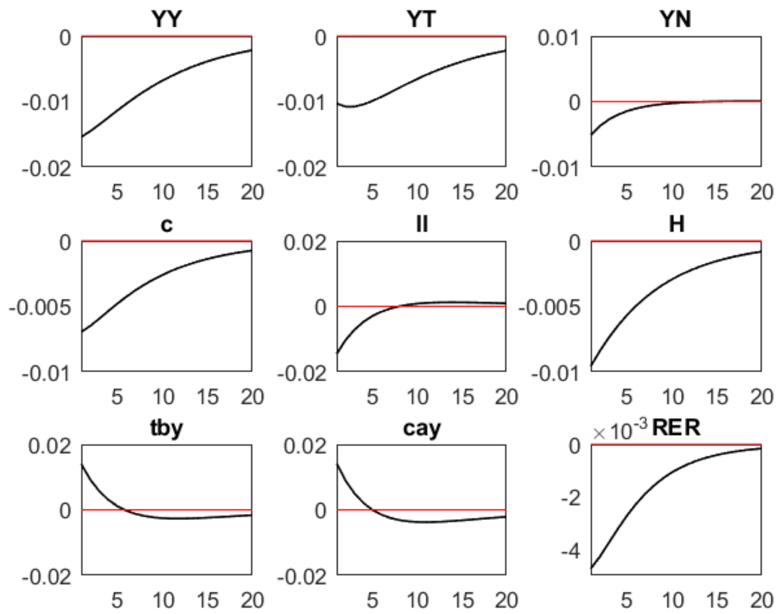
Due to the decrease in foreign debt, households facing a reduction in resources diminish their consumption, investment, and, thus, their capacity to produce. As a result, the shock causes a decline in consumption, investment, and overall production. A reduction in production capacity also results in a contraction in the labor market.

2.4.3.6. Foreign Price Shock

Figure 21 shows the IRFs of the selected variables to the foreign or world price level shock. To put it another way, this shock process represents a rise in the cost of tradable goods.

When considering aggregate demand, households decrease their consumption and investment as a result of their diminishing budgets. Considering the aggregate supply, the production decrease in all sectors. Essentially, this shock mechanism exerts a contractionary impact on the economy.

Figure 21: IRFs of the Variables to Foreign Price Shock



Note: *The black and red lines show the path of the variable following the shock process and the steady state levels, respectively. The x- and y-axes represent the time period following the shock process and the percentage deviation from the steady state value, respectively.*

The fluctuation of the exchange rate can be described as follows. This shock process indirectly raises the costs of borrowing from external sources. Increasing prices for external debt lead to less borrowing activity. As the amount of capital flowing into the country drops, the exchange rate of the country's currency depreciates (RER increases). Simultaneously, as a consequence of this shock process, a depreciation in worldwide exchange rates leads to an appreciation in the local currency (RER decreases). Despite the contrasting impacts of these two factors, the second one exerts more influence. As a result, the RER decreases by 0.4%.

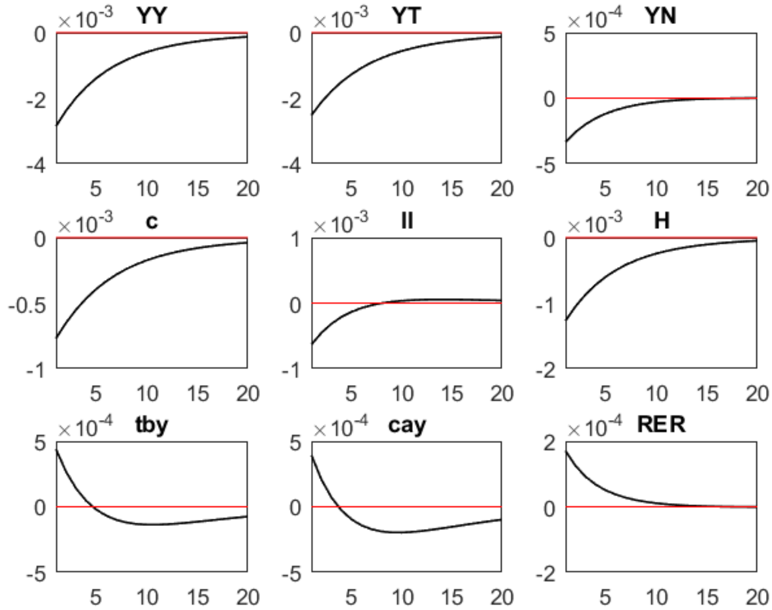
More importantly, after the variations in global financial markets decrease, *tby* and *cay*, which experience a minor increase as a result of reduced external borrowing in the first phase of the shock, ultimately attain a level that is lower than the steady state levels.

While the variables' values gradually improve, there are still variations in the time it takes for complete recovery. On the supply side, non-tradable goods production reaches its steady state value before any other sector's. The recovery processes in the productions of tradable and final goods sectors are comparatively more time-consuming. Regarding the demand side, total investment reaches its long-term equilibrium level far more rapidly compared to consumption's, although the percentage deviation from the steady state in total investment is greater than that of consumption's.

2.4.3.7. Imported Input Price in Tradable Goods Sector Shock

Figure 22 shows the IRFs of the selected variables to the price of imported inputs in the tradable goods sector shock.

Figure 22: IRFs of the Variables to Imported Input Price in Tradable Goods Sector Shock



Note: *The black and red lines show the path of the variable following the shock process and the steady state levels, respectively. The x- and y-axes represent the time period following the shock process and the percentage deviation from the steady state value, respectively.*

This shock process pertains to the escalation of prices for imported inputs in the tradable goods sector. The rise in imported input costs leads to a greater allocation of resources towards imported inputs, in accordance with the constraints of the production function, which does not allow imported inputs to reach zero.

The constructed model's primary differentiating factor is the use of imported inputs, which sets it apart from existing research in the literature. As a result, the investigation of the fluctuations in imported input prices in both sectors is quite important.

Upon initial examination, the rise in imported input prices has a diminishing impact on both the aggregate supply and the aggregate demand. Imported input price hikes have a direct negative impact on production, leading to a drop across all sectors. Concurrently with the decline in production, there is a corresponding reduction in demand, which means a decrease in consumption and investment. Furthermore, this rise in imported input prices also exerts a contractionary impact on the labor market because of a lack of production.

The variables *tby* and *cay* exhibit similar improvements in response to the foreign price shock case. The reduction in aggregate supply leads to a decreased demand for external borrowing, resulting in an improvement in both *tby* and *cay*. Similar to the prior shock process, both ratios converge to a value that is lower than their corresponding steady state values.

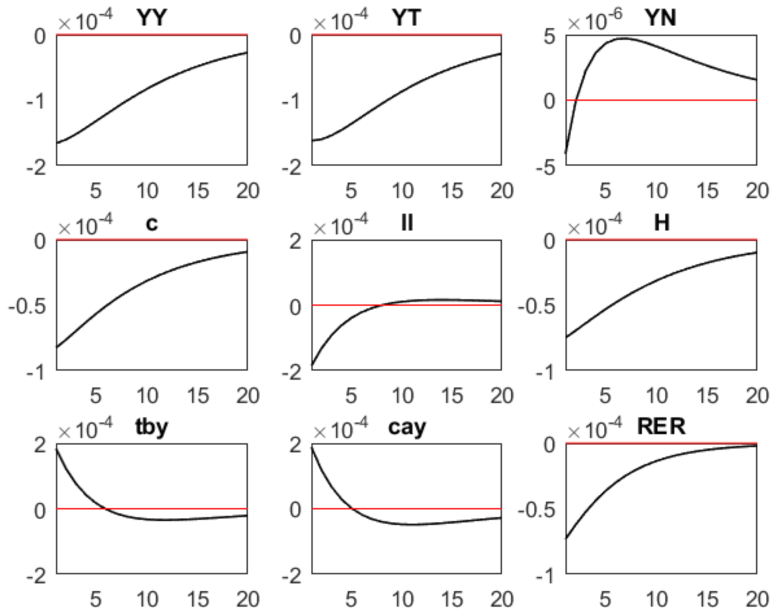
The exchange rate movement in this scenario has an inverse relationship with the foreign price shock case. The rise in imported input prices can be understood as an allocation of additional resources towards international markets. Alternatively, we could interpret this condition as capital outflows. Therefore, this particular situation results in a rise in the value of the RER, which is equivalent to a depreciation within the current economic scenario.

2.4.3.8. Imported Input Price in Non-Tradable Goods Sector Shock

Figure 23 shows the IRFs of the selected variables to the price of imported inputs in the non-tradable goods sector shock. In this case, the term shock process refers to the increase in the price of imported inputs in the non-tradable goods sector's production.

We have similar observations about the prior shock process, considering aggregate supply and demand dynamics. The rise in imported input prices in the non-tradable sector reduces production across all sectors. Consumption and investment also decrease. Surprisingly, production in the non-tradable goods sector rises shortly after the increase in imported input prices. This is because the inability to meet the demand for non-tradable goods from external sources has focused resources on this sector. Consequently, production in the non-tradable sector quickly surpasses the equilibrium threshold. Subsequently, it experiences a slight decrease and, eventually, reaches the steady state equilibrium level.

Figure 23: IRFs of the Variables to Imported Input Price in Non-Tradable Goods Sector Shock



Note: *The black and red lines show the path of the variable following the shock process and the steady state levels, respectively. The x- and y-axes represent the time period following the shock process and the percentage deviation from the steady state value, respectively.*

The consequences concerning *tby*, *cay*, and the labor market are once again comparable. *tby* and *cay* enhance, but the labor market declines due to decreasing overall production and a greater allocation of resources towards imported inputs.

In this scenario, the exchange rate experiences an appreciation, unlike the rise in imported input prices in the tradable goods sector. While imported input prices have led to a greater outflow of capital, the drop in production in other sectors has resulted in a decrease in overall borrowing. The cumulative impact of the two opposite effects leads to an appreciation (decreasing in the RER) in the domestic currency.

