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ASSESSMENT OF MONETARY POLICY INSTRUMENTS OF AN EMERGING MARKET ECONOMY UNDER FINANCIAL CONSTRAINTS

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Assessment of Monetary Policy Instruments of an Emerging Market Economy under Financial Constraints

Bir Gelişmekte Olan Ekonominin Finansal Kısıtlar Altında Para Politikası Araçlarının İncelemesi

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PREFACE

This dissertation was only possible because I was surrounded with the right people and I would like to thank everyone who contributed to the development and publication of it.

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ABSTRACT

Emerging market economies, often small open economies, are subject to shocks from foreign developments. In response to these developments, they may use the typical monetary and fiscal policies, and increasingly they also employ macroprudential policies. In this study, we first start with building a model of an emerging market economy with Banks and foreign borrowing, and calibrate this model to the Turkish economy in the last two decades. We incorporate shocks to foreign interest rates, foreign demand for local goods, total factor of production, domestic demand, and labor supply. Then, we investigated the effects of these monetary and macroprudential policies in response to shocks, and analyzed them using the Turkish economy. Macroprudential policies have been employed in Türkiye starting from early 2010's and are increasingly in use as of 2022. On the other hand, we observe that the way they are used, often as a response rather than precautionary, can lead to unintended consequences. We also analyze the COVID19 episode using these monetary and macroprudential policies. Looking at the shocks to the economy, both serially and simultaneously, we analyzed the combined effect of these shocks and effectiveness of the policies to counter them.

Keywords: Monetary Policy, Macroprudential Policy, Reserve Requirements, New Keynesian Economics, Emerging Market

ÖZET

Gelişmekte olan ekonomiler, genellikle küçük ve açık ekonomiler, dışsal şoklara maruz kalabilirler. Bu tür gelişemelere karşı tipik olarak para ve maliye politikalarında düzenleme yaparlar. Son yıllarda ise bu politikalara ilave olarak giderek makroihtiyati politikalara da yer vermektedirler. Bu çalışmada öncelikle içerisinde bankalar ve dış borçlanma olan bir gelişmekte olan ekonomi modeli geliştirdik ve bu modeli Türkiye ekonomisinin son iki on yılını temsil edecek şekilde kalibre ettik. Modelin içerisinde dış borçlanmanın faiz oranına, ihracat talebine, toplam üretim faktörlerine, ülke içi toplam talebe, ve de işgücü arzına şoklar verdik; bu şokları karşılamak üzere ülkedeki politika yapıcıların uygulayabileceği politikaların etkinliklerini Türkiye ekonomisini örnek olarak kullanarak analiz ettik. Türkiye'de makroihtiyati politikalar 2010'ların başında yoğun olarak kullanılmaya başlandı ve 2022 itibariyle artan bir yoğunlukta kullanılmaya devam ediyor. Bununla birlikte, makroihtiyati politikaların kullanım şekli itibariyle, şoklara önlem değil tepki olarak kullanımı, istenenden farklı sonuçlar doğurabileceğini de gözlemledik. Sonrasında bu şokları ve politikaları COVID19 dönemini analiz etmekte kullandık, COVID19 politikalarının ayrı ayrı ve birlikte gelen şokları karşılamakta ne kadar etkili olduğunu inceledik.

Anahtar Kelimeler: Para Politikası, Makro İhtiyati Politika, Zorunlu Karşılıklar, Yeni Keynesyen Ekonomi, Gelişmekte Olan Ekonomi

INTRODUCTION

We live at a time modern countries have market economies when conducting their business activities, in which goods and services are priced according to some measure. This is common for most economies, from the mostly-free-market western countries of Europe and the US, to formerly centrally-planned Russia and China. On the other hand, how these markets operate is different everywhere, with every country implementing its own version of market dynamics, various checks and balances, regulations, and policies.

Policies addressing the fiscal aspects of government revenues and expenditures are often grouped under fiscal policy; those addressing money supply, money creation, and monetary transmissions are grouped under monetary policy; and the various mechanisms that aim to mitigate financial risks of the economy as a whole, which may overlap with monetary and fiscal domains, are the macroprudential policies. Similarly to their domains, their objectives are different as well: While fiscal policy strive to achieve desired government funding and spending, monetary policy's objective is price stability, and macroprudential policy aims to build a more resilient financial system.

The tools these policies use vary as well. Fiscal policy is conducted via taxes and government budgeting. The tax codes themselves are often complicated, but when representing them in the macroeconomic models we resort to aggregated tax rates. Similarly for monetary policy, which is conducted by Central Banks via interest rates, which we represent by a short-term reference interest rate set by the monetary authority in order to gain the policy objective of inflation targeting, price level targeting, production/income targeting, or exchange rate targeting.

Macroprudential measures are different everywhere, with every country building its policies and regulations around the financial conditions they find themselves in. Practices in this vein were always present in economies, but it was after the crisis of 2008-2009 they became prominent. In the runup to the crisis, according to (Bank of England 2009), increasingly leveraged financial institutions, as well as the mismatches in liquidity conditions, led to increased systemic risk, culminating with the Great Recession[1]. Neither tax rates nor interest rates were

[1]Term that refers to the financial crisis of late 2000's, likening it to the Great Depression, which

sufficient enough address the ever-growing assets in the bank balance sheets, in the Great Moderation[2] period they had freely increased their leverage ratios in the absence of large shocks to their liquidity or solvency, and they became exposed to shocks. A key policy element, that which would prevent banks from becoming overly exposed, were missing from the policy mix.

A similar crisis had occured in Türkiye earlier in the decade: Banks were not ready for a severe financial shock in 2001-2002, and in the ensuing crisis 25 banks went bankrupt, greatly instabilizing the financial sector (Özatay and Sak 2002). This crisis wasn't just for a lack of macroprudential measures, of course, it had deeper roots in the monetary policy applied in the years before it, structure in which the Central Bank and and Treasury were placed, other (non-monetary) policies pursued by the coalition governments, and even the effects of two large earthquakes.[3] Following this crisis, by the advice of IMF, Türkiye founded the BRSA to specifically supervise banks, overhauled banking regulation, and positioned the Central Bank more independently.

These macroprudential measures, particularly those work coherently with the monetary policy, indeed make a difference. All these structural reforms made the Turkish banking sector more resilient, to the point that while the Global Recession did indeed cause a GDP drop[4] in Türkiye, no bank went bankrupt. On the other hand, these policies may come at a cost: They slow down growth, prevent a hasty recovery when a crisis happens anyway, and in general carry opportunity costs or risks that may materialize at an undesired time.[5]

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became popular following the usage by International Monetary Fund in their World Economic Outlook(IMF 2009) report.

[2]Term first used by (Stock and Watson 2002) and brought to attention by Ben Bernanke's speech (Bernanke 2004), used commonly to refer to the moderation period between 1980's and late 2000's until the financial crisis, where the US economy grew consistently at 2.2% annually, and there was relatively little volatility in the markets.

[3]See (Dibooglu and Kibritcioglu 2004) for an analysis of developments from 1980 to 2002 in the Turkish economy, and (Akyüz and Boratav 2003) for an analysis of how the crisis came along, tying it to financial fragility as a result of lacking policies and institutions.

[4]European Commission report of October 2009 (European Commission 2009) ties the GDP drop mostly to contraction in external demand, but local demand also dropped during this period. This is one of the reports mentioning that with the economy avoiding a full on financial crisis, the structural reforms must have worked.

[5](Galati and Moessner 2013a) provides a literature review of papers on macroproduential policies. For some country-specific examples, see (Lim et al. 2011). Also, (Arregui et al. 2013) provides a framework in which the net effects of macroeconomic policies could be evaluated.

Unlike fiscal policies which are largely determined as tax rates, and monetary policies which are largely determined as interest rates, macroprudential policies can take a variety of forms. Among popular applications are capital controls, caps on lending to certain groups, limits on maturities, countercyclical capital requirements for financial institutions, incentives or drawbacks on credit growth, reserve requirements, and various other methods to achieve policy goals. Sometimes, such as limitations on interest rates or modified reserve requirement rules, macroprudential policies overlap with monetary policies; however a distinction must be made in the objectives of these policies. Some of the methods are shown in Figure I.1 below, taken from IMF[6].

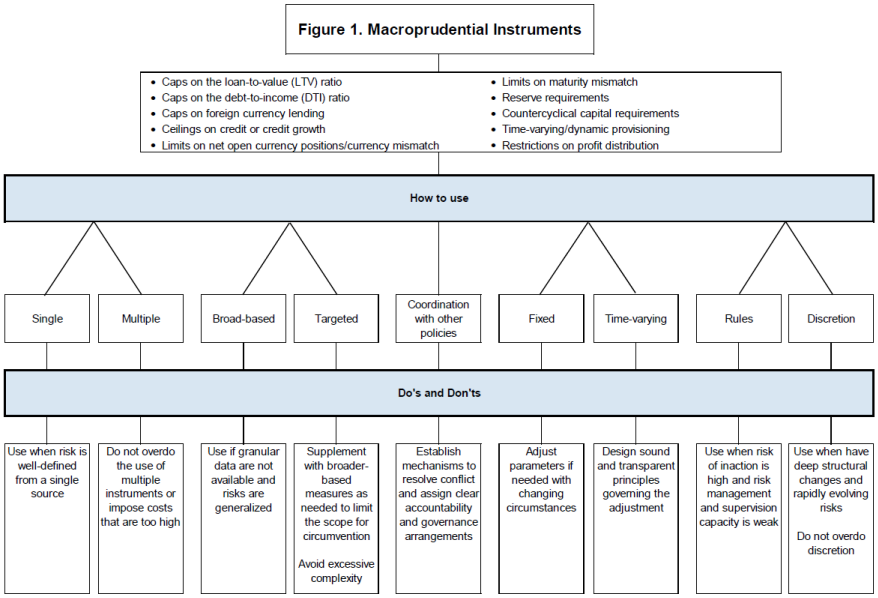

Figure I.1: Macroprudential Policy Instruments (IMF)

Monetary and macroprudential policies of Türkiye, which will be our focus in this study, incorporated various such mechanisms. During most of last decade, for instance, Central Bank of Türkiye incorporated multiple interest rates, known as the interest rate corridor, as well as different funding rates at different maturities. It also active managed reserve requirement ratios, differing them for Turkish Lira and foreign currency liabilities, all of which are rarely changed in many other economies. Following the political crisis of 2018 and the decline of Turkish Lira,

[6]Practices vary greatly among countries and time periods. For a list of instruments used by various countries, see (Villar 2018). For a general guideline on implementing macroprudential policies, see (Krishnamurti and Lee 2014) and (IMF 2009).

they introduced policies in limiting and in some cases inhibiting rules on currency swaps in order to prevent speculators from shorting Turkish Lira. Most recently, during 2020, with the COVID19 pandemic in effect, regulators actively and directly encouraged credit growth through the modified reserve requirement rules and the newly introduced Asset Ratio[7].

There are many studies on monetary and macroprudential policies in the literature, most of which being reports related to certain implementations and empirical analyses, and a smaller number of them including them in modern macroeconomic models. An even smaller number of them focus on emerging economies, with most of them giving more attention to the practices of advanced economies. Emerging market economies are largely small open economies: They participate in international trade and they are open to shocks in the international markets, but they are small enough that they cannot influence international prices on their own. We want this property to be present in our model, as it will allow us to study the effect of external demand shocks, as well as various developments affecting exchange rates.

This last part is an area we are particularly interested in: Turkish Lira has been very volatile in recent years, and most of the difficult periods in the economy also had an accompanying decline of Turkish Lira. We want to be able to capture the effects of variations in national currency at a time when other economic factors are also changing. In particular, we want to be able to study how the regular practice of borrowing in foreign currency, converting it to local loans via currency swaps, and lending it locally is affected by the sudden increases in foreign currency exchange rates.

Finally, we want to be able to examine how the monetary, fiscal, and macroprudential policies help diminish the effects of these financial conditions. For instance, the accomodative policies of the government in 2020 led to a great expansion of credit, at the same time increasing inflation, and increasing foreign exchange rates. All of these happened at a time when the economy has been going

[7]Asset Ratio was a regulatory metric introduced by BRSA (Banking Regulation and Supervision Agency, Türkiye 2020) in April 2020 and kept until end of 2020. It aimed to ”minimize the impact of COVID-19 pandemic to the economy, markets, production, and jobs, and most efficiently utilize the assets banks hold”, a textbook macroprudential policy objective. It started off very strict, eased during upcoming months, and discontinued by end of 2020.

through an unprecedented shock, both domestically and in the international scene. How the the applied policy mix help? How prepared were we? Will there be lasting damage to the economy? Was there a better policy mix? Is there one now? Would the government's response be different if the country wasn't already stressed by the time pandemic hit? Similarly during the second half of 2018, when there was political friction with the US, how could the economic policies help alleviate the issues?

While there are some studies measuring the impact of policies, there are few for an economy similar to that of Türkiye, even fewer that includes the multitude of properties we mention here, and to our knowledge, none that combines all of these aspects in one unified model and apply a multiple policy mix. This is where we hope to contribute to the field.

In this study, we start with a New Keynesian model with monetary and fiscal policies which also incorporate foreign borrowing, and we extend it to include the monetary and macroprudential policy mechanisms similarly to how they were implemented in Türkiye during the last decade, with a particular focus on 2018 onwards.

At the end, we aim to have a model that incorporates different monetary policy tools incorporating the macroprudential measures, which in return replicates the Turkish economy well enough, with counterfactual experiments on key policy decisions.

OBJECTIVE

Our objective is to build a model of Turkish economy that features fiscal, monetary, and macroprudential policies, analyze the effects of recent policy responses of Turkish regulators to various shocks the economy has lived through, particularly in the dimensions of GDP, foreign exchange rate, domestic interest rates, inflation, and the actual policy mixes that were implemented. Because Turkish economic policies have been unorthodox for most of last few years, it is important to have a strong baseline economic model that can incorporate all of these features, so that we can analyze the effects of various policies properly.