2.4.4. Variance Decomposition Analysis

Variance decomposition measures the degree to which external disturbances to other variables in the model explain a particular variable's expected deviation. This method allows for differentiation between the significance and influence of different types of shocks on macroeconomic fluctuations. Essentially, we determine the influence of each shock on business cycle fluctuations by dividing them into ratios for each shock process.

Table 13 displays the outcomes of the variance decomposition analysis. The table displays the percentage of selected variables' fluctuations that the corresponding shock processes can account for.

Table 13: Variance Decomposition of the Model (in Percent)

	YY	YT	YN	c	II	H	tby	cay	RER
Final Goods Tech.	23.3	22.0	8.9	15.5	9.7	19.5	4.5	6.2	44.2
Non-Tradable Tech.	0.8	1.1	0.0	0.6	0.4	0.5	0.2	0.3	2.2
Tradable Tech.	11.2	11.2	1.8	3.3	0.5	7.2	2.1	3.2	0.8
Int. Preference	0.0	0.0	0.1	0.7	0.0	0.0	0.2	0.2	0.1
Country Premium	49.3	52.2	80.5	70.1	83.4	58.9	87.5	84.4	25.8
Foreign Price	15.1	13.3	8.7	9.9	5.9	13.8	5.5	5.7	27.0
Imp. Price in Trad.	0.3	0.3	0.0	0.1	0.0	0.2	0.0	0.0	0.0
Imp. Price in Non.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: *The shock processes are final goods technology, non-tradable goods technology, tradable goods technology, intertemporal preference, country premium, foreign price, price of imported inputs in the tradable sector, and price of imported inputs in the non-tradable sector. Each value is represented as a percentage.*

Among all shock mechanisms, the country premium shock stands out as the most informative one. It has the ability to account for over 50% of the fluctuations in the majority of variables. When considering the international trade variables, the explanatory capacity of the country premium shock is particularly enhanced. For example, this shock process accounts for 87.5% of the fluctuations in *tby* and 84.4% of the fluctuations in *cay*, respectively.

The most significant explanatory shock process following the country premium shock is the final goods technology shock. A change in technology in the production of final goods can account for 23.3% of the fluctuations in total GDP, 22.0% of the fluctuations in the tradable goods sector, 19.5% of the fluctuations in the labor market, and 15.5% of the fluctuations in consumption. Furthermore, changes in the final goods technology account for a significant portion of the fluctuations in the RER, accounting for approximately 44.2%.

The shock processes related to non-tradable goods technology, intertemporal preference, and the prices of imported inputs fail to adequately explain the fluctuations in the selected variables. Upon examining the tradable goods technology shock process, we observe that it can account for 11.2% of the fluctuations in both tradable and final goods productions. However, it is inadequate for explaining the fluctuations in other variables.

Furthermore, a shock in foreign prices has an impact on all variables' fluctuations in the domestic economy. In this economy, foreign price shocks explain 27.0% of the fluctuations in the RER, 15.1% of the fluctuations in overall GDP, 13.8% of the fluctuations in the labor market, and 13.3% of the fluctuations in the tradable goods sector. Moreover, this shock process also accounts for a small fraction of the fluctuations in other variables. Based on these findings, the following section will implement a range of robustness tests to ensure the reliability and strength of the obtained results.

2.5. ROBUSTNESS

We explain the robustness tests in this section. As a reminder, the domestic interest rate in this economy is characterized as debt-elastic:

$$r_t = r^* + e^{\mu_t - 1} - 1 + \psi(e^{d_t - \bar{d}} - 1)$$

where r^* is the foreign or world interest rate. Also, the expression $(e^{\mu_t - 1} - 1)$ represents the country premium shock process. The remaining part shows the debt-elastic interest rate premium.

The definition of a foreign interest rate is critical. In the literature, there are multiple perspectives on the precise significance of the foreign interest rate. Some studies argue that the foreign interest rate is an exogenous phenomenon, completely detached from the country's dynamics, while others underscore the importance of domestic factors. Domestic factors encompass variables such as the country's debt level, total factor production, and income level.

This section aims to determine if the results vary by altering the definition of the interest rate that a country encounters in global markets. In order to accomplish this aim, we develop four different alternative models. The first setting, the debt-elastic interest rate, is the same as in the benchmark scenario:

$$r_t = r^* + e^{\mu_t - 1} - 1 + \psi(e^{d_t - \bar{d}} - 1) \tag{94}$$

The second one is the income-elastic interest rate premium, as follows:

$$r_t = r^* + e^{\mu_t - 1} - 1 - \psi(e^{YY_t - \bar{YY}} - 1) \tag{95}$$

where YY and $\bar{YY}$ are the GDP and the long-term equilibrium level of GDP, respectively. According to Equation 95, if the country's production exceeds (falls below) the equilibrium production level, the risk premium will reduce (rise). Put differently, during economic contractions, the risk premium, which rises due to pessimistic predictions, will raise borrowing costs from international markets. Conversely, during periods of economic expansion, optimistic views about the country will decrease the risk premium and lower borrowing interest rates.

The third and the fourth ones are the exogenous interest rate cases:

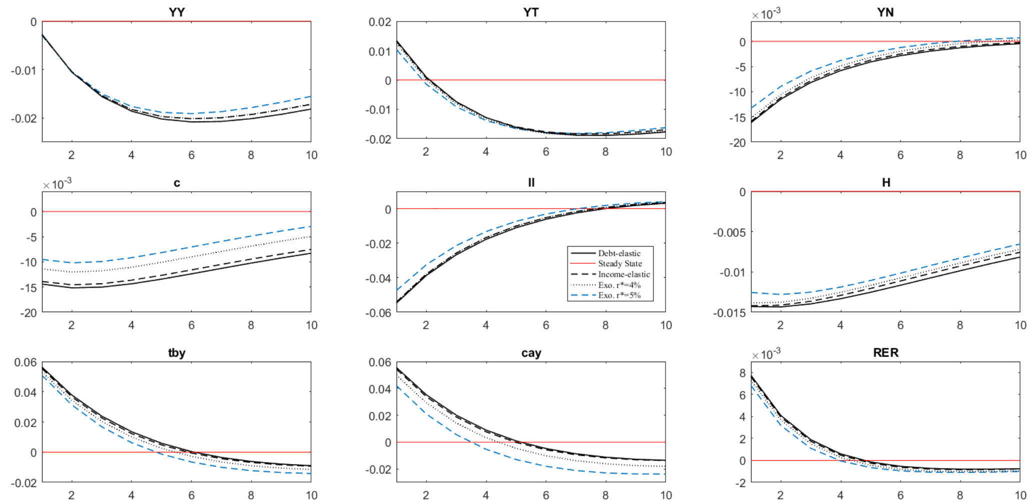
$$r_t = r^* + e^{\mu_t - 1} - 1 \tag{96}$$

In this scenario, we assume that external factors exclusively influence the domestic interest rate. There is no consideration for a risk premium function, and the foreign interest rate is governed solely by the monetary policy of developed/advanced countries and the changes in the global risk appetite. To examine various foreign interest rates, one scenario involves using the default world interest rate of $r^* = 4\%$ from the benchmark model; the other involves using an additional interest rate of $r^* = 5\%$. We decide on such a level, considering that an EME might be subject to a higher rate of foreign interest.

We analyze four different scenarios designed to investigate three significant shock processes identified by variance decomposition. Figure 24, 25, and 26 display the IRFs of the country premium, the foreign price, and the final goods technology shock processes, respectively.

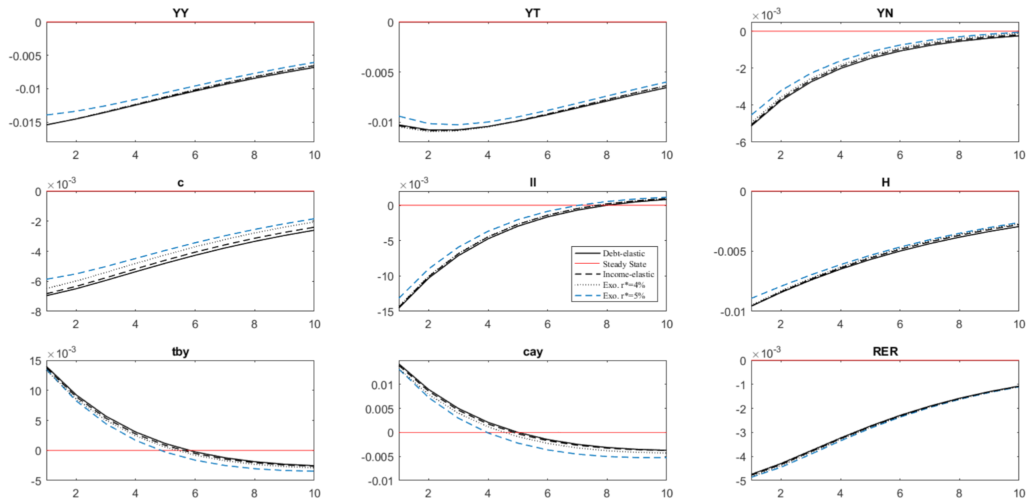
The figures demonstrate that various definitions of interest rate have minimal impact on the model findings. According to the IRFs, the direction of the variables' responses remains consistent across different circumstances, but there may be modest variations in the amount of their changes.

Figure 24: IRFs under Different Interest Rate Definitions: Country Premium Shock



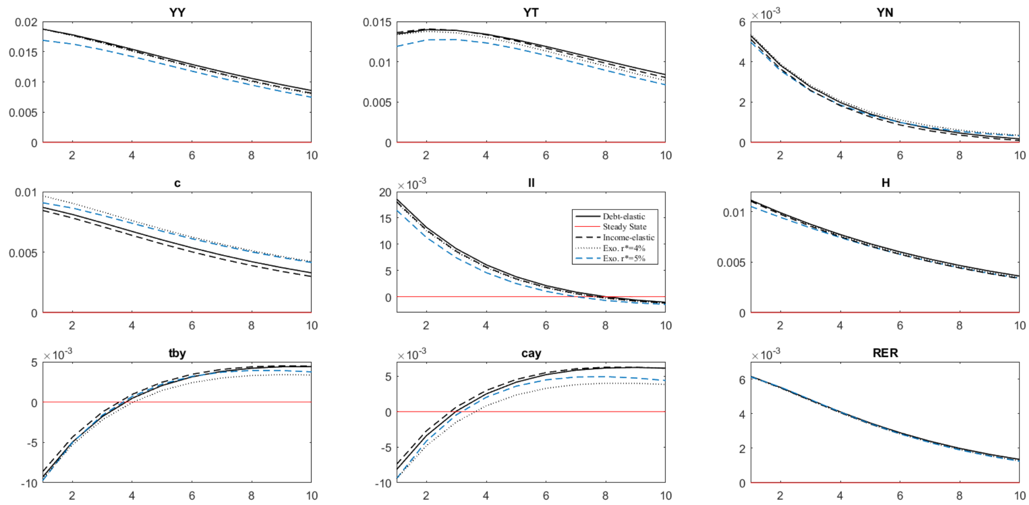
Note: *The black solid, the black dashed, the black dotted, and the blue dashed lines represent the benchmark model case (debt-elastic interest case), the income-elastic interest case, the exogenous interest case (4%), and the case of the higher (5%) exogenous interest rate, respectively.*

Figure 25: IRFs under Different Interest Rate Definitions: Foreign Price Shock



Note: *The black solid, the black dashed, the black dotted, and the blue dashed lines represent the benchmark model case (debt-elastic interest case), the income-elastic interest case, the exogenous interest case (4%), and the case of the higher (5%) exogenous interest rate, respectively.*

Figure 26: IRFs under Different Interest Rate Definitions: Final Goods Technology Shock



Note: *The black solid, the black dashed, the black dotted, and the blue dashed lines represent the benchmark model case (debt-elastic interest case), the income-elastic interest case, the exogenous interest case (4%), and the case of the higher (5%) exogenous interest rate, respectively.*

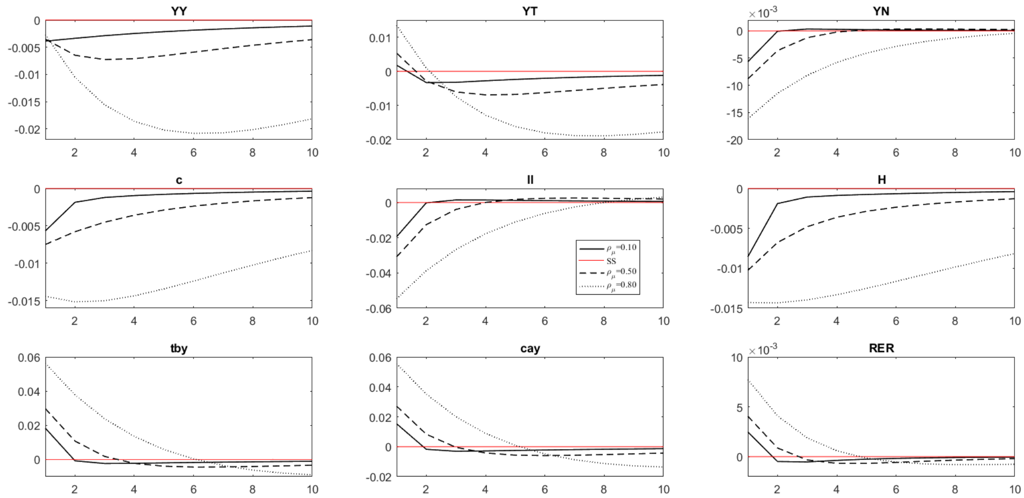
In addition to considering different interpretations of interest rates, we conduct a range of robustness tests by varying selected shock persistency parameters. The selected parameters are ρ_μ, ρ_x, and ρ_F for robustness tests. We select the values of 0.10, 0.50, and 0.80 for each of these parameters. Figures 27, 28, and 29 are derived from simulations conducted while maintaining the other parameter set identical to that of the benchmark model.

Figure 27 shows the IRFs of the selected variables under different persistency levels of the country premium shock. We observe that the response direction of variables to the shock process remains unaffected by varying parameter values. However, as the persistency of the shock process increases, several variables exhibit heightened sensitivity to the shock process.

As an illustration, the variables *cay* and *tby*, which experience only 2% change when ρ_μ is 0.10, exhibit a deviation of approximately 6% from their long-term equilibrium when ρ_μ equals 0.80. Moreover, the time it takes for the shock's influence to diminish and return to SS equilibrium lengthens as the value of the persistency parameter increases.

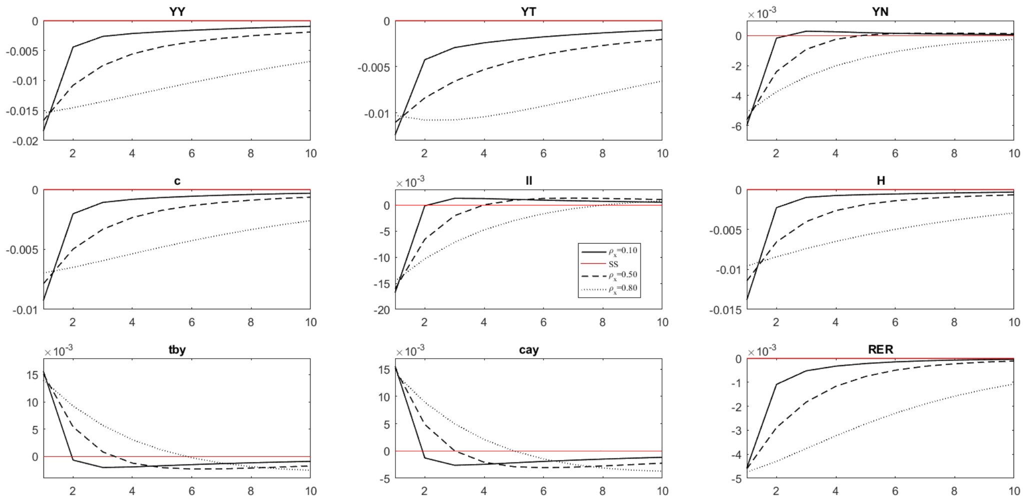
Figure 28, depicting the foreign price shock, and Figure 29, illustrating the final goods technology shock, can be subject to comparable findings. In cases of the foreign price and the final goods technology shock processes, the persistency parameters do not have a large impact on the responses of the variables. However, they do play a substantial role in determining how long it takes for the system to reach long-term equilibrium levels.

Figure 27: IRFs under Different Shock Persistency Parameters: Country Premium Shock



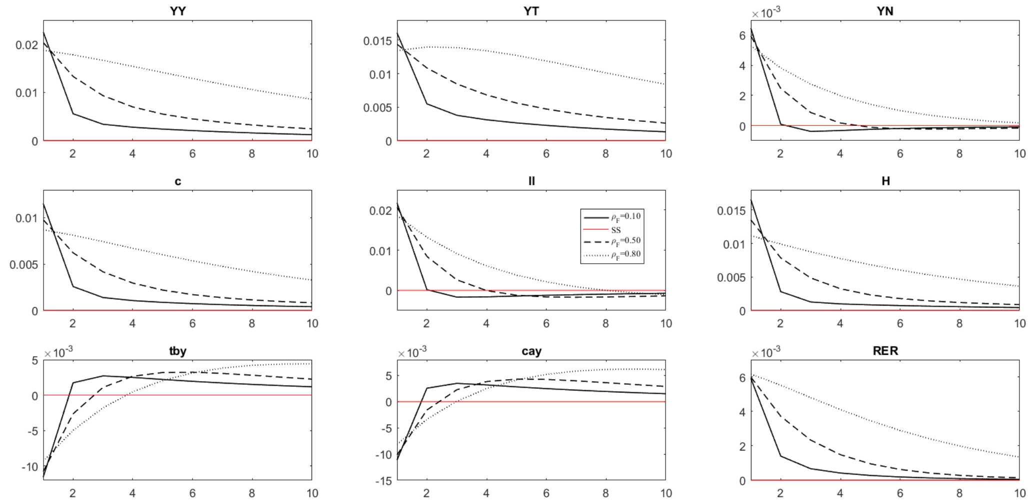
Note: *The black solid, dashed, and dotted lines represent that* ρ_μ *equals* 0.10, 0.50, *and* 0.80, *respectively.*

Figure 28: IRFs under Different Shock Persistency Parameters: Foreign Price Shock



Note: *The black solid, dashed, and dotted lines represent that* ρ_x *equals* 0.10, 0.50, *and* 0.80, *respectively.*

Figure 29: IRFs under Different Shock Persistency Parameters: Final Goods Technology Shock



Note: *The black solid, dashed, and dotted lines represent that* ρ_F *equals* 0.10*,* 0.50*, and* 0.80*, respectively.*

2.6. CONCLUSION

This chapter has examined the impact of sector differentiation and imported inputs on the economic performance of EMEs. By conducting a thorough comparison of the non-tradable and tradable goods sectors, we acquire valuable knowledge about the complex processes that influence both sectors and how they interact with the overall economy.

Our analysis emphasizes the importance of considering the differences between sectors and the impact of imported inputs when examining the factors that drive economic development and productivity in EMEs. Advancements in total factor productivity, geopolitical developments, and the overall global risk appetite impact both the tradable goods sector, which is connected to global markets, and the non-tradable goods sector, which primarily serves domestic demand.

Imported inputs are essential in both sectors because they significantly contribute to production procedures, facilitate technology transfer, and enable integration within the value chain. Nevertheless, EMEs face potential hazards, including supply chain disruptions, exchange rate volatility, and trade imbalances, due to their dependence on imported inputs. These risks have the potential to affect economic stability and resilience. Taking into account these potential hazards, we have constructed a model that incorporates imported inputs into the production procedures.