Monetary policy is often the topic of New Keynesian macroeconomic models and there's extensive literature on this topic, so this is our starting point. We want our economy to have a financial sector to carry the monetary transmission mechanisms, but it should also be able to support unconventional policies that may be employed by the Central Bank, which is why we followed the literature opened by (Gertler and Kiyotaki 2010) and (Gertler and Karadi 2011a). In addition, the model must be of a small open economy which includes borrowing from foreign entities, which brought us to (Aoki, Benigno, and Kiyotaki 2016) article. Building upon these, we build the various monetary and macroprudential policies used in the Turkish economy, notably the extended reserve requirements rules, and the asset ratio as implemented in most of 2020.

An important aspect of our work will be the analysis of COVID19 crisis from monetary and financial viewpoint, and the policy responses formulated to overcome the burden it created. It will have similar characteristics to the 2009 recession in Türkiye, as there is greatly reduced external demand and also reduced domestic demand. On the other hand, it will also have contraction in supply, as preliminary studies show that the larger part of the COVID19 shock consists of supply shocks[8], as a result of the lockdowns imposed. In Türkiye lockdowns were not as strict as they were in China or Europe, it was more similar to the US response. Still, it will be good exercise to check how the economy would be shaped under different lockdown scenarios. We do not intend to build a full

[8] We will dedicate a section to COVID19 shock and we will study it in detail. For now, see (Brinca, Duarte, and Castro 2020a) for a breakdown of supply and demand shocks arising from COVID19 pandemic.

SIR/SEIR[9] model to predict the effects of various levels of lockdowns; we will use the results presented by the papers that do these studies, and place in our model as TFP and/or labor shocks.

We will cover in greater detail the policy responses of the government. Türkiye's response to the COVID19 crisis was similar to that of other countries', but also different in one aspect: Most countries put the financial burden on the government, and used their reserves to combat the economic effects of the pandemic; while in Türkiye the relief mostly came in the form of bank loans since the government was already under enormous pressure by the time COVID19 hit. Even tough these were cheaper loans than what would have been for it not the government policies, they are still loans that must be paid back or rolled over in the future, potentially with a higher interest rate. This difference in policy response was at least partially because the government had used most of its reserves in previous years combatting the negative results of previous policies and also of political tension between Türkiye and the US.

As part of our analysis, we aim to run some counterfactual simulations and debate on how different economic indicators would appear without these political events, or if COVID19 crisis never came, or if different policies were implemented. We will also run a variety of different policy mixes in response to the shocks, in an attempt to measure how much the actual policy response helped. We likely will not examine every single possible path, but we will try to cover all the main and/or controversial decisions.

We end this section by mentioning that ours won't be a study of COVID19, but rather that of an emerging market economy under financial stress which also had to endure a pandemic. We will link our work with the COVID-related papers when relevant, however, our main focus will be on policy responses themselves.

[9]SIR: Susceptible-Infected-Recovered, SEIR: Susceptible-Exposed-Infected-Recovered. For a recent paper modelling Turkish economy using a SIR methodology for COVID19 pandemic, see (Cakmakli et al. 2020b), and their earlier paper (Cakmakli et al. 2020c). Note that these studies consider R(Recovered) a sink node, where the recovered patients do not become exposed again. Later studies found that might no be the case, and recovered patients may become infected after a period of time.

RELATED LITERATURE

We have established earlier that we want a macroeconomic model with fiscal, monetary, and selected macroprudential policies, one that also incorporates foreign borrowing, government intervention to firm funding, and banks as financial intermediaries converting foreign currency demoninated borrowing to local currency denominated loans. Since we specifically want to study the short-to-medium term effects of applied policies, we also want frictions in the market, both in terms of cost of changing policy and changing funding, also in terms of price stickiness of goods and services, attributes which are most often found in New Keynesian models.

Concepts used in New Keynesian models go as far back as (Mankiw 1985), which makes use of the term ”menu costs” to identify the situation in which changing prices in an economy has its own costs, and due to these costs prices do not change instantaneously. These menu costs show themselves in firm price stickiness, costs of changing funding levels, and costs of changing policy. For instance, (Calvo 1983) introduces staggered prices, in which at every period only fraction firms update their prices, and others continue with the old prices. There are also convexities in the economy, where changing one variable shifts the equilibrium, which then reinforces back and causes another shift in variable value, such as described in (Romer 1990). These nonconvexities lie in the heart of our policies, where optimal policy needs to be evaluated by taking into account the second order effects. Following these two concepts, (Calvo 1998a) and (Calvo 1998b) discuss sudden stops, in which economies are not supposed to suddenly change course because of frictions caused by menu costs, and crisis happens if they do.

A common theme in all these concepts is that they introduce frictions, and agents in the economy do not immediately respond to the developments in the market. (Taylor 1993) offers a rule of thumb for monetary policy, which again effectively introduces frictions in policy, but also expectations of future developments. We make use of these concepts within our model to implement time lags and friction costs, ranging from simple AR(1) processes to complex dynamic systems.

Modern New Keynesian models start appearing in early 2000's. (Bernanke, Gertler, and Gilchrist 1999) introduces the concept of financial accelarators, where the shocks to credit market amplifies and propagates shocks to the macroeconomy, also incorporating money and prices stickiness to the model. (Clarida, Gali, and Gertler 2000) formulates the monetary policy as a function of expected inflation and output to find out monetary policy incentives changed before and after Volcker period. (Christiano, Eichenbaum, and Evans 2005) incorporate nominal rigidities in their model to examine why inflation is persistent, and opens up a new line of literature.

In a small open economy setting, (Gali and Monacelli 2005) builds a model with monetary policy and exchange rate volatilies in the existence of sticky prices. It examines three different types of monetary policies: Domestic inflation targeting, CPI targeting, and exchange rate peg. This paper is what inspired us to make policy experiments in an analytical setting and debate which policies end up with the most beneficial results, even though we ended up not using the model structure present in this model.

The model that we did end up using here follows literature opened by (Gertler and Kiyotaki 2010) and (Gertler and Karadi 2011b) on how the financial intermediaries are represented in the model setup. The unconventional monetary policy in the latter, as well as those in (Gertler and Karadi 2018), (Gertler and Kiyotaki 2015) and (Gertler, Kiyotaki, and Queralto 2012), are examples of what we could use when modelling the truly unconventional policy practices implemented by the Turkish regulators. Of course, the unconventional policies in these papers mostly refer to the US economy and the quantitative easing employed by the FED, which do not use directly in our work without modifying them for the Turkish economy.

The model that we take and build upon is (Aoki, Benigno, and Kiyotaki 2016), which progresses the same literature, applying it in a small open economy setting, extending it with foreign borrowing, in order to formulate the "original sin" of emerging markets, whereby the economy borrows from foreign investors in the form of foreign currency denominated loans, converts them to domestic currency, and lends to domestic actors, becoming dependent on foreign flows and sensitive to exchange rates. This is precisely the case for the modern Turkish economy, in

which local firms with domestic currency revenues are indebted in foreign currencies, and with the currency shocks since 2018 they fell under tremendous amount of stress. This paper puts the burden of foreign exchange risk on the banks and not the firms, but overall effects of foreign exchange risks can be observed.

This model does not incorporate sovereign and/or firm defaults, which we had originally intended to do, such as in (Arellano, Bai, and Mihalache 2020) which combines (Arellano 2008) and (Gali and Monacelli 2005) into a model that brings together sovereign default and monetary policy. In the case of Türkiye, while the CDS premiums are high enough to consider the default risks, it is also true that public debt to GDP ratio is low and we don't consider the government's incentive to default high enough to put more weight into this part. We may later come back to this, but for now we do not follow this path.

We also make use of the open economy financial accelarator models such as in (Aghion, Bacchetta, and Banerjee 2001) and (Gertler, Gilchrist, and Natalucci 2007), and the Calvo sudden stop model's implementation as in (Mendoza 2010).

There's growing literature on joint modelling of monetary and macroprudential policies, something we want to do in our work. Some contributors here, for an open economy, are (Unsal 2011), (Medina Guzman and Roldos 2014), (Céspedes, Chang, and Velasco 2017), (Chang and Velasco 2017), and (Davis and Presno 2017). One thing we should note, however, is when macroprudential measures are mentioned, first thing that usually comes to mind is capital controls, which was not implemented in Türkiye in the strict sense of the phrase; in fact the Turkish government took great care[10] to emphasize that it was never even in the options. Similarly, (Korinek and Sandri 2016)[11] argues that capital controls and macroprudential regulation are inherently different in how they separate the

[10]The term "capital controls" carry a negative connotation politically, often implying that a country may limit the flow our foreigner's funds without advance notice, which is why Türkiye has been carefully avoiding usage of this term, although the academic meaning of the term is more neutral. In a move away from this negative connotation, IMF (Pasricha and Nier 2022) adopted another term, capital flow management measures, in place of capital controls.

[11](Korinek and Sandri 2016) argues that capital controls control flows between domestic and foreign markets, with the goal of protecting the domestic markets from disruptive effects of foreign fund flows both into and out of the country; while macroprudential regulation control flows between borrowers and lenders, domestic or international, with the goal of protecting the robustness of the financial structure and avoid excessive debt. This is a neat distinction separating the two often interchangibly used terminologies, although regulations may carry elements from both.

domestic lenders, domestic borrowers, and foreign agents; a view we share here. While we draw some insight from these models, we develop our own methods when implementing the policies in the model.

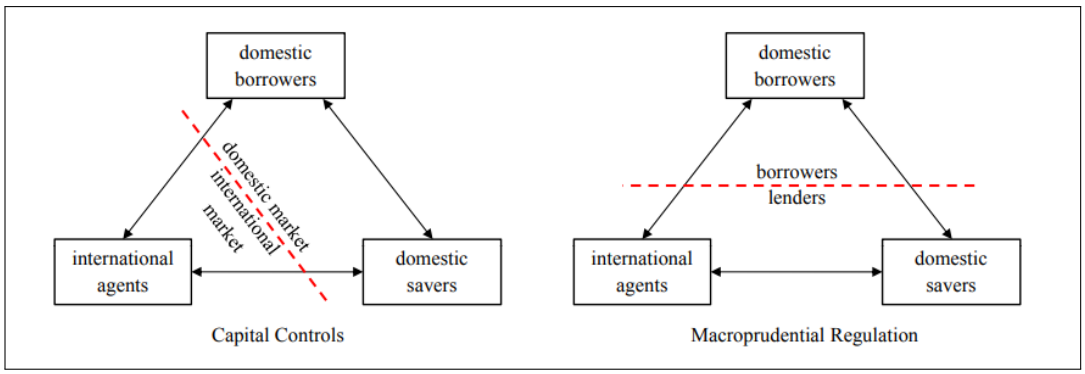

Figure I.2: Capital Controls vs Macroprudential Regulation (Korinek and Sandri 2016)

ECONOMIC ENVIRONMENT

In recent years Turkish economy experienced two periods of stress. First, following the expansionary policies starting with 2017 and an overheated economy, the increase in political tension with the US resulted in a currency crisis, when inflation and interest rates rose and Turkish Lira depreciated. During this period economic growth also slowed down, actually helping the current account deficit. Second, COVID19 hit the world in 2020 and Türkiye was no exception. All economies, including Türkiye, faced both negative supply shocks and negative demand shocks, and their GDP's taking massive hits.

Figure I.3 below shows the headline CPI peaking above 25% in the forth quarter of 2018. We can also see that inflation was already in the rise before relations with the US soured, and it was already going to be a difficult time for the economy, but with the political crisis, it also trigered a sharp decline in the currency, with Turkish Lira depreciating by 80% year-on-year at its peak. It recovered afterwards, but the Central bank had to burn through most of their reserves by the end of it.

A depreciating currency is the hallmark of financial worries in Türkiye, since

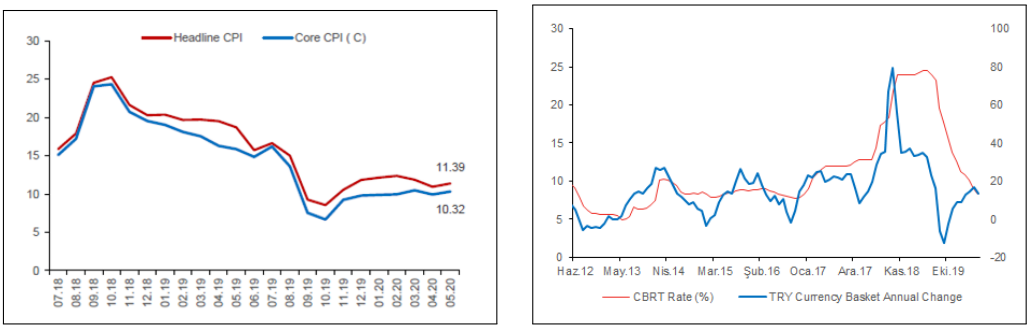

Figure I.3: Inflation, Central Bank policy, and FX rate

external financing is prevalent, and even domestic investors increase their weights in foreign currencies when they foresee hard times ahead. Figure I.4 below, taken from (Cakmakli et al. 2020b), shows the composition of external debt. Majority of it is in US Dollars, and most of the rest is in other foreign currencies dominated by EUR and XAU[12], and only a fraction of it in Turkish Lira. At the same time, share of public debt within the decomposition is relatively low, indicating that the depreciating currency hits the firms borrowing in foreign currency the most.

This concept is the so called Origin Sin in some economic literature, whereby ”most countries are not able to borrow abroad in their domestic currency” (Eichengreen and Hausmann 1999)[13], and resort to debt in foreign currency, generating foreign exchange risk for whoever is converting it to domestic currency and as a result carrying an FX position.

COVID19 pandemic came along in early 2020, and Türkiye was hit together with every other country, after keeping itself out of it until March. First quarter of 2020 saw a modest growth in GDP, but starting with April great shocks to both supply and demand materialized. Industrial production fell by almost 30% in the second quarter, as seen in figure I.5 below.