This chapter adds to the existing literature on EME-RBC by incorporating sector differentiation in the production process, utilization of imported inputs in the production of subsectors, exogenous shocks to the world price level, and imported input prices. An EME is considered, which accurately reflects the typical characteristics of such economies. Moreover, we construct a model using the DSGE methodology, which includes households, various firms, and the rest of the world.

A significant discovery in the study is comparing the second moments of the constructed hypothetical economy with Turkish data as an example of EMEs. In this context, the distinction between sectors has intriguing outcomes. The inclusion of sector differentiation has resulted in altered outcomes, as most previous models in the literature often focus on a single product. For instance, the fluctuations in the non-tradable goods sector's production are comparatively lower than those in other macroeconomic variables like consumption and investment. Conversely, the production fluctuations in the tradable and final goods sectors exceed those in consumption and investment.

Variations in sectors lead to discrepancies in international trade statistics. Foreign trade variables such as tby and cay have an inverse and strong correlation with the non-tradable sector, but they demonstrate a positive correlation with the tradable sector. Also, the autocorrelation coefficients of the variables in the model are compatible with those in the data from Türkiye.

The investigation of the IRFs yields notable findings. Notably, the impacts of technology shocks vary across different sectors. For instance, a positive shock in technology within the tradable sector leads to a rise in tby and cay. Conversely, a positive shock in technology within the non-tradable sector leads to a fall in tby and cay. Likewise, the RER exhibits totally opposite movements with these shocks since different technological shocks exert distinct effects on both aggregate supply and aggregate demand.

The intertemporal preference and the country premium shock processes have varying impacts on different sectors as well. When there is a positive preference shock, it leads to an increase in the production of non-tradable goods. Conversely, when there is a country premium shock, the initial reaction is to increase tradable goods production.

The inclusion of the foreign price level and the imported input prices of both sectors in the constructed model yields remarkable results. Initially, these shock processes result in a reduction in production across all sectors. Also, the variables exhibit differences in reaching their long-term equilibrium levels. Regarding the non-tradable goods sector production, there is a faster recovery following the changes in global prices, but in relation to the tradable goods sector production, the instability caused by the change in imported input prices within the tradable goods sector gets absorbed more quickly.

Furthermore, we conduct a variance decomposition analysis in addition to the IRFs analyses. This strategy enables identification of the specific influence each shock has on the variables' volatilities. According to the data, the country premium shock is the primary factor in explaining variables' volatilities. After considering the primary factor, the main factors that cause volatility are the shock in technology for final goods and the shock in the foreign price. Shock processes in the intertemporal preference, technology in the non-tradeable sector, and the imported input prices of both the non-tradable and tradable goods sectors are not enough to explain the volatilities.

Finally, we conduct a range of robustness tests. By expanding the scope of the foreign interest rate definition, we provide debt-elastic, income-elastic, and exogenous foreign interest rate definitions. We analyze the effects of different interest rate definitions on specific critical shock processes. We find that variations in interest rate definitions do not exert a significant influence on the variables' fluctuations. Furthermore, our research shows that we observe similar responses of variables to shock processes when we modify the shock persistency parameters arbitrarily assigned in the benchmark model.

In summary, the findings in this chapter greatly enhance our understanding of the complex economic dynamics present in EMEs. By carefully analyzing the dynamics of sectoral diversification and imported inputs, this study emphasizes the critical importance of understanding and considering the various characteristics and external factors that define these economies.

Our work has revealed the complex and diverse structure of EMEs, highlighting the relationship between domestic and foreign forces as well as the nuanced connections between various sectors of the economy. Acquiring a more profound understanding not only improves our theoretical understanding, but also provides critical insights for policymakers and stakeholders responsible for navigating the economic environment of EMEs.

EMEs must skillfully manage the dynamics of various sectors and their reliance on external factors. EMEs can establish themselves as active participants in the global economy, promoting inclusive and sustainable development for their citizens and contributing to the overall prosperity of the international community by implementing strategic policies and creating a favorable environment for investment, innovation, and entrepreneurship.

Future research can concentrate on empirically validating and estimating this DSGE model for different EMEs, building upon its theoretical origins. By utilizing the model in countries like Brazil, Columbia, South Africa, and Türkiye, researchers can derive the model parameters using empirical data, thereby confirming the theoretical concepts and revealing country-specific economic dynamics. This comparative analysis aims to offer a more comprehensive understanding of how imported inputs and sectoral differentiation impact economic outcomes in various situations. It will emphasize both common trends and the different aspects of each market.

Another potential area for further investigation is the interaction between trade policy and the effects on certain sectors within the model. Researchers can gain significant insights into the optimal design of trade policies by simulating the effects of tariffs, trade agreements, and import restrictions on industries that heavily rely on imported inputs. These research endeavors will not only enhance the theoretical framework but also provide practical policy recommendations customized to the requirements of EMEs.

CONCLUSION

This dissertation offers a thorough investigation into the economic dynamics and difficulties faced by EMEs, with a specific emphasis on Türkiye. In a thorough examination that covers two chapters, we have explored the complex interaction of factors that influence the economic situation of EMEs. Especially, this dissertation has provided insights into the key determinants that drive growth, stability, and resilience.

Chapter 1 performs a thorough analysis of the business cycles of EMEs, which are characterized by both trade deficits and foreign debt. Our analysis uncovers the complex relationship between trade deficits, external debt, and domestic economic performance, revealing the vulnerability of EMEs to external shocks and the necessity of prudent economic management in addressing these difficulties. Chapter 1 provides a clear explanation of the factors that cause macroeconomic fluctuations. It establishes the foundation for a more profound comprehension of the strengths and weaknesses present in the economic structures of EMEs.

Chapter 2 examines the effects of sectoral differentiation and imported inputs on EMEs' economic development, with a particular emphasis on the non-tradable and tradable goods sectors. By doing a comparative analysis, we have discovered the contrasting dynamics that are present in these sectors. This analysis emphasizes the crucial role that sectoral composition has in shaping growth patterns and productivity levels. Furthermore, our analysis emphasizes the critical role of imported inputs in driving technological progress and value chain integration. This emphasizes the significant impact that international trade and investment may have on the economic development of EMEs.

By combining the knowledge from both Chapters 1 and 2, this dissertation enhances our comprehension of the complex economic challenges faced by EMEs like Türkiye. The dissertation emphasizes the significance of embracing a comprehensive approach to economic analysis and policymaking that takes into account variations between sectors and worldwide interdependence. Our findings underscore the significance of policymakers devising tailored strategies that leverage the potential of sector differentiation and international integration while simultaneously mitigating associated risks.

The objective of this thesis is to enhance the existing body of knowledge on EME-

RBC. In Chapter 1, we specifically design a DSGE model for the Turkish economy. We use the Bayesian estimation approach to estimate the model parameters. The estimation results significantly contribute to the existing body of knowledge. The second moments, IRFs, and the variance decomposition techniques serve as analytical tools. Furthermore, the model results elucidate the important distinctions between Türkiye and other EMEs.

In Chapter 1, we analyze and compare the historical growth rates of both Türkiye and selected EMEs, Argentina and Mexico. There exist significant disparities among these countries during various time periods; however, they demonstrate comparable long-term economic growth. In addition, we analyze the changes in the shock variables derived from the model estimation during Türkiye's crises in 1994, 2001, and 2009. We demonstrate that the growth shock exerts a substantial influence on the rate of output growth, while the country premium shock has a notable effect on the trade balance to output ratio, *tby*.

Regarding Chapter 1's outcomes, there is a notable degree of compatibility between the second moments of the observed data and the model. The model replicates the observed relationship in the data. Additionally, there are negative correlation coefficients between *tby* and other variables. This outcome is also consistent with the data.

Upon examination of the IRFs analyses, no major deviations from the anticipated macroeconomic outcomes are observed. The influence of technology and growth shocks on variables such as investment, consumption, and output growth is generally positive. However, it is important to note that their effects on *tby* varies from one another.

Following the positive technology shock, there is a drop in the need for external borrowing and a modest increase in *tby*. Nevertheless, after the growth shock, there is an increase in the requirement for external borrowing and, correspondingly, a decrease in *tby*.

When considering the intertemporal preference shock, there is an observed increase in current consumption. To achieve this level of consumption, the investment declines while *tby* decreases as a result of increased external borrowing. As expected, the emergence of the country premium shock has a negative impact on investment, consumption, and output growth. The occurrence of a country premium shock results in an increase in borrowing costs from foreign sources, leading to a decline in access to external resources and an increase in *tby*.

Lastly, in the event of a domestic expenditure shock, there is a decline in both investment and consumption within the country. The subsequent period experiences a decline in output as a result of less investment. The reduction in production leads to a drop in the requirement for external funding, hence resulting in an enhancement of *tby*.

According to the estimation results, Türkiye has a high level of persistency in growth shocks. This implies that growth shocks play a critical role in elucidating the economic fluctuations observed over the medium and long terms. According to Aguiar and Gopinath's (2007) research, growth shocks hold greater significance than technology shocks in explaining the fluctuations, but the study of Garcia Cicco et al. (2010) present a contrasting viewpoint. Chapter 1's results corroborate Aguiar and Gopinath's (2007) research, despite using a lengthy dataset and a model that closely resembles Garcia Cicco et al.'s (2010) research.

Chapter 2 of the study involves the construction of a DSGE model that encompasses both non-tradable and tradable goods sectors. Furthermore, the inclusion of imported inputs, which are important for EMEs, improves the production functions of both sectors. This approach provides a theoretical contribution to the existing body of knowledge.

In accordance with the existing literature, we calibrate the parameters within the established theoretical model. Furthermore, we compute the the steady state solutions and, subsequently, compare them with Türkiye's macroeconomic data for the year 2022, serving as an illustration of EMEs. The model findings exhibit a substantial replication of the data.

We also compute the second moments of the model in addition to the steady state solutions. Sector differentiation reveals that the tradable and non-tradable goods sectors exhibit distinct volatilities. We also conduct an analysis to investigate the correlation coefficients between each sector and the selected macroeconomic variables. The research reveals a positive correlation between variables related to international trade and the tradable goods sector, while these variables and the non-tradable goods sector exhibit a negative correlation.

The analysis of IRFs also reveals interesting findings. While technological shocks across many industries have a comparable impact on macroeconomic variables like consumption and investment, their impacts on the RER vary. For instance, a positive technological shock in the tradable goods sector results in a decline in the RER, indicating an appreciation of the domestic currency. Conversely, a positive technological shock in the non-tradable goods sector leads to an increase in the RER, indicating a depreciation of the domestic currency.

Examining the impact of shock processes on imported input prices, an increase in imported input prices in the tradable goods sector leads to a decrease in production across all sectors. Nevertheless, an increase in imported input prices in the non-tradable goods sector results in an increase in production within the same sector. The intriguing outcome, in particular, stems from the reliance of the production process on imported inputs. The non-tradable goods sector does not offer the same possibility to reduce output and import its output as it does in the tradable goods sector.

The model incorporates eight different shock processes, each with varying degrees of explanatory power in relation to the volatilities of the variables. The findings indicate that the country premium shock holds the most importance as an explanatory shock process. The most significant explanatory shock processes are the country premium shock, the technology shock in final goods production, and the foreign price level shock processes.

In Chapter 2, we also perform various robustness tests to ensure the reliability and stability of our results. We provide several definitions of interest rates: debt-elastic, income-elastic, and exogenously given. In each scenario, we examine the effects of specific critical shock mechanisms. We observe that differences in interest rate definitions do not have a significant effect on the variables' fluctuations. Also, our research shows that changing the arbitrarily assigned shock persistency parameters in the model makes the macroeconomic variables respond to the shocks in a similar way. These findings support the reliability of the model's outcomes.

Both Chapters 1 and 2 of the thesis use the DSGE methodology, but it is important to recognize the limitations of these models. While the DSGE models generally serve as useful tools for macroeconomic analysis and policy evaluation, it is crucial to recognize their inherent limitations.

Critics contend that these models have the potential to oversimplify the complexities of economic reality, disregard significant aspects of real-world economies, and generate outcomes that are deceptive or untrustworthy in certain circumstances.[29] Hence, while the model findings appear promising, it is crucial to exercise caution when selecting the conclusions and policy recommendations based on these findings, given the limitations of the DSGE technique.

In addition to these factors, the data and the theoretical framework employed in the estimation process may yield inaccurate outcomes. For instance, the trade openness of Türkiye during the 1950s and 2010s exhibits notable disparities. Also, the country premium shock fails to include the variations among the specific years under consideration. In addition, modifying the data used can potentially change the outcomes of the model.

Given the previously mentioned constraints, it is crucial to subject the model conclusions to empirical investigation. The future research should focus on empirically examining the theoretical conclusions presented in the thesis. Furthermore, we assume that the agents in both models are homogeneous and/or identical. For instance, we can formulate an alternative model that allows households to exhibit heterogeneity or categorize them into different groups based on their income level. By employing this process of differentiation, we can derive significantly more interesting results.

Furthermore, the dynamics of the labor market have undergone a notable shift due to the escalating migration patterns observed globally in recent years. Chapter 2 provides a definition of the workforce in different sectors. Nevertheless, it is possible to make extensions that expose the differences in skills among the workers in these labor markets. The primary factor driving this expansion is the disparity in the exportation or importation of high-skilled and low-skilled labor between different countries.

Chapter 2 introduces a model that serves as a benchmark. We can empirically evaluate the efficacy of this approach across various EMEs and its level of success within specific countries. This study gathers pertinent data pertaining to a specific country, such as Türkiye, Mexico, or Argentina, and might apply a predictive methodology. In this way, the benchmark model clearly identifies which countries it effectively serves.

To conclude, this dissertation signifies a substantial advancement in realizing the

[29]See Christiano et al. (2018), Gali (2017), and Korinek (2018).

complete capabilities of EMEs in the global economy. We provide a guide for policymakers and researchers to understand and negotiate EMEs' complex economic environments and establish a course towards equitable and sustainable development by clarifying the factors that contribute to economic growth and stability. By implementing coordinated initiatives and making decisions based on solid evidence, EMEs such as Türkiye have the potential to capitalize on the opportunities presented by the twenty-first century and establish themselves as powerful catalysts for economic expansion and success worldwide.

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APPENDIX 1

1A. STEADY STATE CONDITIONS

Define $y_t = \frac{Y_t}{X_{t-1}}$, $c_t = \frac{C_t}{X_{t-1}}$, $i_t = \frac{I_t}{X_{t-1}}$, $k_t = \frac{K_t}{X_{t-1}}$ and $d_t = \frac{D_t}{X_{t-1}}$. A collection of stationary solutions for the model's FOCs determines a stationary competitive equilibrium. We will provide the variables as parameters, each corresponding to its respective value, given the complex structure of the solutions. Every statement offers instructions for subsequent conditions. The ss expression located at the top-right of the variables denotes the steady state level of each variable.

Growth rate of the productivity:

$$g^{ss} = \bar{g} \tag{97}$$

Domestic interest rate:

$$r^{ss} = \frac{\bar{g}^{\gamma}}{\beta} - 1 \tag{98}$$

Capital to labor ratio:

$$\frac{k^{ss}}{h^{ss}} = \bar{g}\Big(\frac{r^{ss} + \delta}{\alpha}\Big)^{\frac{1}{\alpha-1}} \tag{99}$$

Labor:

$$h^{ss} = \Big((1-\alpha)\bar{g}\Big(\frac{k^{ss}}{\bar{g}h^{ss}}\Big)^{\frac{\alpha}{\theta}}\Big)^{\frac{1}{\omega-1}} \tag{100}$$

Capital:

$$k^{ss} = \Big(\frac{k^{ss}}{\bar{g}h^{ss}}\Big)\bar{g}h^{ss} = \Big(\frac{r^{ss} + \delta}{\alpha}\Big)^{\frac{1}{\alpha-1}}\bar{g}h^{ss} \tag{101}$$

Investment:

$$i^{ss} = (\bar{g} - 1 + \delta)k^{ss} \tag{102}$$

Output:

$$y^{ss} = (k^{ss})^{\alpha}(\bar{g}h^{ss})^{1-\alpha} \tag{103}$$

Domestic spending:

$$s^{ss} = \bar{s}y^{ss} \tag{104}$$

Foreign debt:

$$d^{ss} = \tilde{d}y^{ss} = \bar{d} \tag{105}$$

Trade balance:

$$tb^{ss} = \bar{d}\left(1 - \frac{\bar{g}}{r^{ss}}\right) \tag{106}$$

Trade balance to output ratio:

$$tby^{ss} = \left(\frac{tb^{ss}}{y^{ss}}\right) \tag{107}$$

Consumption:

$$c^{ss} = y^{ss} - s^{ss} - i^{ss} - tb^{ss} \tag{108}$$

Growth of output, consumption and investment:

$$g_y^{ss} = g_c^{ss} = g_i^{ss} = \bar{g} \tag{109}$$

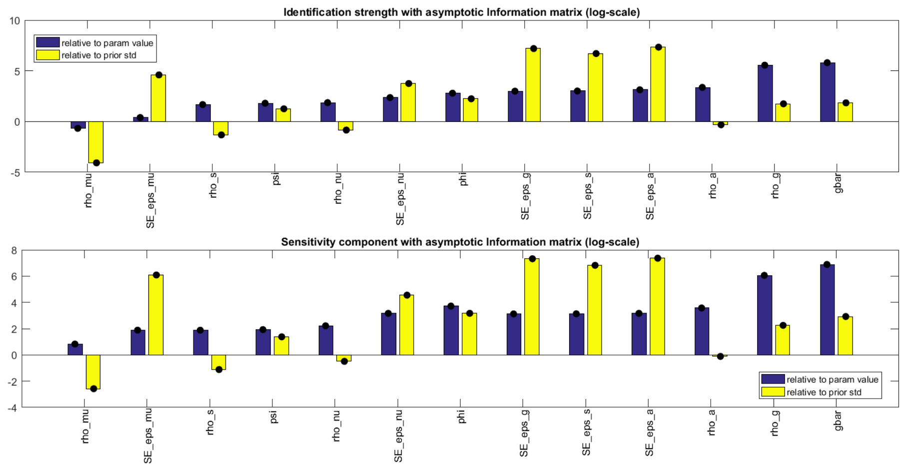
Technology, country premium and intertemporal preference shocks:

$$a^{ss} = \mu^{ss} = v^{ss} = 1 \tag{110}$$

1B. IDENTIFICATION TEST RESULTS

The following figure depicts the identification test results:

Figure 30: Identification Test Results

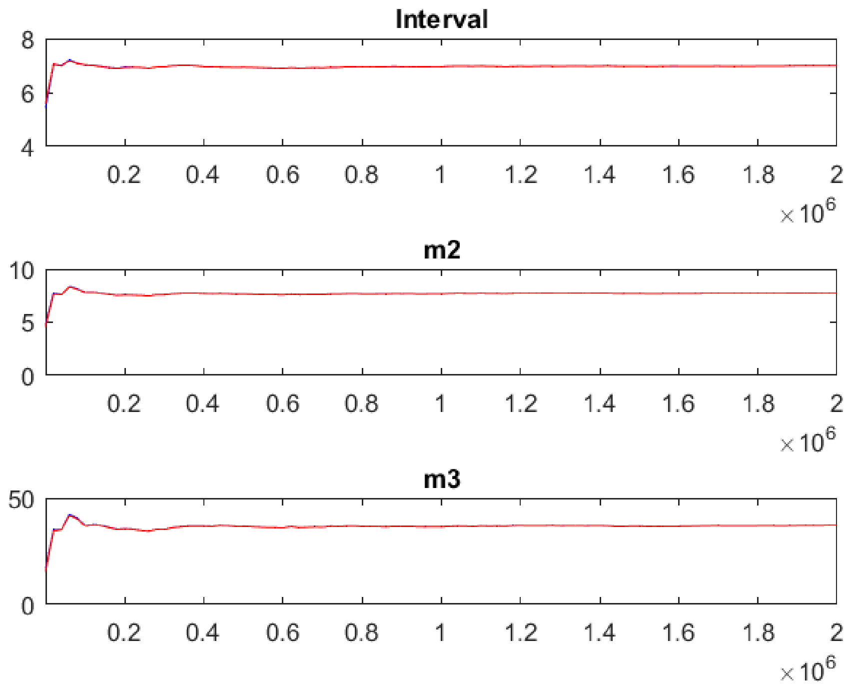


Note: *The blue and yellow bars display the degree to which the prior distribution mean and variance influence the determination of the parameters, respectively. The parameter on the far right is the most strongly identified parameters. The one on the far left is the weakest.*

1C. MULTIVARIATE MCMC CONVERGENCE DIAGNOSTICS

The following figure depicts the outcomes of the Multivariate MCMC Convergence diagnostics.