Combined shocks to production, demand, foreign exchange rates, and interest rates would be extremely hard to deal with for the exposed firms. Emerging markets, Türkiye included, saw great risk-off shocks, with the 5 year Turkish CDS

[12]ISO 4217 standard code for gold, considered a currency for most practical purposes

[13]This is the first of a series of papers by Eichengreen, Haussman and Panizza about the term Original Sin. For others, see (Eichengreen, Hausmann, and Panizza 2003),(Eichengreen, Hausmann, and Panizza 2002), and (Hausmann and Panizza 2002).

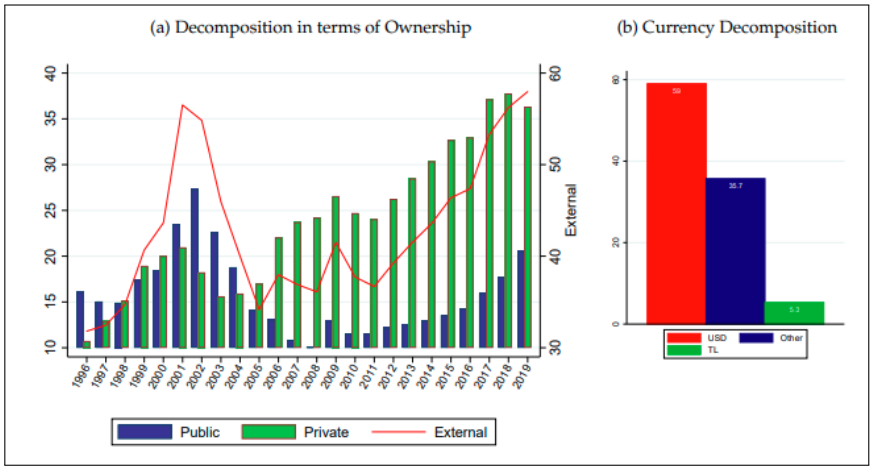

Figure I.4: External Debt Decomposition (Cakmakli et al. 2020b)

premiums going over 600. Overall, as (Cakmakli et al. 2020b) mentions, there was still quite a bit of external foreign investment going on, so it was important to keep the FX investments in the country, as scaring them off would mean a spiralling depreciation of Turkish Lira, leading to massive bankruptcies. In hindsight, looking back after one year, it appears that Türkiye managed to keep the investors in the country. It also helped that both FED and ECB followed extremely loose monetary rules[14], setting interest rates close to (FED) or below (ECB) 0%, and following otherwise expansionary policies.

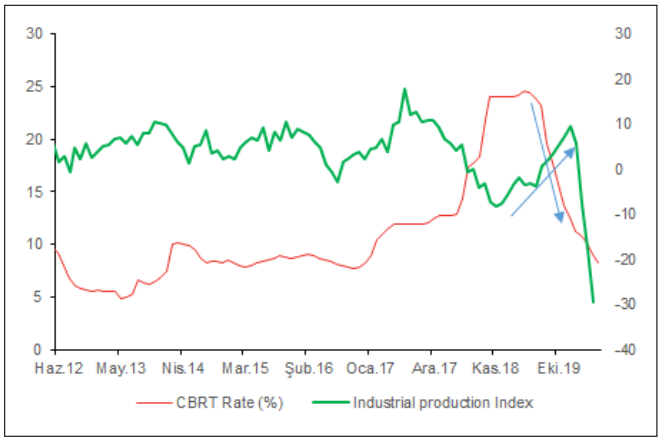

Figure I.5: Demand and Production

[14]See (Federal Reserve 2020) and (Fleming, Sarkar, Van Tassel, et al. 2020) for FED's policy response, and (Aguilar et al. 2020) for ECB's.

POLICY RESPONSES TO DEVELOPMENTS

By the time COVID19 pandemic hit, Turkish economy was already troubled. It was overheating due to the policies implemented since 2017, with inflation on the rise, and the political issues of 2018 had led to an exchange rate crisis, in which rapidly declining Turkish Lira created extra stress on the firms that were under foreign currency debt. Monetary and fiscal policies, as well as certain macroprudential measures such as limitations on currency swaps and fx interventions, were implemented to accomodate the economic recovery.

In response, Central Bank quickly loosened policy (see figure I.6 below), cutting their rates in March and again in April, in order to facilitate cheaper funding to banks and in return cheaper loans to firms and/or households. It also opened up swap lines with even cheaper rates, and eased collateral requirements for Central Bank funding, effectively providing unlimited funding to banks so that they wouldn't be liquidity-stressed during a time where they were expected to be creating credit quickly. Change in reserve requirement policy before COVID19 was already accomodative, and with the introduction of Asset Ratio on top of it, credit growth increased immensely, funding the firms.

From the fiscal policy aspect, the stimulus package was similar to those of other countries'. Taxes on imported goods were increased in order to boost demand on domestic goods and also because it was undesirable to keep imports at pre-crisis levels when exports plunged. Taxes of many sectors were deferred until later, and some saw tax breaks as well. Limits on Credit Guarantee Fund were increased to make room for even more bank lending. Overall expenditure by the government has been limited to around 5% of GDP, a comparatively small number given most of the advanced economies spend well over 10% of their GDP, lead by Germany which spent 32% of its GDP to COVID19 relief[15].

Policy Tool Focus: Reserve Requirements

Reserve requirements are regular monetary policy tools used by central banks to regulate money creation and credit growth. By requiring banks to keep a portion

[15](IMF 2020) keeps track of all policies that were adopted as a response to COVID19.

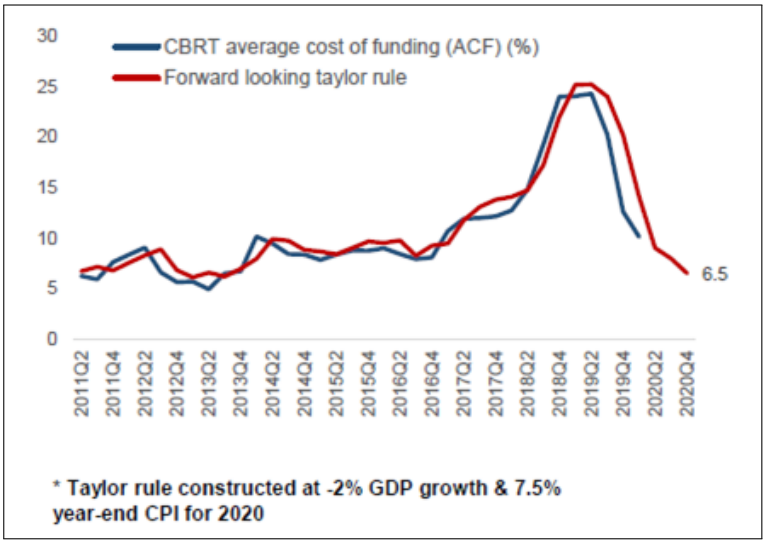

Figure I.6: Central Bank Funding Rate, Taylor Rule

of their assets in the central bank, they place a limit on how much credit can be generated, and consequently how much money is created.

Figure I.7: Effect of Reserve Requirement Ratio on Loan Creation

Reserve requirement ratio is most often a single ratio applicable identically to all banks, and do not change very often in a stable economy. It is often seen as a secondary monetary policy tool to interest rates, and considered a macroprudential policy tool as well.

Central Bank of Türkiye actively managed the reserve requirement rates throughout the last decade, but it was between mid-2019 and late-2020 that they used it to actively promote loan growth: Banks which grew their real loan balance by more than 5% would get reduced reserve requirement rates and increased returns on the reserve requirements that they do hold.

The modified rule for reserve requirements were discontinued in late 2020,

together with the normalization of other policy instruments.

Policy Tool Focus: Asset Ratio

Asset Ratio was introduced in March 2020 by BRSA to better utilize financial assets during the COVID19 crisis. Initially banks had to keep the ratio above 100%, which was later reduced to 95%, then 90%, and then it was discontinued by end of 2020.

Initial calculation methodology (later modified):

$$AR = \frac{\text{Loans} + \text{Securities} \cdot 0.75 + \text{TCMB Swaps} \cdot 0.50}{\text{TRY Deposits} + \text{FX Deposits} \cdot 1.25}$$

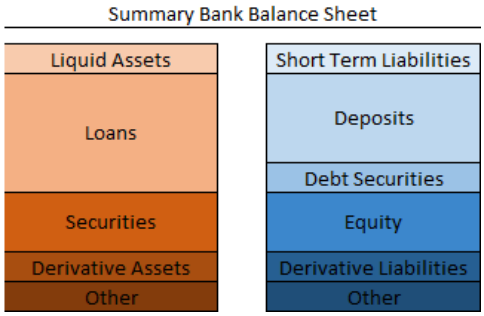

Figure I.8: Summary Bank Balance Sheet Composition

Implication of this policy for banks was manyfold. First, they had to do majority of their currency swaps through the Central Bank, funding the foreign currency needs of the government, since the reserves had melted down during the previous two years. Second, it forced the banks to buy more government securities, funding the government's TRY needs at a time tax revenues were insufficient. Third, it forced the banks to lend TRY loans and cut their FX loans, rolling their FX loans in TRY in most cases, both reducing the FX exposure of firms, as well as funding them through the initial COVID shock. Forth, it penalized banks when they collected FX deposits, forcing them to decrease the interest rate paid to FX deposits, removing at least the interest rate incentive at a time when the economy was in rapid dollarization. Fifth, finally, it implicitly favored banks which were able to find diversified funding outside deposits, so whichever bank funded themselves via foreign funding, for instance, had an easier

time staying over the regulatory limit.

Loan Growth

As a result of these policies, extremely high loan growth has been achieved, with 77% growth at TRY loans by mid 2020, compared to a year ago. Loans kept growing through 2020 Q3, and stabilized by end of year. In another year this much loan growth could result in an extrememly overheated economy, but under the negative demand and supply shocks, economy remained calm enough.

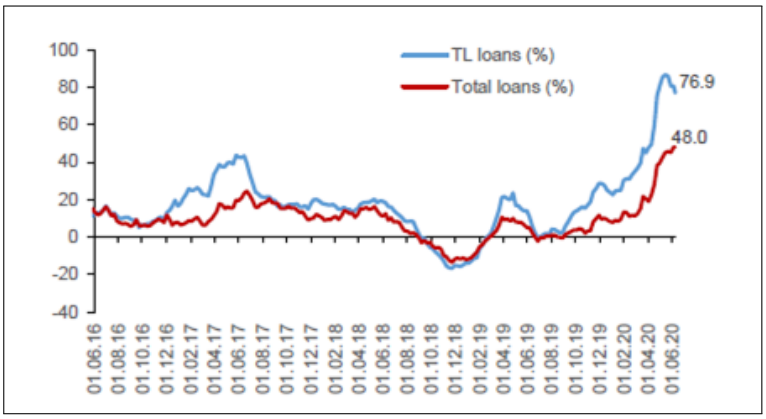

Figure I.9: Loan Growth

CHAPTER 1: TURKISH ECONOMY UNDER TRADITIONAL MONETARY POLICIES

1.1. INTRODUCTION

In this chapter we examine the Turkish economy under a traditional monetary policy which aims to control inflation, and no other policy instruments to complement the monetary policy. We will analyze how vulnerable the economy is to productivity and foreign interest rate shocks, as well as how sensitive it is to shocks in the monetary policy.

Monetary policy, in its traditional form as outlined by (Taylor 1993), aims to keep the economy in given growth and inflation levels, and acts to stabilize if the economy deviates from these targets. Considering that targeting both growth and inflation is very complicated, Central Banks often prioritize the inflation, running inflation-targeting regimes. Considering that inflation is closely linked with money supply, it is expected that rising interest rates will slow down credit, which in return will contract money supply and slow down inflation. On the other hand, this policy will also slow down growth, which may run against the Government's growth and employment policies.

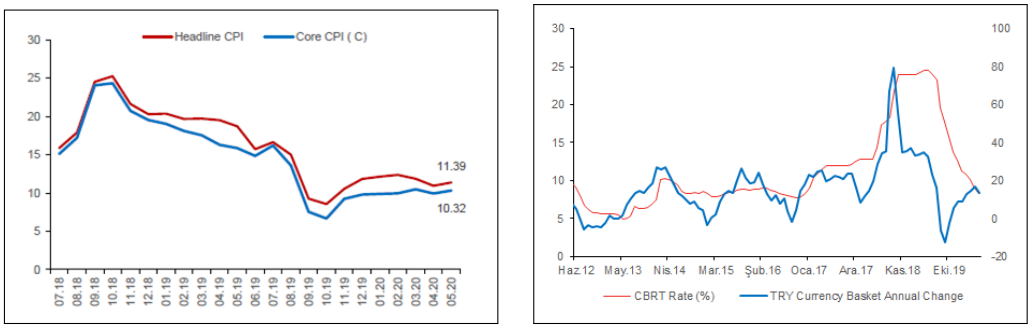

Figure 1.1: Inflation, Central Bank policy, and FX rate

Same can be said for the Central Bank of Türkiye, which states that its "primary objective is to achieve and maintain price stability" (CBRT 2022), though in recent years it also made policy decisions which ran contrary to price

stability aims.[16] Being an emerging market, and a small open economy, Turkish economy is open to shocks coming from abroad, both from and interest rate and financing perspective, as well as monetary flows and exchange rate perspective, and the CBRT has to defend against the secondary effects of these shocks as well. We can see in Figure 1.1 that, putting all the heterodox policies employed by the CBRT in recent years aside, throughout most of 2002-2017 it responded to inflation pressures relatively in the more traditional ways.

Our aim in this chapter is to first build a model of Türkiye's economy with the relevant agents and calibrate the model accordingly, and then analyze how shocks to TFP, foreign interest rate, and monetary policy affect the equilibrium. We will be particularly interested in the effectiveness of discretionary monetary policy on top of the interest rate rules[17] in responding to other shocks.