Figure 31: Multivariate MCMC Convergence Diagnostics



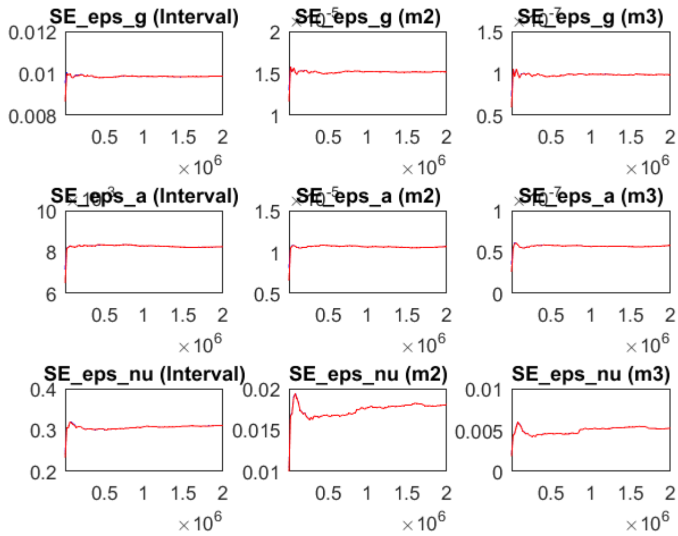
Note: *The first figure (interval) uses the Brooks and Gelman convergence test for the 80% interval, the second figure (m2) for the variance, and the third figure (m3) for the third moment. The number* $2x10^6$ *on the x-axis represents the total number of iterations per chain.*

In Figure 31, the first figure (interval) uses the Brooks and Gelman convergence test for the 80% interval, the second figure (m2) for the variance, and the third figure (m3) for the third moment. The blue line reflects combined samples from all chains, while the red line represents values from an individual chain. We anticipate the two lines to stabilize horizontally and approach each other if the chains converge. Hence, the estimated model successfully passes the multivariate MCMC convergence diagnostic.

1D. UNIVARIATE MCMC CONVERGENCE DIAGNOSTICS

The following figures depict the outcomes of the Univariate MCMC Convergence diagnostics.

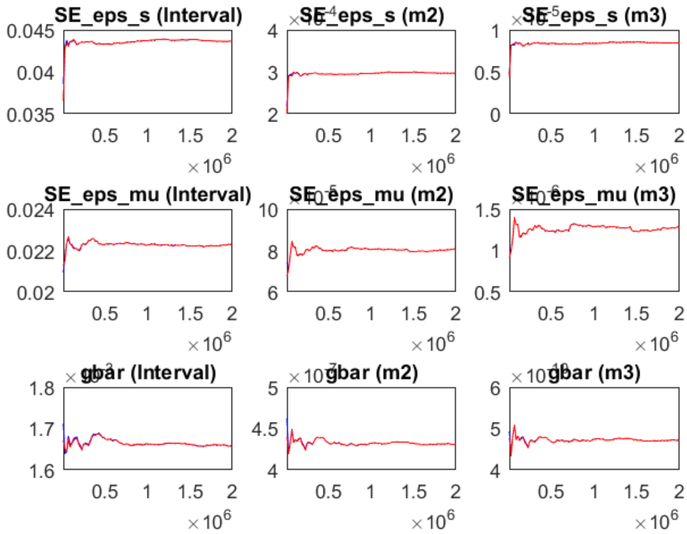
Figure 32: Univariate MCMC Convergence Diagnostics (a)



Note: *The first figure (interval) uses the Brooks and Gelman convergence test for the* 80% *interval, the second figure (m2) for the variance, and the third figure (m3) for the third moment. The number* $2x10^6$ *on the x-axis represents the total number of iterations per chain.*

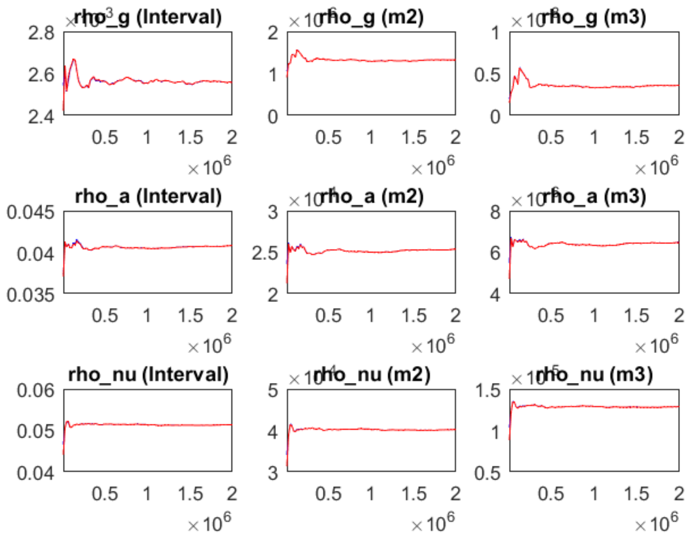
In Figures 32 to 36, the first figures (interval) use the Brooks and Gelman convergence test for the 80% interval, the second figures (m2) for the variance, and the third figures (m3) for the third moment. The blue line reflects combined samples from all chains, while the red line represents values from an individual chain. We anticipate the two lines to stabilize horizontally and approach each other if the chains converge. Thus, the estimated model successfully passes the univariate MCMC convergence tests.

Figure 33: Univariate MCMC Convergence Diagnostics (b)



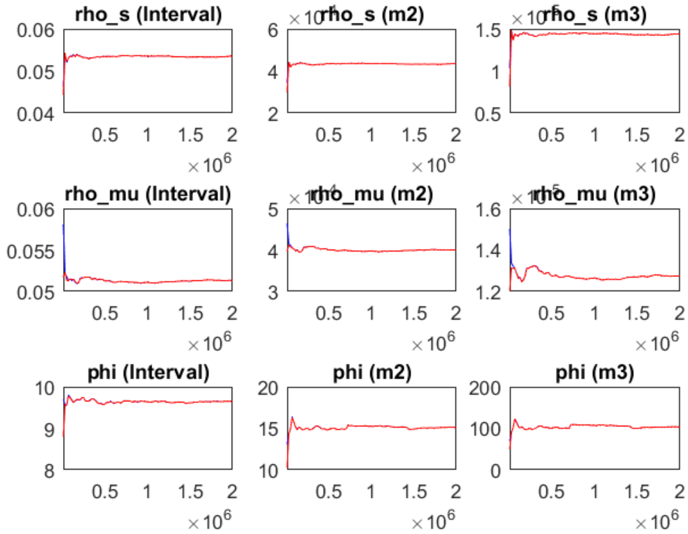
Note: *The first figure (interval) uses the Brooks and Gelman convergence test for the 80% interval, the second figure (m2) for the variance, and the third figure (m3) for the third moment. The number* $2x10^6$ *on the x-axis represents the total number of iterations per chain.*

Figure 34: Univariate MCMC Convergence Diagnostics (c)



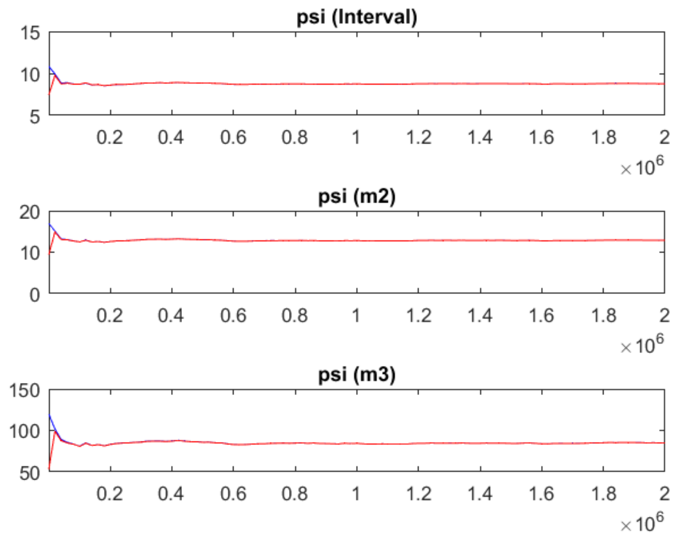
Note: *The first figure (interval) uses the Brooks and Gelman convergence test for the 80% interval, the second figure (m2) for the variance, and the third figure (m3) for the third moment. The number* $2x10^6$ *on the x-axis represents the total number of iterations per chain.*

Figure 35: Univariate MCMC Convergence Diagnostics (d)



Note: *The first figure (interval) uses the Brooks and Gelman convergence test for the 80% interval, the second figure (m2) for the variance, and the third figure (m3) for the third moment. The number* $2x10^6$ *on the x-axis represents the total number of iterations per chain.*

Figure 36: Univariate MCMC Convergence Diagnostics (e)



Note: *The first figure (interval) uses the Brooks and Gelman convergence test for the 80% interval, the second figure (m2) for the variance, and the third figure (m3) for the third moment. The number* $2x10^6$ *on the x-axis represents the total number of iterations per chain.*

APPENDIX 2

2A. LIST OF COUNTRIES AND FOREIGN VALUE-ADDED SHARE OF EXPORTS

Table 14 displays the selected EMEs and the share of foreign value-added in their total exports in 1995 and 2020.