1.2. OUTLINE

We look at the Turkish economy with households, firms, banks, and foreign investors. Banks can borrow from households or foreign investors and use their borrowings to fund the firms. Foreign borrowing is denominated in foreign currency, which is converted to local currency using the exchange rate. The economy may come under stress if either TFP or labor declines, but also if foreign funding or foreign interest rate change.

This economy is largely representative of how Türkiye operated from 2002 to 2017 in terms of monetary policy, with some disruptions in 2009 and 2016, years of global crisis and attempted coup d'etat respectively. 2009 in particular was especially rough for the Turkish policymakers since it was turbulent throughout the world, and they had to come up with some aggressive policies to counter the volatility in the financial markets. Throughout these years, monetary policy did

[16]The CBRT is expected to accommodate Government policies, defined by the CBRT Law (CBRT 1970) as "The Bank shall, provided that it shall not be in confliction with the objective of achieving and maintaining price stability, support the growth and employment policies of the Government.", which is the basis of why it at times deviates from its inflation targeting policies.

[17]While we do represent the Central Bank policy with a Taylor Rule, and the Turkish Central Bank at least somewhat loosely follows a similar path, discretion in the monetary policy still plays a large part, especially considering monetary environment in Türkiye may change swiftly and the Central Bank does not always have the luxury of following a pre-set rule.

indeed follow a Taylor Rule, hiking interest rates to counter the increasing exchange rates and inflation.

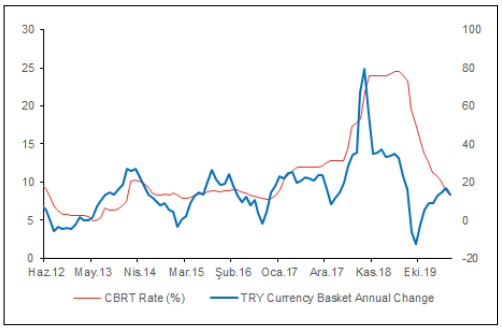

Figure 1.2: Central Bank Policy and FX rate

We leave the fiscal policy out of our analysis here. Our focus will largely be on monetary and macroprudential policies throughout the study, and include taxes and other fiscal elements to the degree that they relate to the macroprudential framework. Other than that, we leave out the fiscal elements outside our models. This is something we take note of, and is an open area for further analysis.

The model is a New Keynesian model with price and cost rigidities, which also includes a banking sector and foreign borrowing in addition to the homogeneous households and firms.

In the model, we take the (Aoki, Benigno, and Kiyotaki 2016) paper, which itself builds upon Gertler and Karadi's paper (Gertler and Karadi 2011b), adds foreign borrowing, and simulates the effects of borrowing in foreign currency. The economy consists of households, producers, banks, and foreign investors. Government regulates the economy via monetary (interest rate) and fiscal (tax rate) policies. Introduction of a foreign entity is what allows us to examine how the economy behaves under certain borrowing constraints, both in terms of costs arising from friction and in terms of borrowing limits. We will first establish the baseline model, then recalibrate it for the Turkish economy, and then extend it to implement various policy mechanisms used by the Turkish government.

Agents and flows in the model economy is shown in figure 1.3.

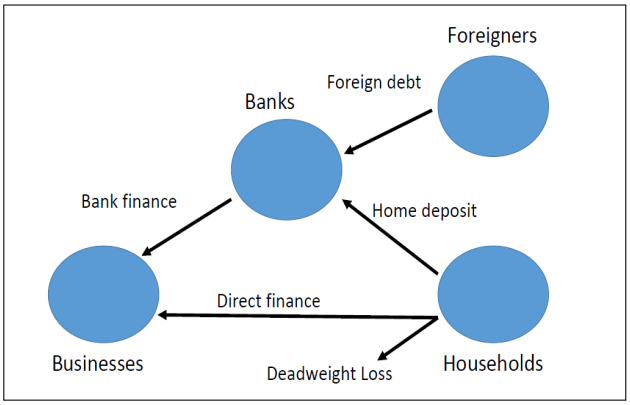

Figure 1.3: Baseline Economy

1.3. RELATED LITERATURE

We require a model that incorporates a banking sector that collects deposits and funds firms, borrowing from foreign investors, a simple monetary policy rule in the form of a Taylor Rule, and banks as financial intermediaries converting foreign currency denominated borrowing to local currency denominated loans. Since we specifically want to study the short-to-medium term effects of certain shocks, we also want frictions in the market to observe price stickiness of goods and services as well as inflation persistence, attributes which are most often found in New Keynesian models.

Constructs used in New Keynesian models go as far back as (Mankiw 1985), which makes use of the term ”menu costs” to identify the situation in which changing prices in an economy has its own costs, and analyzes the effects on welfare of the resulting sticky prices. These menu costs may show themselves in firm price stickiness, wage stickiness, and inflation persistence. Mankiw isn’t the first to use the concept of sticky prices or menu costs, though. (Akerlof and Yellen 1985), for instance, looks whether small deviations from rationality make significant differences to economic equilibria, essentially asking the same question from a different angle, and concluding that firms might not want to change prices unless the benefit of changing price is higher than cost of it.

In terms of modeling price rigidities mathematically, (Calvo 1983) introduces staggered prices, in which at every period only fraction firms update their prices following a probability independent of its last repricing, and others continue with

the old prices. Assuming a continuum of firms, the probability of an individual firm can be generalized to a constant measure showing the rate of change of prices. This is what we nowadays call Calvo type contracts or staggered contracts and it's the most common way to model price rigidities in New Keynesian models.

Calvo pricing was used in the development of the New Keynesian Phillips Curve by (Roberts 1995), which states that the price-setting is forward looking and takes into expectation the future prices in their current pricing, meaning that future expected inflation affects current inflation as well. This curve is commonly used in New Keynesian models to model the inflation persistence, which was known as the ”momentum” of inflation for some time and accounted for in time series analyses.

There are also nonconvexities in the economy, where changing one variable shifts the equilibrium, which then reinforces back and causes another shift in variable value, such as described in (Romer 1990). These nonconvexities lie in the heart of policies, where optimal policy needs to be evaluated by taking into account the often counter-intuitive effects. Following these two concepts, (Calvo 1998a) and (Calvo 1998b) discuss sudden stops, in which economies are not supposed to suddenly change course because of frictions caused by menu costs, and crisis happens if they do. Sudden stops in capital flows, in particular, have been a threat to many chronically current account deficit running emerging economies.

A common theme in all these concepts is that they introduce frictions, and agents in the economy do not immediately respond to the developments in the market. (Taylor 1993) offers a rule of thumb for monetary policy, which again effectively introduces frictions in policy, but also expectations of future developments, similarly to the New Keynesian Phillips Curve. We make use of these concepts within our model to implement time lags and friction costs, ranging from simple AR(1) processes to complex dynamic systems.

Modern New Keynesian models start appearing in early 2000's. (Bernanke, Gertler, and Gilchrist 1999) introduces the concept of financial accelarators, where the shocks to credit market amplifies and propagates shocks to the macroeconomy, also incorporating money and prices stickiness to the model. (Clarida, Gali, and Gertler 2000) formulates the monetary policy as a function of expected inflation and output to find out monetary policy incentives changed before and after Volcker

period.

One of the most influential New Keynesian articles have been the (Christiano, Eichenbaum, and Evans 2005) paper, which incorporates nominal rigidities in the model to examine why inflation is persistent and how money supply factors into the inflation expectations, opening up a new line of literature which developed to include price and wage rigidities throughout the following years.

In a small open economy setting, (Gali and Monacelli 2005) builds a model with monetary policy and exchange rate volatilies in the existence of sticky prices. It examines three different types of monetary policies: Domestic inflation targeting, CPI targeting, and exchange rate peg. We find this paper important especially because it models a small open economy, and it examines the effectiveness of several monetary policy alternatives, which is something we want to do as part of our work.

Within our work, path we ended up using and expanding follows literature opened by (Gertler and Kiyotaki 2010) and (Gertler and Karadi 2011b) on how the financial intermediaries are represented in the model setup. We wanted there to be banks in out model, because they play a key role in the monetary transmission and also in the implementation of several monetary and macroprudential policies. The unconventional monetary policy in the latter, as well as those in (Gertler and Karadi 2018), (Gertler and Kiyotaki 2015) and (Gertler, Kiyotaki, and Queralto 2012), are examples of what we could use when modeling the truly unconventional policy practices implemented by the Turkish regulators. Of course, the unconventional policies in these papers mostly refer to the US economy and the quantitative easing emplyed by the FED, which do not use directly in our work without modifying them for the Turkish economy, for which we will have to develop our own versions of extensions.

The model that we take and build upon is (Aoki, Benigno, and Kiyotaki 2016), which progresses the same literature, applying it in a small open economy setting, extending it with foreign borrowing, in order to formulate the ”original sin” of emerging markets, whereby the economy borrows from foreign investors in the form of foreign currency denominated loans, converts them to domestic currency, and lends to domestic actors, becoming dependent on foreign flows and sensitive

to exchange rates. This was precisely the case for the modern Turkish economy, in which local firms with domestic currency revenues were indebted in foreign currencies, and with the currency shocks they fell under tremendous amount of stress. This paper puts the burden of foreign exchange risk on the banks and not the firms, but overall effects of foreign exchange risks can be observed.

1.4. MODEL

1.4.1. Producers

Final goods Y_t is produced from a variety of differentiated intermediate goods $y_{it}, i \in [0,1]$ according to a constant returns to scale technology as

$$Y_t = \left(\int_0^1 y_{it}^{\frac{\eta-1}{\eta}} di \right)^{\frac{\eta}{\eta-1}} \tag{1}$$

where $\eta > 1$.

Each differentiated goods is produced from capital k'_{it}, labor l_{it}, and imported material m_{it} as

$$y_{it} = A_t \left(\frac{k'_{it}}{\alpha_K} \right)^{\alpha_M} \left(\frac{m_{it}}{\alpha_M} \right)^{\alpha_m} \left(\frac{l_{it}}{1-\alpha_K-\alpha_M} \right)^{1-\alpha_K-\alpha_M}$$

Each intermediate goods producer faces a demand curve as

$$y_{it} = \left(\frac{p_{it}}{P_t} \right)^{\eta} Y_t$$

where p_{it} is the nominal price of i and P_t is the aggregate price index as

$$P_t = \left(\int_0^1 p_{it}^{1-\eta} di \right)^{\frac{1}{1-\eta}}$$

Let Z_t, ϵ_t, w_t be price of capital, price of imported material (which equals the foreign exchange rate), and wage rate in terms of final goods. Marginal cost of production is

$$m_t^C = \frac{1}{A_t} Z_t^{\alpha_K} \epsilon_t^{\alpha_M} w_t^{1-\alpha_K-\alpha_M} \tag{2}$$

Producer i chooses (p_{it}, y_{it}) to maximize their profit

$$E_0 \left(\sum_0^\infty \Lambda_{0,t} \left[\left(\frac{p_{it}}{P_t} - m_t^C \right) y_{it} - \frac{\kappa_t}{2} \left(\frac{p_{it}}{p_{it-1}} - 1 \right)^2 Y_t \right] \right)$$

where the first term is sale price minus production cost, second term is the adjustment cost of price, and $\Lambda_{0,t}$ is the stochastic discount factor.

From the first order condition with respect to p_{it} evaluated under symmetric equilibrium $p_{it} = P_t$, we have:

$$(\pi_t - 1)\pi_t = \frac{1}{\kappa}(\eta m_t^C + 1 - \eta) + E_t[\Lambda_{t,t+1} \frac{Y_{t+1}}{Y_t} \pi_{t+1}(\pi_{t+1} - 1)] \tag{3}$$

where $\pi_t = \frac{P_t}{P_{t-1}}$ is one plus inflation rate.

Log linearly approximating around the non-inflationary steady state with $\pi = \frac{\eta}{\eta-1} m^C = 1$, we get a usual New Keynesian Phillips curve:

$$\hat{\pi_t} = \frac{\eta - 1}{\kappa} \hat{m_t^C} + \beta E_t[\hat{\pi_{t+1}}]$$

where $\hat{\pi_t} = (\pi_t - \pi)/\pi$ is the deviation from steady state value.

Under symmetric equilibrium, we have

$$Y_t = A_t \left(\frac{K_{t-1}}{\alpha_K}\right)^{\alpha_K} \left(\frac{M_t}{\alpha_M}\right)^{\alpha_M} \left(\frac{L_t}{1 - \alpha_K - \alpha_M}\right)^{1-\alpha_K-\alpha_M} \tag{4}$$

where K_{t-1},M_t,L_t are aggregate capital, materials, and labor, in which

$$K_{t-1} = \int_0^1 k'_{it}, M_t = \int_0^1 m_{it}, L_t = \int_0^1 l_{it}$$

Cost minimization implies:

$$\frac{\epsilon_t M_t}{Z_t K_{t-1}} = \frac{\alpha_M}{\alpha_K} \tag{5}$$

$$\frac{w_t L_t}{Z_t K_{t-1}} = \frac{1 - \alpha_K - \alpha_M}{\alpha_K} \tag{6}$$

Capital stock accumulates as

$$K_t = I_t + \lambda K_{t-1} \tag{7}$$

Total investment cost equals $(1 + \Phi(\frac{I_t}{I}))I_t$ where $\Phi(\frac{I_t}{I})$ is the additional production cost of supplying investment goods that is different from non-stochastic

steady state level of I, and $\Phi(1) = \Phi'(1) = 0$ and $\Phi''(I_t/I) > 0$.

The particular function we use here is $\Phi(\frac{I_t}{I}) = \frac{\kappa_I}{2}(\frac{I_t}{I} - 1)^2$, where $\Phi''(1) = \kappa_I$ so that price elasticity of investment is consistent with variable estimates in (Eberly 1993)

We assume that export demand for final goods is a decreasing function of relative price of the export and foreign income as

$$E_{X_t} = \left(\frac{P_t}{e_t P_t^*}\right)^{-\varphi} Y_t^* = \epsilon_t^{\varphi} Y_t^* \tag{8}$$

where e_t and $\epsilon_t = e_t P_t^*/P_t$ are the nominal and real exchange rates, P_t^* is foreign price nominal level, φ is a constant price elasticity of foreign demand, and Y_t^* is an exogenous parameter of foreign demand.

We assume there is no inflation in foreign country, so

$$P_t^* = P^* = 1$$

1.4.2. Households

The representative household consists of a continuum of bankers and workers with the population size normalized to unity. Workers are regular households, and bankers act as the financial intermediaries in the general scope of the model.

Each banker manages a bank until retirement, which occurs with probability $1 - \sigma$. When bankers retire, they transfer their net worth to the households as dividend, and are replaced by an equal number of workers who become new bankers. New bankers receive ξ fraction of total assets from the households as start-up funds, and these funds become the initial net worth of new banks.

Bankers finance nonfinancial businesses by buying equity to receive rental income without financial frictions. Workers, on the other hand, must pay a premium $\chi(K_t^h) = \frac{\varkappa}{2}(K_t^h)^2$ as extra management cost, to receive the same payoff as the bankers.

Workers can also deposit their money in a bank, giving it to the bankers. Those who deposit D_t^n of money receive $(1 + i_t)D_t^n$ at $t + 1$.

Banks can borrow from foreign investors. Foreigners do not buy capital from or lend to home firms, neither do they borrow from or lend to workers. All transaction between foreign and home entities go through banks. We assume all foreign financial contracts are short term, non-contingent, and denominated in foreign currency. Banks, therefore, borrow in foreign currency and lend in local currency, bearing the currency risk.

Representative household chooses consumption C_t, labor supply L_t, direct capital ownership K_t^h, and nominal deposit D_t^h to maximize expected utility

$$E_0 \left[\sum_{t=0}^{\infty} ln \left(C_t - \frac{\zeta_0}{1+\zeta} L_t^{1+\zeta} \right) \right]$$

subject to budget constraint

$$C_t + Q_t K_t^h + \kappa(K_t^h) + D_t = w_t L_t + \Pi_t + (Z_t + \lambda Q_t) K_{t-1}^h + R_t D_{t-1}$$

where Q_t is equity price in terms of goods, $D_t = D_t^n / P_t$ is the real value of deposits, and $R_t = \frac{1+i_{t-1}}{\pi_t}$ is the gross real interest rate on deposit from $t - 1$ to t.

Value of Π_t is the sum of distribution from production, investment return, and bank dividends

$$\Pi_t = \int_0^1 \left[\left(\frac{p_{it}}{P_t} - m_t^C \right) y_{it} - \frac{\kappa}{2} \left(\frac{p_{it}}{p_{it-1}} Y_t \right) \right] di$$
$$+ \left[Q_t - 1 - \Phi(\frac{I_t}{I}) \right] I_t$$
$$+(1-\sigma)[(Z_t + \lambda Q_t)K_{t-1}^b - R_t D_{t-1} - \epsilon_t R_{t-1}^* D_{t-1}^*] - \xi(Z_t + \lambda Q_t)K_{t-1}^b$$

with first line showing profits coming from production, second line from investments in equity, and third line from banks, respectively.

First order conditions for labor, saving in equity, saving in deposits, and investment in goods imply:

$$w_t = \zeta_0 L_t^\zeta \tag{9}$$

$$1 = E_t \left(\Lambda_{t,t+1} \frac{Z_{t+1} + \lambda Q_{t+1}}{Q_t + \varkappa K_t^h} \right), \text{where } \Lambda_{t,\tau} = \beta^{\tau - t} \frac{C_t - \frac{\zeta_0}{1+\zeta} L_t^{1+\zeta}}{C_t - \frac{\zeta_0}{1+\zeta} L_\tau^{1+\zeta}} \tag{10}$$

$$1 = E_t(\Lambda_{t,t+1} R_{t+1}) \tag{11}$$

$$Q_t = 1 + \Phi(\frac{I_t}{I}) + \frac{I_t}{I} \Phi'(\frac{I_t}{I}) \tag{12}$$

1.4.3. Government

In the baseline model government only sets the home interest rate through the central bank. We consider central bank policy rate as part of government's activities, generally following a Taylor rule:

$$i_t - i = (1 - \rho_i)\omega_\pi(\pi_t - 1) + \rho_i t(i_{t-1} - i) + \xi_t^i$$

We will expand this section progressively to include taxes, reserve requirements, different macroprudential measures, and some modified Taylor Rule settings.

1.4.4. Banks

We structure the financial intermediaries, or simply banks, as it is done in (Gertler and Karadi 2011a) and (Aoki, Benigno, and Kiyotaki 2016). Banks fund their assets by collecting deposits from households, borrowing from foreign investors, and using their own net worth. Each banker manages a bank until retirement with probability $1-\sigma$, and upon retiring they bring back the bank's net worth as dividend. This retirement limits the possibility that banks save their way out of financing constraints by accumulating retained earnings.

Objective of the bank is to maximize the expected present value of future dividend as

$$V_t = E_t \left[\sum_{j=1}^{infty} \Lambda_{t,t+j} \sigma^{j-1} (1-\sigma) n_{t+j} \right]$$

where n_{t+j} is net worth (dividend) of the bank when it retires at $t+j$ with probability $\sigma^{j-1}(1-\sigma)$ and $\Lambda_{t,t+j}$ is the stochastic discount factor of the representative household.

Let R_t^* be the foreign real gross interest rate from t to $t+1$, which is equal to the nominal interest rate because there is no inflation in foreign country. Then the flow of funds constraint of a bank is

$$\frac{\chi^b}{2} x_t^2 Q_t k_t = n_t + d_t + \epsilon_t d_t^* \tag{13}$$

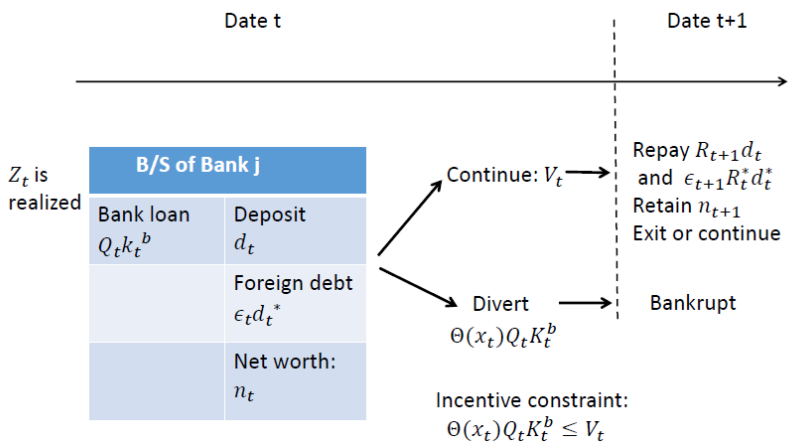

Figure 1.4: Bank Timing

$$n_t = (Z_t + \lambda Q_t)k_{t-1} - R_t d_{t-1} - \epsilon_t R_{t-1}^* d_{t-1}^*$$

where k_t,d_t, and d_t^* are capital holding, home real deposit, and foreign debt of the bank.

If banks have a positive spread between lending and borrowing, which will be the case in a functioning economy and is a requirement in our model, they will want to infinitely increase lending and borrowing. In order to limit this, we introduce a moral hazard problem: Bankers may divert a fraction assets to their own use, in which case the bank will default. We also place the timing of this such that the creditors to the banks know of this, and they won't lend the bankers any more if it is more profitable for the bank to default.

Specifically the banker can divert

$$\Theta(x_t) = \theta\left(1 + \frac{\gamma}{2}x_t^2\right)$$

fraction of assets where $x_t = \frac{\epsilon_t d_t^*}{Q_t k_t}$ is the fraction of assets financed by foreign borrowing and θ, γ are positive parameters. γ measures the degree of home bias in

banker's finance, and θ measures the severity of the bank moral hazard.

The banker's decision boils down to comparing the franchise value of the bank V_t at the end of period t with the gains from diverting the funds.

A financial arrangement between the bank and its creditors must satisfy the following incentive constraint:

$$V_t >= \Theta(x_t) Q_t k_t \tag{14}$$

Each bank chooses the balance sheet (k_t, d_t, d_t^*) to maximize its value

$$V_t = E_t\{\Lambda_{t,t+1}[(1-\sigma)n_{t+1} + \sigma V_{t+1}]\}$$

subject to balance sheet constraint and incentive constraint

$$(1+\tau_t^K)Q_t k_t = (1+\tau_t^N)n_t + d_t + (1-\tau_t^{D^*})\epsilon_t d_t^*$$

$$V_t >= \Theta(x_t) Q_t k_t$$

Because the objective and the constraints are constant returns to scale, we can divide them by n_t as

$$\psi_t = \frac{V_t}{n_t} = E_t\left[\Lambda_{t,t+1}(1-\sigma+\sigma\psi_{t+1})\frac{n_{t+1}}{n_t}\right]$$

We can think of ψ_t as the Tobin's Q ratio of the bank.

Because the investors know that the banks may default on their debt at a given borrowing level at the beginning of a period, they get to limit their exposure to a level that's not profitable for the banks to do so. This is the limiting factor on banks, blocking them from infinitely seeking funding and lending to firms when trying to maximize benefits.

An alternate approach would model the firms that can default, but not the banks, and banks would try to limit their exposure, rather than the investors. Here, we simply assume that the interest rate of lending to firms includes the default risk.

1.4.5. Equilibrium

Output is the sum of consumption, investment, exports, and the costs of changing prices, managing household capital, and raising foreign debt:

$$Y_t = C_t + \left[1 + \Phi(\frac{I_t}{I})\right] I_t + E_{Xt} + \frac{\kappa}{2}(\pi_t - 1)^2 Y_t + \chi^H + \chi^B \tag{15}$$

GDP equals output minus value of import

$$Y_t^{GDP} = Y_t - \epsilon_t M_t$$

Net output is total output minus imports and the costs

$$Y_t^{net} = Y_t - \epsilon_t M_t - \frac{\kappa}{2}(\pi_t - 1)^2 Y_t - \chi^H - \chi^B$$

Net foreign debt evolves through net imports and repayment of previous period's debt

$$D_t^* = R_{t-1}^* D_{t-1}^* + M_t - \frac{1}{\epsilon_t} E_{Xt} \tag{16}$$

Aggregate net worth of banks evolves as

$$N_t = (\sigma + \xi)(Z_t + \lambda Q_t) K_{t-1}^b - \sigma R_t D_{t-1} - \sigma \epsilon_t R_{t-1}^* D_{t-1}^* \tag{17}$$

Aggregate bank balance sheet is

$$Q_t K_t^b = \phi_t N_t \tag{18}$$

$$= N_t + D_t + \epsilon_t D_t^* \tag{19}$$

$$x_t = \frac{\epsilon_t d_t^*}{Q_t K_t^b} \tag{20}$$

Total capital ownership is the sum of those owned by banks and households:

$$K_t = K_t^b + K_t^h \tag{21}$$

Central bank follows a Taylor rule

$$i_t - i = (1 - \rho_i)\omega_\pi(\pi_t - 1) + \rho_i t(i_{t-1} - i) + \xi_t^i \tag{22}$$

TFP, foreign interest rate, and foreign demand (A_t, R_t^*, Y_t^*) follow exogenous processes. Endogenous state variables are $(K_{t-1}, K_{t-1}^b, D_{t-1}, R_{t-1}^*, D_{t-1}^*, i_{t-1})$. Competitive equilibrium is given by

- Price variables $(m_t^C, \pi_t, Z_t, w_t, i_t, \epsilon_t, Q_t, \tau_t^N)$
- Quantity variables $(Y_t, M_t, L_t, C_t, I_t, K_t, E_{Xt}, N_t, K_t^b, K_t^h, D_t, D_t^*)$
- Bank variables $(x_t, \psi_t, \phi_t, \nu_t, \mu_t, \mu_{dt}^*)$

which satisfy functions of exogenous and endogenous state variables.

1.4.6. Calibration

Model parameters are calibrated to fit the trajectory of Turkish economy between 1999 and 2019. This interval includes two major periods of recession in 2001 and 2009, and noteworthy events in 2013, 20167, and 2018. We do not include 2020 in it, which will be the subject of our experimentation here.

TFP, foreign demand, and foreign interest rate are exogenous variables in the model. Their evolution throughout our window is shown in figure 1.5 below.

Figure 1.5: Türkiye GDP, TFP, Foreign Demand, Foreign Interest Rate Evolution

We take TFP from Penn World Tables. Data is initially annual, we expand it to quarterly data by linear interpolation.

Exports are defined as $E_{X_t} = \epsilon_t^{\varphi} Y_t^*$ in the model. We take exports from Turkish Statistics Institute, real effective exchange rate from Central Bank of Türkiye, and calculate foreign demand using the equation.

For foreign interest rate, we simply the FED funding rate rather than try to calculate a mixed funding rate, since USD is the majority of foreign borrowing and it also carries political weight in Türkiye, which is not the case for other currencies. Another option was to include EUR in the mix and calculate the weighted average interest rate, which we did not want to do partly because of its relatively lesser importance, but also because EUR with negative interest rates has its own problems which could have biased effects in our calculations.

We take Frisch elasticity of labor supply as $2/3$, similar to (Torul and Öztunalı 2018) and (Fiorito and Zanella 2012). The original Aoki, Benigno, and Kiyotaki 2016 article purposefully sets this parameter unusually high at 5, which we replace here.