Table 14: Foreign Value-Added Share of Exports in 1995 and 2020

Country	Abbreviation	1995	2020
Argentina	ARG	5.6	9.5
Brazil	BRA	8.8	13.9
Chile	CHL	13.6	12.3
China	CHN	14.1	15.8
Colombia	COL	11.4	11.4
Costa Rica	CRI	20.1	15.9
Czechia	CZE	22.4	37.7
Greece	GRC	14.0	36.3
Hungary	HUN	25.6	45.9
India	IND	10.7	17.2
Indonesia	IDN	11.3	11.2
Korea	KOR	25.1	29.7
Mexico	MEX	30.3	35.0
Peru	PER	7.9	10.6
Poland	POL	14.3	28.9
Portugal	PRT	22.3	29.7
Russia	RUS	7.8	9.5
Slovakia	SVK	32.0	47.7
Slovenia	SVN	28.8	33.1
South Africa	ZAF	13.4	20.3
Türkiye	TUR	8.8	21.6
O.E.C.D.	**OECD**	**3.2**	**7.4**

Note: *The data source is the OECD Statistics on Trade in Value Added 2023 edition.*

2B. STEADY STATE CONDITIONS

The ss expression located at the bottom-right of the variables denotes the steady state level of each variable. The remaining expressions are the parameters. The shock processes are given as 1 at the steady state:

$$a^F_{ss} = 1 \tag{111}$$

$$a^N_{ss} = 1 \tag{112}$$

$$a^T_{ss} = 1 \tag{113}$$

$$\mu_{ss} = 1 \tag{114}$$

$$\upsilon_{ss} = 1 \tag{115}$$

$$x_{ss} = 1 \tag{116}$$

$$x^N_{ss} = 1 \tag{117}$$

$$x^T_{ss} = 1 \tag{118}$$

The term of trade exhibits a constant value over an extended period of time:

$$\frac{p^T_{ss}}{p^N_{ss}} = \bar{p} \tag{119}$$

The rental rate of capitals as follows:

$$u^N_{ss} = \frac{1}{\beta} - 1 + \delta^N \tag{120}$$

$$u^T_{ss} = \frac{1}{\beta} - 1 + \delta^T \tag{121}$$

The ratio of tradable goods to non-tradable goods, which is constant, will be used for calculating the other variables:

$$\frac{z^T_{ss}}{z^N_{ss}} = \Big(\frac{\bar{p}\chi}{1-\chi}\Big)^{-\xi} \tag{122}$$

The price of non-tradable goods:

$$p^N_{ss} = \chi\Big(\chi + (1-\chi)\Big(\frac{z^T_{ss}}{z^N_{ss}}\Big)^{1-\frac{1}{\xi}}\Big)^{\frac{1}{1-\frac{1}{\xi}}-1} \tag{123}$$

The price of tradable goods:

$$p_{ss}^T = \bar{p}p_{ss}^N \tag{124}$$

Lagrange multipliers for firm profit maximization problems in both sectors:

$$\gamma_{ss}^N = \gamma_{ss}^T = 1 - \beta \tag{125}$$

Capital to imported input ratio in tradable goods sector:

$$\frac{k_{ss}^T}{m_{ss}^T} = \frac{pm^T \alpha^T}{u_{ss}^T(1 - \alpha^T - \theta^T)} \tag{126}$$

Labor demand to imported input ratio in tradable goods sector:

$$\frac{h_{ss}^T}{m_{ss}^T} = \left(\frac{pm^T}{p_{ss}^T(1 - \alpha^T - \theta^T)\left(\frac{k_{ss}^T}{m_{ss}^T}\right)^{\alpha^T}} \right)^{\frac{1}{\theta^T}} \tag{127}$$

Using the corresponding ratios gives the wage in tradable goods sector:

$$w_{ss}^T = \frac{p_{ss}^T \left(\frac{k_{ss}^T}{m_{ss}^T}\right)^{\alpha^T} \left(\frac{h_{ss}^T}{m_{ss}^T}\right)^{\theta^T - 1}}{1 + \gamma_{ss}^T \eta^T} \tag{128}$$

Capital to imported input ratio in non-tradable goods sector:

$$\frac{k_{ss}^N}{m_{ss}^N} = \frac{pm^N \alpha^N}{u_{ss}^N(1 - \alpha^N - \theta^N)} \tag{129}$$

Labor demand to imported input ratio in non-tradable goods sector:

$$\frac{h_{ss}^N}{m_{ss}^N} = \left(\frac{pm^N}{p_{ss}^N(1 - \alpha^N - \theta^N)\left(\frac{k_{ss}^N}{m_{ss}^N}\right)^{\alpha^N}} \right)^{\frac{1}{\theta^N}} \tag{130}$$

Using the corresponding ratios gives the wage in tradable goods sector:

$$w_{ss}^N = \frac{p_{ss}^N \left(\frac{k_{ss}^N}{m_{ss}^N}\right)^{\alpha^N} \left(\frac{h_{ss}^N}{m_{ss}^N}\right)^{\theta^N - 1}}{1 + \gamma_{ss}^N \eta^N} \tag{131}$$

Labors for both sectors:

$$h_{ss}^N = w_{ss}^{N\left(\frac{1}{\omega^N - 1}\right)} \tag{132}$$

$$h_{ss}^T = w_{ss}^{T\left(\frac{1}{\omega^T - 1}\right)} \tag{133}$$

Working capital for both sectors:

$$M_{ss}^N = \eta^N w_{ss}^N h_{ss}^N \tag{134}$$

$$M_{ss}^T = \eta^T w_{ss}^T h_{ss}^T \tag{135}$$

The imported input in the non-tradable goods sector:

$$m_{ss}^N = \frac{h_{ss}^N}{\left(\frac{pm^N}{p_{ss}^N(1-\alpha^N-\theta^N)\left(\frac{k_{ss}^N}{m_{ss}^N}\right)^{\alpha^N}}\right)^{\frac{1}{\theta^N}}} \tag{136}$$

The imported input in the tradable goods sector:

$$m_{ss}^T = \frac{h_{ss}^T}{\left(\frac{pm^T}{p_{ss}^T(1-\alpha^T-\theta^T)\left(\frac{k_{ss}^T}{m_{ss}^T}\right)^{\alpha^T}}\right)^{\frac{1}{\theta^T}}} \tag{137}$$

The output in the non-tradable goods sector:

$$y_{ss}^N = \left(k_{ss}^N\right)^{\alpha^N}\left(h_{ss}^N\right)^{\theta^N}\left(m_{ss}^N\right)^{1-\alpha^N-\theta^N} \tag{138}$$

The output in the tradable goods sector:

$$y_{ss}^T = \left(k_{ss}^T\right)^{\alpha^T}\left(h_{ss}^T\right)^{\theta^T}\left(m_{ss}^T\right)^{1-\alpha^T-\theta^T} \tag{139}$$

The investment in the non-tradable goods sector:

$$i_{ss}^N = \delta^N k_{ss}^N \tag{140}$$

The investment in the tradable goods sector:

$$i_{ss}^T = \delta^T k_{ss}^T \tag{141}$$

The domestic interest rate:

$$r_{ss} = r^* \tag{142}$$

Non-tradable goods sector market clearing condition:

$$z_{ss}^N = y_{ss}^N \tag{143}$$

The domestic needs of tradable goods:

$$z_{ss}^{T} = z_{ss}^{N}\big(\frac{\bar{p}\chi}{1-\chi}\big)^{-\xi} \tag{144}$$

Trade balance:

$$tb_{ss} = p_{ss}^{T}(y_{ss}^{T} - z_{ss}^{T}) - pm^{N}m_{ss}^{N} - pm^{T}m_{ss}^{T} \tag{145}$$

External debt:

$$d_{ss} = \bar{d} = -tb_{ss}\frac{1+r_{ss}}{r_{ss}}\frac{1}{p_{ss}^{T}} \tag{146}$$

Current account:

$$ca_{ss} = tb_{ss}^{T} - p_{ss}^{T}r_{ss}^{T}d_{ss} \tag{147}$$

Final goods:

$$f_{ss} = \left(\chi z_{ss}^{N\,(1-\frac{1}{\xi})} + (1-\chi)z_{ss}^{T\,(1-\frac{1}{\xi})}\right)^{\left(\frac{1}{1-\frac{1}{\xi}}\right)} \tag{148}$$

The capital adjustment costs:

$$\Phi_{ss}^{N} = \Phi_{ss}^{T} = 0 \tag{149}$$

Consumption:

$$c_{ss} = f_{ss} - i_{ss}^{N} - i_{ss}^{T} \tag{150}$$

The lagrange multiplier of the household problem:

$$\lambda_{ss} = \left(c_{ss} - \frac{(h_{ss}^{N})^{\omega^{N}}}{\omega^{N}} - \frac{(h_{ss}^{T})^{\omega^{T}}}{\omega^{T}}\right)^{-\sigma} \tag{151}$$