Table 1.1: Parameter Values

β	discount rate	0.985
ζ	inverse of Frisch elasticity of labor supply	1.5
ζ_0	inverse of labor supply capacity	6.12
χ	cost of direct finance	0.001
α_K	cost share of capital	0.32
α_M	cost share of imports	0.3
λ	one minus depreciation rate	0.96
η	elasticity of demand	1.1
ω	price stickiness (share of non-adjusters	0.33
κ_I	Investment adjustment costs	0.9
φ	price elasticity of export demand	1

We calculate the labor supply capacity by use of labor force participation rate, which was slightly under 50% in recent years, and assuming one-third utilization capacity, coming up at 0.16.

We assume the cost share of capital and imports are identical to their shares in the GDP. This gives us $\alpha_K = 0.32$ and $\alpha_M = 0.3$. These values fluctuate slightly throughout the years, we simply took the more recent values and assumed them constant. We take the capital depreciation rate as 4%, figure coming from Penn World Tables.

Among the friction parameters, (Christiano, Eichenbaum, and Evans 2005) takes the cost of changing investment as 0.40 for the US economy. (Groth and Khan 2010), a more recent study, calculates them close to zero. (Çiçek and Elgin 2011) takes it as 0.9, itself similar to (Kehoe 2003), and we use the same value as well. As for price stickiness, two relatively recent articles (Özmen and Sevinç 2016) and (Yilmaz and Suslu 2018) find that Türkiye's prices are updated comparatively quicker than those of developed markets. While latest developments show that prices are updated almost instantaneously under very high inflation, in the time period we analyze using our model it was not the case, though it was still relatively quick. Accordingly, we set $\omega = 0.33$, so that at each period two-thirds of firms update their prices, with the average price update duration at 1.5 periods, which fits the empirical observations.

(Ozer 2003) analyzes demand elasticities for different industries. We find the aggregate demand elasticity as 1.1 by calculating the weighted average elasticity of these industries by their shares in the output. Similarly for export demand elasticities, (Cosar 2012) provides elasticities of different products to exchange rate and income changes.

We take cost of direct finance 0.1%, which sits slightly above the average commission applied by intermediaries. Including the regulatory holding and processing costs, this figure should be fairly accurate.

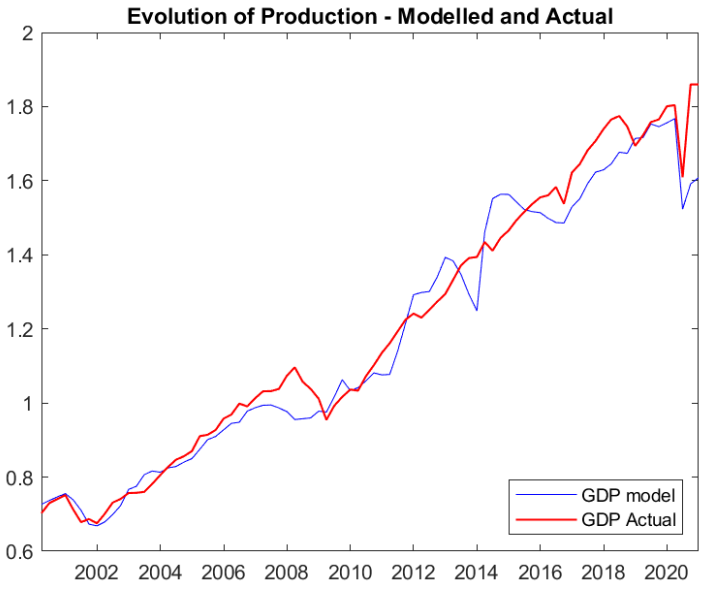

Figure 1.6: GDP Actual vs GDP Modelled

When simulated, modelled GDP trajectory is shown in figure 1.6. It catches the general direction of the GDP, but has some deviations from it. Notably, it shows a small contraction in 2008, when in reality economy kept growing that year and contracted in 2009 more sharply. It also shows a more volatile GDP path during 2013-2017, even a sharp contraction in 2013-2014, a period which was indeed troubllesome for Türkiye but didn't cause a contraction. Similarly, our model also projects a contraction 2015-2016, leading up to the attempted coup, which again didn't materialize. These differences show that, our model, while generally capturing the direction of the economy, struggles with certain short term deviations.

1.5. IMPULSE RESPONSES - BASELINE ECONOMY

When we look at the impulse responses in this baseline economy, without using any additional policy instruments other than following rule based monetary policy, meaning penalties on foreign borrowing or risky asset holding do not exist, reserve requirement rates do not exists, government does not provide any subsidized funding to firms and subsequently does not issue any bonds, no limitations or frictions in lending or borrowing. This economy is consistent with one that government does not counteract the developments, and do not use any discretionary policy, apart from the monetary policy shocks we will examine separately.

Foreign Interest Rate Shock

First shock we analyze is that of an increase in foreign interest rates. As of 2022, most of the world's advanced economies, including US and EU which have a significant relations with Türkiye, are increasing or at least talking about increasing their interest rates, so we think this is a fitting one to start with. We simulate impulse responses with first order approximations around the non-stochastic steady state. All values are in precentages to get comparable quarterly metrics, except interest rates and inflation which are annualized.

We look at the impulse responses of our economy to a 1% increase in foreign interest rate, as shown in figure 1.7. Exchange rate increases (Local currency depreciates) by 1.5%, as well as the exports which they have a direct relationship with. Imports, on the other hand, drop by 1.7%, which, coupled with the increasing exports, contributing positively to output. On the other hand, increasing exchange rate decreases value added productivity, because imports are now more expensive, contributing negatively to output. It decreases the capital price by 0.6%, which in return reduces the bank net worth by 3%, and through that, reduces capital investment by 1.7%, and indirectly reduces output from another channel. Overall, output drops by 0.5%, and consumption drops by 0.7%.

Looking at the interaction between capital price and bank net worth, we

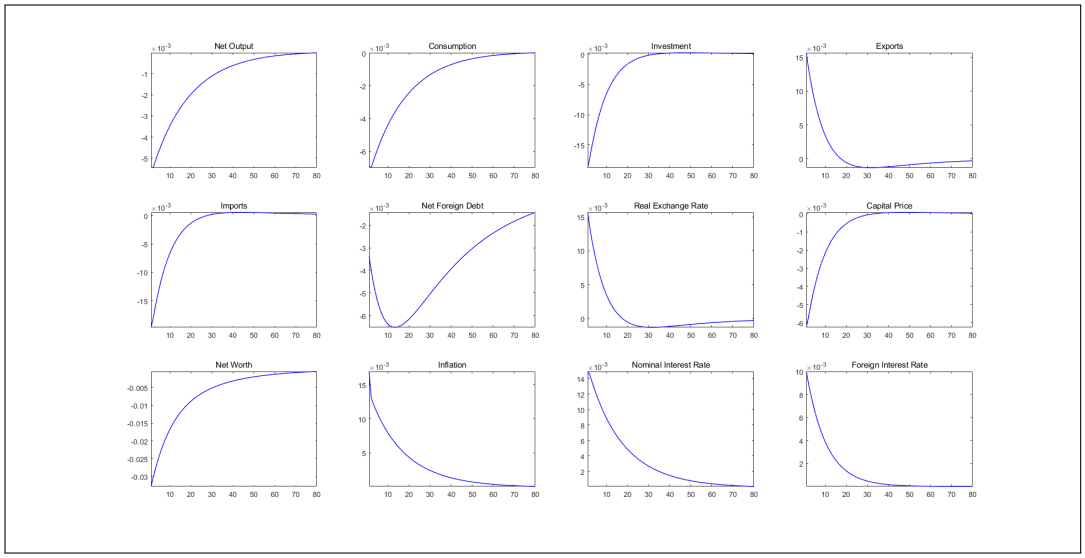

Figure 1.7: Impulse responses to 1% increase in Foreign Interest Rate

observe that bank net worth drops more than capital price due to the leveraged position of the banks. The more leverage the banks have, the more they decline in net worth in case of the shock[18], an issue which can (and will, in future chapters) be mitigated by an appropriate policy.

Because inflation rises by 1.5% with increasing exchange rate, Central Bank rises interest rates by 1.4% to stabilize it, increasing borrowing costs further. Because banks with lower net worth needs to fund themselves with outside funding, they keep rolling over their foreign debt, though it declines by as much as 0.6% before recovering towards steady state.

TFP Shock

Impulse responses to 1% drop in TFP is shown in Figure 1.8. Effects of the drop in productivity is immediately seen in output, inflation, and capital price; all which are directly linked to the TFP. In response to a 1% drop in productivity, production drops by 1.4% initially, more than the productivity drop, due to the bank net worths dropping even more, by 2%. Because output drops by more than TFP, it is balanced by decreases in cost of capital by 0.8% and exchange rate by 1%. Because the exchange rate drops and imports are cheaper, decline in value

[18]Here we observe a financial accelarator in effect, such as mentioned in (Bernanke, Gertler, and Gilchrist 1999) or in (Gertler and Kiyotaki 2015).

added productivity is, to a degree, mitigated.

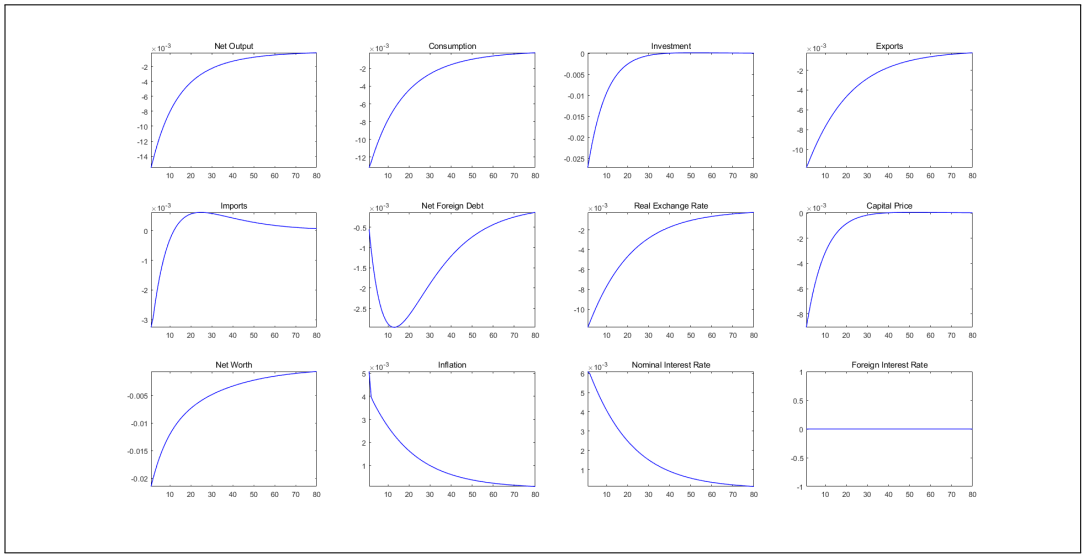

Figure 1.8: Impulse responses to 1% drop in TFP

Similarly to the foreign interest rate shock, in the TFP shock, too, we see that investment is hit heavily, with a decline by 2.5% initially, because of the cascading effects of declining asset prices (or bank net worths) and capital price decreases. This is an observation we wanted to see, where the foreign currency borrowers are strained by lack of buffers and struggles to roll over its debt, increasing its costs and pushing the production down.

Exports are hit by 1%, harder than imports' decline of 0.3%, negatively affecting the current account balance. Imports also recover a lot faster, even increasing for some time, thanks to the declining exchange rate. This happens, in our model, because exports are fully correlated with exchange rate, while imports factor into the production function and non-linearly affected. Relatively quick recovery of imports, coupled with the lower exchange rate, helps mitigate the decline in output.

Monetary Policy Shock

Throughout our work we will mostly be using the discretionary monetary policy as a response to another development. Here, though, we wish to see the separate effect of a monetary policy shock. For this purpose, we apply an

exogenous 1% shock to the monetary policy rate. Impulse responses are shown in Figure 1.9. Differently from other shocks, monetary policy also has an endogenous rule (the Taylor rule), so it recovers to its steady state value quite fast.

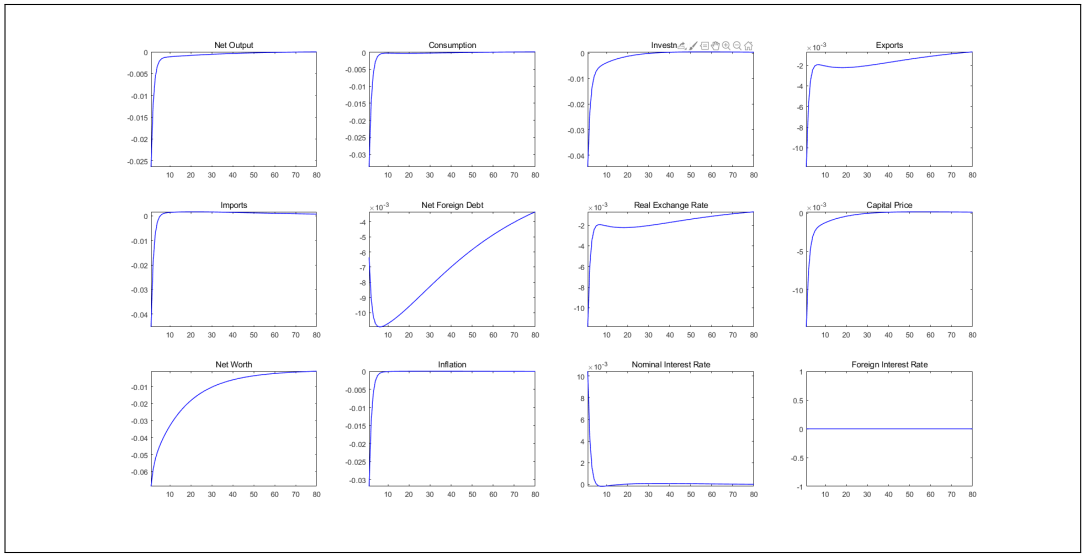

Figure 1.9: Impulse responses to 1% change in CB Policy Rate

The immediate consequence of increasing the interest rate is the declining asset prices and bank net worths by 6%, which is higher than the previous cases. Similarly to the other shocks which stressed bank net worths, banks become less inclined to provide funding to firms, resulting in a 4% decline in investment, and 1.5% in capital price. Another consequence of increasing the interest rate is the effect on exchange rate, where it decreases by 1%, together with exports with the same magnitude. With negatively affected investments and net exports, net output drops by 2.5%, and consumption follows by a 3% decline.

An interest rate hike is expected to cool down the economy by tightening credit conditions, reducing funding to firms by banks, and slow down production, while also bringing down inflation and exchange rate. By these points, the monetary policy shock appears to work as expected in our model, as it addresses all of them.

Foreign Demand Shock

Lastly, we look very briefly into the effects of a foreign demand shock. We value the analysis of foreign demand shocks more now than before, in light of the

events in the past few years, where the foreign demand of Türkiye's production did indeed face shocks because of political turmoil, active military conflicts in geographical vicinity, as well as a deadly global pandemic. We will analyze this further, together with policy responses, but for now let us glance over what happens in our baseline model. Figure 1.10 shows the impulse responses.

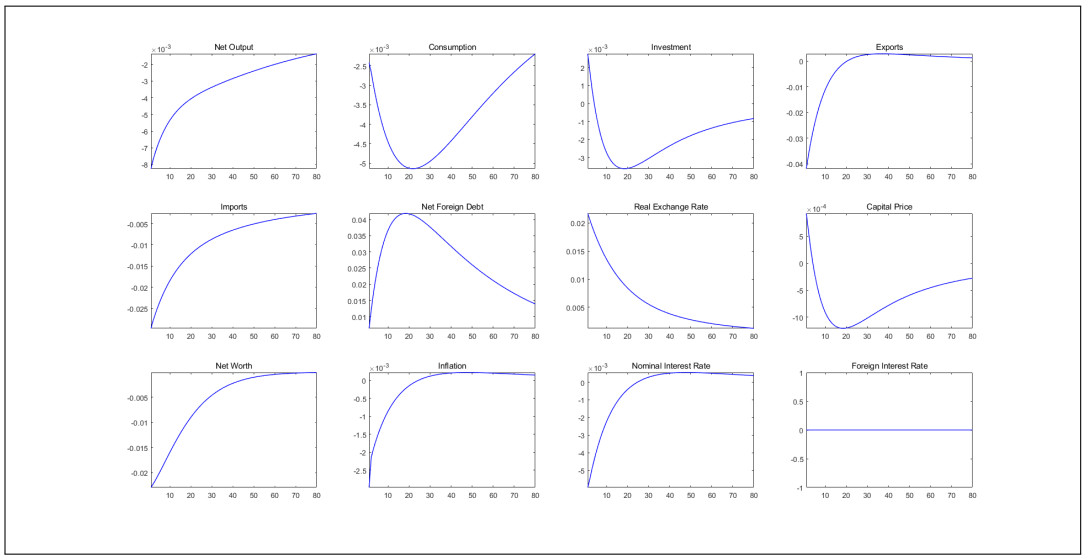

Figure 1.10: Impulse responses to 1% drop in foreign demand

The shock on foreign demand directly affects the exports by 4%, which in turn drops the output by 0.8%. Decline in consumption is relatively low at 0.3%, although it declines to as low as 0.5% before starting to recover. Investment initially increases by 0.2% as a greater share of the production will stay local. Local prices decline, bringing inflation by 0.3%, and following inflation interest rates decline by 0.5% as well.

Declining interest rate rises the exchange rate by 2%, which is again larger than the shock in foreign demand. In previous shocks, shocks to exchange rate and exports were identical, which changes when foreign demand itself is shocked and exports are no longer fully correlated with exchange rates. While the exchange rate increase does help with exports, effect of lesser demand dominates. Increasing foreign exchange rate also decreases bank net worths by 2%. Capital price initially slightly increases, following investment, but it also falls down quickly. Because imports become more expensive with exchange rate, they decline by 2% as well.

The results are mostly intuitive, perhaps with the exception of capital investment being positively affected initially. We could also argue that consumption decline is a bit surprising, as less exports and cheaper prices locally should mean increased consumption; however, output declines comparatively more than consumption, which helps close this gap.

We will come back to the treatment of foreign demand shocks in the upcoming chapters. For now, we stop with the impulse responses of the baseline model.

CHAPTER 2: MACROPRUDENTIAL POLICIES IN THE TURKISH ECONOMY

2.1. INTRODUCTION

Throughout the last decade, Turkish economy have been exposed to a number of internal and external shocks, chief among them the announcement of QE tapering by FED in 2013, the Arab Spring in which a number of trade partners were pulled into military conflict, a coup attempt in 2016, a diplomatic crisis in 2018, and a pandemic in 2020. Severity of these shocks are contested, for instance the coup attempt did almost nothing from an economic or financial point of view, but the frequency of them made responding to these shocks harder, increasing borrowing costs and limiting borrowing conditions otherwise, causing a deeper current account deficit and pushing the exchange rate higher, and forcing the policymakers to make unpopular policy decisions, both from they eyes of the public, also in the case of CBRT, from the government. Policymakers responded to these shocks by use of a variety of policies, some of them monetary or macroprudential in nature, which we will be analyzing in this chapter.

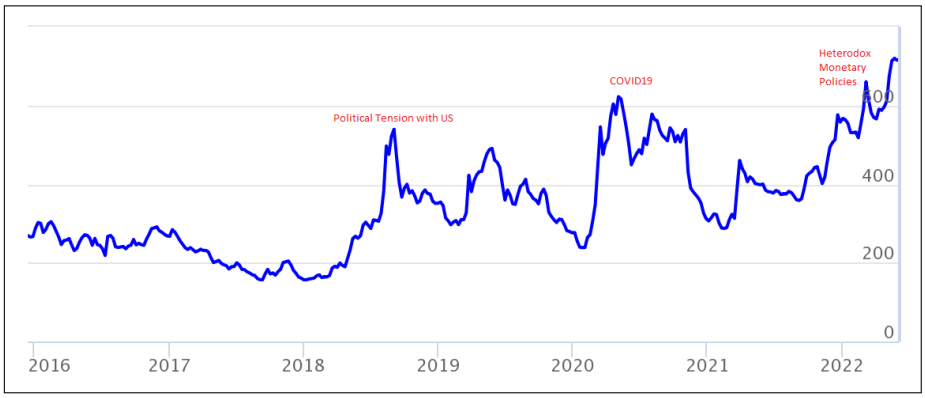

Figure 2.1: Türkiye 5Y CDS History

Macroprudential policies have been implemented to achieve different goals, ranging from slowing or speeding up credit growth, controlling credit quality, introducing limits on the amount, maturity, or type of loans, and protect various agents from unhedgeable positions. For instance, households are not allowed to borrow from banks in foreign currencies, and firms are only allowed if they have verifiable foreign currency income, to protect them from foreign exchange rate

risks. In another example, auto loans are limited to a percentage of the car's full value, real-estate loans similarly have their LTV (loan-to-value) limited by law, to protect the banks as well as the borrowers against asset price declines.

This is not the only venue macroprudential policies were used, though. In recent years, these policies were also used to control credit growth, which is normally an area monetary policy would address, because the CBRT did not always want to respond to shocks by use of monetary policy.

One key recurring theme of the last decade was the cycle of interest rates, exchange rates, inflation, and the current account deficit. Natural growth of Türkiye generated a current account deficit, funded by the growth itself, in a normal year. When growth couldn't match the deficit, however, or one of the aforementioned shocks hit the economy, current account deficit would be funded by purchasing foreign currencies, devaluing the Turkish Lira. The rising exchange rates would have a pass-through effect to the inflation, and the CBRT would increase interest rates to slow down inflation. Once the inflation showed signs of dropping, incentivized by the Government's prodding, CBRT would immediately cut rates down, and growth would return, completing the cycle.

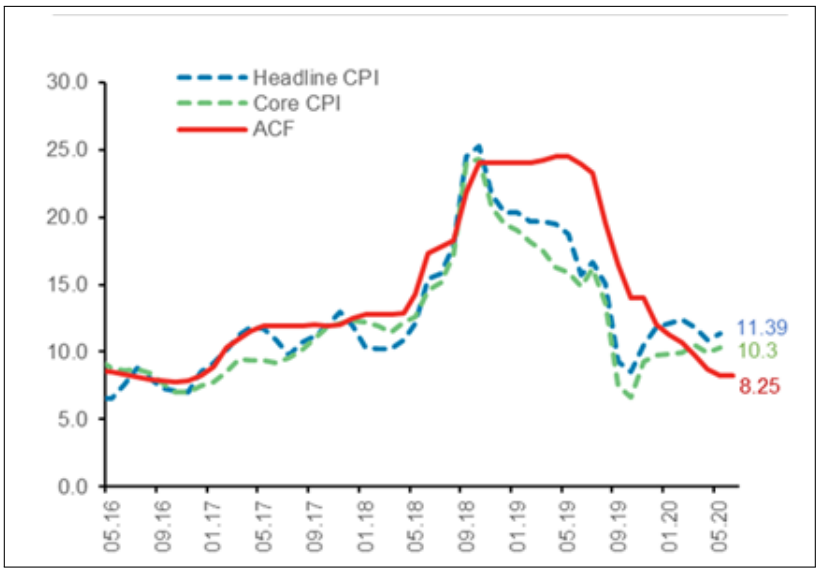

Figure 2.2: CBRT Policy Rate and Inflation

While this theme was very typical from an interest rate policy point of view, other concerns were ever-present, as well. Government would always push the

country towards higher growth, often at the cost of stability in multiple measures, and Government policy would conflict with the CBRT policy, creating tension between the two. The solution to ease the tensions by substituting monetary policy with macroprudential policy, which would have similar effects in slowing down the economy by limiting credit growth via other avenues than just the price. For instance, in figure 2.3 we can see that the CBRT held the reserve requirement rates steady for a decade until after the global crisis of late 2000's, and then started to actively use it to complement interest rates in governing money supply.

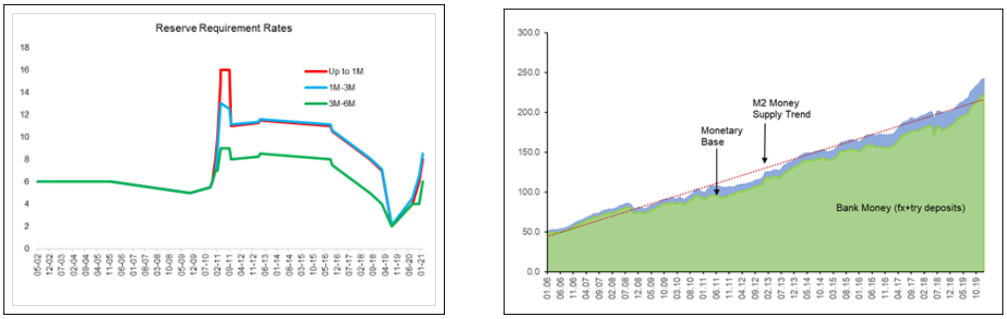

Figure 2.3: Reserve Requirement Rates and Money Supply

The policies themselves are varied, but we collect them under three broad categories. First is the reserve requirements, and creative use of it; second is penalties on risky assets to reduce the banks' exposure to them; and third is penalties on foreign currency borrowing by banks, including foreign currency deposits held by locals. We well go over these policies individually, and combination of them as used by the policymakers, in the following sections.

2.2. OUTLINE

In this chapter, we study the rather non-traditional macroprudential policies employed by the Turkish regulators related to monetary economics. These measures include various mechanisms that works complementary to baseline monetary policy of interest rate setting, those that work to boost or slow credit growth, and those that aim to stabilize the economy at times of monetary or financial stress, sometimes extending to fiscal domain as well. These measures included changes in reserve requirement regime, introduction of taxes on foreign currency buying and selling, increasing or decreasing the tax rate on foreign

currency deposits, and the asset ratio regulation that came with the Covid19 pandemic. We will rebuild the model with these mechanisms, individually at first, and then combine them to get the full picture of what effect the policies had over the economy.

In the first chapter, government only existed in the form of a Central Bank which follows a predefined rule and does not actively set any different policy. Real economies, however, do not function in a vacuum, as they have competing priorities they have to act upon and this complicates policy-making. Rather, economies are managed actively by a set of actors, both through regulation of markets and active participation of government; and these actors respond to the developments in the markets so that the most severe effects of certain shocks to the economy can be mitigated.

Here we will have a few separate extensions: First, government will have a fiscal policy in which foreign deposits and capital returns may be taxed, and these taxes may be used to subsidize bank funding to firms. Second, Central Bank will have reserve requirements and some macroprudential measures as part of its monetary policy, which can be used to limit money creation and therefore firm funding.

Using the extended model, our aim is to analyze three different macroprudential policies in how they work under foreign interest rate changes, TFP shocks, or discretionary monetary policy shocks, and discuss how they change the decisions of economic actors. These three policies are i) penalties on asset holding by banks, representing policies which limit banks on their asset creation, ii) penalties on foreign borrowing by banks, representing policies which increases bank funding costs if foreign currency denominated liabilities increase, and iii) reserve requirement rates, capping money creation through loans by banks. These three policies work through the banks, targeting either loans or deposits, accurately representing the Turkish experience.

To our knowledge, while macroprudential policies are researched extensively, there is none focusing on our set of conditions: A small open economy, exemplified by Türkiye; policies addressing the bank balance sheets directly; conventional and unconventional usage of these policies; and their analysis under multiple periods of

stress. This will be our contribution to the existing literature.