Total investment:

$$II_{ss} = i_{ss}^{N} + i_{ss}^{T} \tag{152}$$

Total production (GDP):

$$YY_{ss} = p_{ss}^{N}y_{ss}^{N} + p_{ss}^{T}y_{ss}^{T} \tag{153}$$

Total non-tradable goods:

$$YN_{ss} = p^N_{ss} y^N_{ss} \tag{154}$$

Total tradable goods:

$$YT_{ss} = p^T_{ss} y^T_{ss} \tag{155}$$

Trade balance to output ratio:

$$tby_{ss} = \frac{tb_{ss}}{YY_{ss}} \tag{156}$$

Current account to output ratio:

$$cay_{ss} = \frac{ca_{ss}}{YY_{ss}} \tag{157}$$

Total labor:

$$H_{ss} = h^N_{ss} + h^T_{ss} \tag{158}$$

Total exports:

$$XX_{ss} = p^T_{ss}(y^T_{ss} - z^T_{ss}) \tag{159}$$

Total imports:

$$MM_{ss} = pm^N m^N_{ss} + pm^T m^T_{ss} \tag{160}$$

The real exchange rate:

$$RER_{ss} = p^T_{ss} \tag{161}$$

APPENDIX 3: ETHICS COMMISSION FORM

	HACETTEPE ÜNİVERSİTESİ SOSYAL BİLİMLER ENSTİTÜSÜ	Doküman Kodu *Form No.*	FRM-DR-12
		Yayım Tarihi *Date of Pub.*	22.11.2023
	FRM-DR-12 Doktora Tezi Etik Kurul Muafiyeti Formu *Ethics Board Form for PhD Thesis*	Revizyon No *Rev. No.*	02
		Revizyon Tarihi *Rev.Date*	25.01.2024

HACETTEPE ÜNİVERSİTESİ
SOSYAL BİLİMLER ENSTİTÜSÜ
İKTİSAT ANABİLİM DALI BAŞKANLIĞINA

Tarih: 24/06/2024

Tez Başlığı: Yükselen Ekonomilerde Reel İş Çevrimi Modelleri

Yukarıda başlığı verilen tez çalışmam:

1. İnsan ve hayvan üzerinde deney niteliği taşımamaktadır.
2. Biyolojik materyal (kan, idrar vb. biyolojik sıvılar ve numuneler) kullanılmasını gerektirmemektedir.
3. Beden bütünlüğüne veya ruh sağlığına müdahale içermemektedir.
4. Anket, ölçek (test), mülakat, odak grup çalışması, gözlem, deney, görüşme gibi teknikler kullanılarak katılımcılardan veri toplanmasını gerektiren nitel ya da nicel yaklaşımlarla yürütülen araştırma niteliğinde değildir.
5. Diğer kişi ve kurumlardan temin edilen veri kullanımını (kitap, belge vs.) gerektirmektedir. Ancak bu kullanım, diğer kişi ve kurumların izin verdiği ölçüde Kişisel Bilgilerin Korunması Kanuna riayet edilerek gerçekleştirilecektir.

Hacettepe Üniversitesi Etik Kurullarının Yönergelerini inceledim ve bunlara göre çalışmamın yürütülebilmesi için herhangi bir Etik Kuruldan izin alınmasına gerek olmadığını; aksi durumda doğabilecek her türlü hukuki sorumluluğu kabul ettiğimi ve yukarıda vermiş olduğum bilgilerin doğru olduğunu beyan ederim.

Gereğini saygılarımla arz ederim.

Oğuz Kaan KARAKOYUN

Öğrenci Bilgileri				
	Ad-Soyad	Oğuz Kaan Karakoyun		
	Öğrenci No	N17147044		
	Enstitü Anabilim Dalı	İktisat		
	Programı	İktisat (İngilizce) - Doktora		
	Statüsü	**Doktora** ☒	**Lisans Derecesi ile (Bütünleşik) Dr**	☐

DANIŞMAN ONAYI

UYGUNDUR.
Doç. Dr. Mustafa Aykut ATTAR

* Tez **Almanca** veya **Fransızca** yazılıyor ise bu kısımda tez başlığı **Tez Yazım Dilinde** yazılmalıdır.

	HACETTEPE ÜNİVERSİTESİ SOSYAL BİLİMLER ENSTİTÜSÜ	Doküman Kodu *Form No.*	FRM-DR-12
		Yayım Tarihi *Date of Pub.*	22.11.2023
	FRM-DR-12 Doktora Tezi Etik Kurul Muafiyeti Formu *Ethics Board Form for PhD Thesis*	Revizyon No *Rev. No.*	02
		Revizyon Tarihi *Rev.Date*	25.01.2024

HACETTEPE UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
DEPARTMENT OF ECONOMICS

Date: 24/06/2024

ThesisTitle (In English): Real Business Cycle Models in Emerging Economies

My thesis work with the title given above:

1. Does not perform experimentation on people or animals.
2. Does not necessitate the use of biological material (blood, urine, biological fluids and samples, etc.).
3. Does not involve any interference of the body's integrity.
4. Is not a research conducted with qualitative or quantitative approaches that require data collection from the participants by using techniques such as survey, scale (test), interview, focus group work, observation, experiment, interview.
5. Requires the use of data (books, documents, etc.) obtained from other people and institutions. However, this use will be carried out in accordance with the Personal Information Protection Law to the extent permitted by other persons and institutions.

I hereby declare that I reviewed the Directives of Ethics Boards of Hacettepe University and in regard to these directives it is not necessary to obtain permission from any Ethics Board in order to carry out my thesis study; I accept all legal responsibilities that may arise in any infrigement of the directives and that the information I have given above is correct.

I respectfully submit this for approval.

Oğuz Kaan KARAKOYUN

Student Information				
	Name-Surname	Oğuz Kaan Karakoyun		
	Student Number	N17147044		
	Department	Economics		
	Programme	Economics - PhD		
	Status	**PhD** ☒	**Combined MA/MSc-PhD** ☐	

<u>SUPERVISOR'S APPROVAL</u>

APPROVED
Assoc. Prof. Dr. Mustafa Aykut ATTAR

APPENDIX 4: ORIGINALITY REPORT

	HACETTEPE ÜNİVERSİTESİ SOSYAL BİLİMLER ENSTİTÜSÜ	Doküman Kodu *Form No.*	FRM-DR-21
		Yayım Tarihi *Date of Pub.*	04.01.2023
	FRM-DR-21 Doktora Tezi Orijinallik Raporu *PhD Thesis Dissertation Originality Report*	Revizyon No *Rev. No.*	02
		Revizyon Tarihi *Rev.Date*	25.01.2024

HACETTEPE ÜNİVERSİTESİ
SOSYAL BİLİMLER ENSTİTÜSÜ
İKTİSAT ANABİLİM DALI BAŞKANLIĞINA

Tarih: 24/06/2024

Tez Başlığı: Yükselen Ekonomilerde Reel İş Çevrimi Modelleri

Yukarıda başlığı verilen tezimin a) Kapak sayfası, b) Giriş, c) Ana bölümler ve d) Sonuç kısımlarından oluşan toplam 111 sayfalık kısmına ilişkin, 23/06/2024 tarihinde şahsım/tez danışmanım tarafından Turnitin adlı intihal tespit programından aşağıda işaretlenmiş filtrelemeler uygulanarak alınmış olan orijinallik raporuna göre, tezimin benzerlik oranı % 9'dur.

Uygulanan filtrelemeler**:

1. ☐ Kabul/Onay ve Bildirim sayfaları hariç
2. ☒ Kaynakça hariç
3. ☒ Alıntılar hariç
4. ☐ Alıntılar dâhil
5. ☒ 5 kelimeden daha az örtüşme içeren metin kısımları hariç

Hacettepe Üniversitesi Sosyal Bilimler Enstitüsü Tez Çalışması Orijinallik Raporu Alınması ve Kullanılması Uygulama Esasları'nı inceledim ve bu Uygulama Esasları'nda belirtilen azami benzerlik oranlarına göre tezimin herhangi bir intihal içermediğini; aksinin tespit edileceği muhtemel durumlarda doğabilecek her türlü hukuki sorumluluğu kabul ettiğimi ve yukarıda vermiş olduğum bilgilerin doğru olduğunu beyan ederim.

Gereğini saygılarımla arz ederim.

Oğuz Kaan KARAKOYUN

Öğrenci Bilgileri			
Ad-Soyad	Oğuz Kaan Karakoyun		
Öğrenci No	N17147044		
Enstitü Anabilim Dalı	İktisat		
Programı	İktisat (İngilizce) - Doktora		
Statüsü	**Doktora** ☒	**Lisans Derecesi ile (Bütünleşik) Dr** ☐	

DANIŞMAN ONAYI

UYGUNDUR.
Doç. Dr. Mustafa Aykut ATTAR

*Tez **Almanca** veya **Fransızca** yazılıyor ise bu kısımda tez başlığı **Tez Yazım Dilinde** yazılmalıdır.
**Hacettepe Üniversitesi Sosyal Bilimler Enstitüsü Tez Çalışması Orjinallik Raporu Alınması ve Kullanılması Uygulama Esasları İkinci bölüm madde (4)/3'te de belirtildiği üzere: Kaynakça hariç, Alıntılar hariç/dahil, 5 kelimeden daha az örtüşme içeren metin kısımları hariç (Limit match size to 5 words) filtreleme yapılmalıdır.

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		Yayım Tarihi *Date of Pub.*	04.01.2023
	FRM-DR-21 Doktora Tezi Orijinallik Raporu *PhD Thesis Dissertation Originality Report*	Revizyon No *Rev. No.*	02
		Revizyon Tarihi *Rev.Date*	25.01.2024

TO HACETTEPE UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
DEPARTMENT OF ECONOMICS

Date: 24/06/2024

Thesis Title (In English): Real Business Cycle Models in Emerging Economies

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Student Information				
Name-Surname	Oğuz Kaan Karakoyun			
Student Number	N17147044			
Department	Economics			
Programme	Economics - PhD			
Status	**PhD** ☒		**Combined MA/MSc-PhD** ☐	

SUPERVISOR'S APPROVAL

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Assoc. Prof. Dr. Mustafa Aykut ATTAR

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