2.3. RELATED LITERATURE

Macroprudential policies have become popular following the Great Recession (Kahou and Lehar 2017), the worst financial crisis in the World since the Great Depression of 1939. The severity of the recession showed that the financial system lacked a prudent macro-based financial regulation, leading to several new practices by regulators and banks alike. These regulations were mostly aimed at banks as they are the institutions where disruptions in the credit supply cause liquidity shortages throughout the entire economies, but they indirectly affected other economic actors as well. Macroprudential policies aim to increase financial stability, reduce systemic risk and therefore reduce the probability and impact of systemic crises, and, by use of countercyclical regulation, reduce the procyclicality of bank loans.

(Galati and Moessner 2013b) provides an extensive literature research of macroprudential policies. It is evident in the popularity of the term that macroprudential policies have become prominent in the years during and following the Great Recession. It mentions that macroprudential policy is a loose definition to describe practices which promote financial stability, but there is no commonly shared definition of what financial stability means. A common theme is countercyclical regulation, which promotes risk-averse behavior when the economy is booming and risk-taking behavior at other times. Among its conclusions, it notes that the effectiveness of macroprudential tools can be studied further, with empirical data analysis and comparisons with other policy tools. Another conclusion relates to the question of how to conduct monetary and macroprudential policies in tandem, by modeling of financial intermediation (via banks) and frictions in the macroeconomics models together. These two points will be among our goals in our research, with the additional goal of how macroprudential policies can be used to promote other objectives guided by the government, which will not always be prudent. Literature on the effects of macroprudential regulations have been improving since (Galati and Moessner 2018) noted that it was still in its infancy, but as new policy instruments are added continuously. Empirical analyses such as (Altunbas, Binici, and Gambacorta 2018) shows that macroprudential policies are effective at gaining policy objectives, and

reducing bank risk.

(Claessens 2014) gives an overview of macroprudential policy instruments. Among the most common are limitations on loan-to-value, debt-to-value, credit growth, and foreign lending; controlling money supply via reserve requirements; and countercyclical requirements.

In Türkiye, as well, macroprudential policies were followed, but not always with the same framework and not always with risk reduction purposes. Sometimes the tools were used to guide the economy in the desired direction, and sometimes the monetary policy tools were used with macroprudential purposes, such as increasing reserve requirement rates significantly to contain credit growth in 2010 (Kara 2016), or decreasing them significantly to promote loan growth in 2020. The varied usage of macroprudential policies offensively in Türkiye has at times been called unorthodox, which, deriving from research such as (Arestis 2017), questioned about in its effectiveness, which we will try to address.

2.4. MODEL

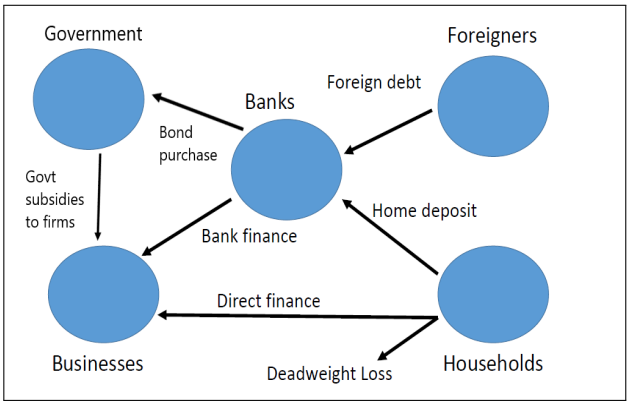

Figure 2.4: Baseline Economy

In this chapter, we take the economy that we built in the first chapter and extend it with the policy instruments, so we only document the changes to the model, rather than copying the full model structure. Changes in the model chiefly concern banks and the government, while producers and households largely keep their setup, although affected indirectly. We also extend the model with exogenous

labor supply and demand shocks.

2.4.1. Changes in Production

Producers in the model are very similar to the baseline model, with the exception of labor supply and demand shocks. We do this in order to be able to

Production function of an intermediate good becomes

$$y_{it} = A_t \left(\frac{k'it}{\alpha_K}\right)^{\alpha_M} \left(\frac{mit}{\alpha_M}\right)^{\alpha_m} \left(\frac{\hat{l}_{it}}{1-\alpha_K-\alpha_M}\right)^{1-\alpha_K-\alpha_M}$$

where

$$\hat{l} = (1-\phi_l)l$$

and ϕ_l is the percentage shock given to the labor supply. A shock to labor supply directly affects the production, and it is useful to represent certain developments in the Turkish economy, such as the effects of COVID lockdown or immigration from war-torn countries.

Demand function becomes

$$y_{it} = (1-\phi_d)\left(\frac{p_{it}}{P_t}\right)^{\eta} Y_t$$

where ϕ_d is the percentage shock to the demand of produced goods. We use this form in order to represent a flat shock to demand, while keeping elasticity unchanged. We also considered using a variable demand elasticity, but decided that it would overcomplicate the analyses.

2.4.2. Government

Government's policy is in the form of taxes on capital holding and foreign borrowing of bankers and subsidy on their net worth. It aims to reduce the fluctuations in consumption. In other words, government objective is to minimize

$$M_t^g = (C_{t-1}/C_{ss} - 1)^2$$

in a standard, no growth scenario. We write this objective function as a rather soft target, we don't include it in the optimization of the model. In order to achieve this goal, government has the option to change the tax rates, as well as provide potentially cheaper funding to firms via subsidies, all of which we define as exogenous processes.

Here we assume that the government aims to advance the welfare of households. However, from a monetary policy point of view, this might not always be the case. For instance, (Huang and Wei 2006) has a government objective function which stabilizes inflation and output, while also trying to maximize public goods provision.

Cost of capital that's funded by government is

$$Z_t^g = \frac{Z_t^0}{(\theta^g + e^{-\gamma^g K_t^g})}$$

where Z_t^g is the cost of government capital, Z_t^0 is cost of generic capital, K_t^g is the capital amount funded by government, θ^g is the parameter that governs how much cheaper (or more expensive) government capital is compared to generic capital, and γ^g is the parameter governing how fast it gets more expensive. At $K_t^g = 0$ the government funding is cheapest, increasing with increased funding.

Then, the average price of capital is

$$Z_t = \frac{Z_t^g K_t^g + Z_t^0 (K_t^b + K_t^h)}{K_t^g + K_t^h + K_t^b}$$

which reduces to $Z_t = Z_t^0$ if government funding K_t^g is at zero.

Government issues bonds to cover subsidies to firms, and banks buy these bonds.

$$K_t^g = B_t^g$$

We fix bond interest rate equal to capital rental rate ($Q_t^g = Q_t$), so that from the bank's perspective it doesn't matter which allocation they make, making the math simpler. We also take the government's issuance decision exogenous, so that B_t^g can be increased or decreased by the government at will. In reality this results in large costs for the government and due to the long maturities of bonds might not be

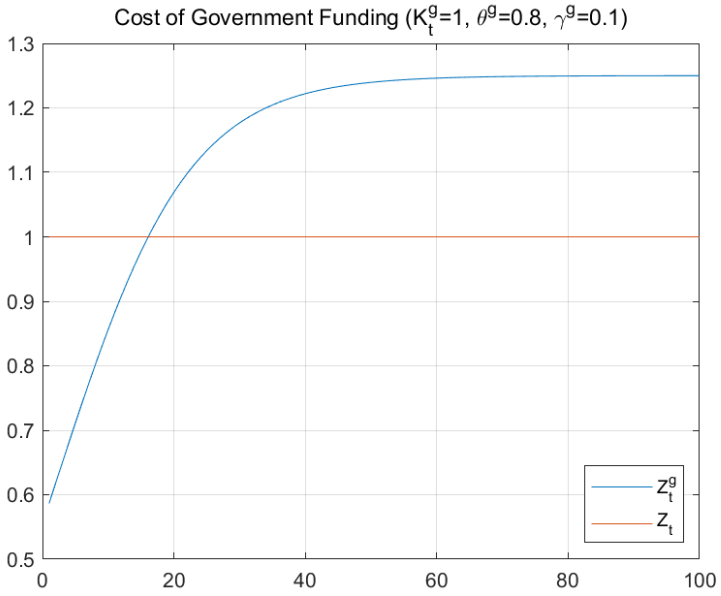

Figure 2.5: Cost of Government Funding

practical. We will obtain this by inputting exogenous shocks as close to reality as possible, which itself is quite unorthodox as we mentioned earlier.

2.4.3. Penalties on Risky Assets and Foreign Borrowing

Let τ_t^K be the tax rate on capital holding, $\tau_t^{D^*}$ be the tax rate on foreign debt, and τ_t^N be the subsidy rate on net worth. These values, together with bond issuances and government funding to firms, form the budget equation:

$$K_t^g + B_{t-1}^g + \tau_N N_t = \tau_K Q_t K_t + \tau_D^* \epsilon D_t^* + Q_t B_t^g + (Z_t^g + \lambda Q_t) K_{t-1}^g \tag{23}$$

Government sets the tax rates on capital holding and foreign debt, and uses the proceeds to subsidize the banks. This policy (any combination of it with positive tax rates) penalizes risky asset holding and foreign borrowing, and incentivizes net worth buffers.

Government budget equation, when only these taxes are considered, is

$$\tau_N N_t = \tau_K Q_t K_t + \tau_D^* \epsilon D_t^*$$

As a direct result of this policy, bank flow of funds equation will become

$$(1+\tau_t^K+\frac{\chi^b}{2}x_t^2)Q_tk_t=(1+\tau_t^N)n_t+d_t+(1+\tau^{D_t^*})\epsilon_t d_t^*$$

This policy is, being a tax, part of fiscal policy perimeter, but we also call it a macroprudential policy since its aim is to reduce the riskiness of banks. We will use it as a generic macroprudential policy similar to how (Aoki, Benigno, and Kiyotaki 2016) does, but also show how it couples with the other policies pursued by the Turkish government, particularly following 2018 where the government really did increase the witholding tax rate on foreign currency deposits (or decreased those of Turkish Lira deposits), as well as actively penalized them as part of the Asset Ratio.

2.4.4. Central Bank Interest Rate Policy

We consider central bank policy rate as part of government's activities, generally following a Taylor rule:

$$i_t-i=(1-\rho_i)\omega_\pi(\pi_t-1)+\rho_i t(i_{t-1}-i)+\xi_t^i$$

Turkish central bank will not always follow this rule, and we will make modifications in the parameters for when it changes policy.

2.4.5. Reserve Requirements

We introduce reserve requirement rates as a policy instrument which serves to purposes: First, it places a limit on bank lending through fractional reserves; and second, it gives us a tool to manage credit growth, similarly to how it was by CBRT during 2019 and 2020.

The way it was implemented in Türkiye was to provide banks bonuses once they hit a threshold, mathematically a step function. We replicate this step function using a steep enough logistic function, so that we won't have trouble with differentiation.

Let RR_t be the fraction of funds, home and foreign, which has to be held in the central bank, and has zero return. Then the flow of funds constraint becomes:

$$K_t^g + B_{t-1}^g + \tau_N N_t = \tau_K Q_t K_t + (1 - RR_t)(\tau_D^* \epsilon D_t^*) + Q_t B_t^g + (Z_t^g + \lambda Q_t) K_{t-1}^g$$

We define the reserve requirement rate as an inverted logistic function (figure 2.6)

$$RR_t = \frac{2 \cdot RR_t^s}{1 + e^{-k^s(\frac{K_t^b}{K_{t+1}^b} - K^0)}}$$

where RR_t^s is the base level of reserve requirement rate, K^0 is the parameter governing credit growth target, and k^s is the coefficient of subsidization.

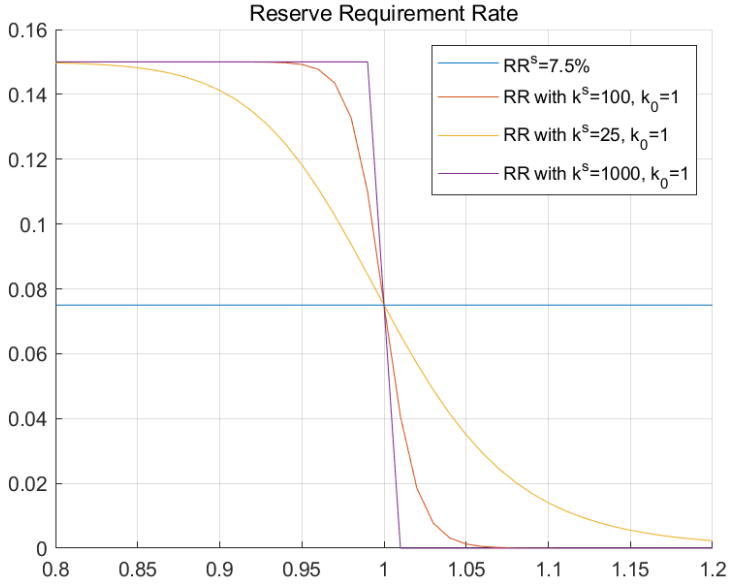

Figure 2.6: Reserve Requirement Rates

This implementation is different from the single reserve requirement rate that's applied by most central banks, favoring banks when they have stronger loan growth. When $k^s > 0$ and $K^0 = 1$, reserve requirement policy is in its conventional form.

2.4.6. Asset Ratio

We introduce the asset ratio as a metric that promotes bank lending to businesses and penalize foreign borrowing.

$$AR_t = \frac{K_t^b + \zeta_t^{AR_B} B_t^g}{D_t + \zeta_t^{AR_{D^*}} D_t^*}$$

Initially the parameter values were $\zeta_t^{AR_B} = 0.75$ and $\zeta_t^{AR_{D^*}} = 0.5$, but they were modified later on.

Bonds B_t^g are exogenous. Government chooses the $\zeta_t^{AR_B}, \zeta_t^{AR_{D^*}}, B_t^g$ to bring the asset ratio to desired level. Since banks buy all the bonds government issues, and remaining funds go to firm capital directly from banks, banks do not have a choice, they passively implement the allocation. Asset ratio, by design, brings contradicting incentives as well: Banks must buy bonds, but at the same time are incentivized to grow their loan book through the modified reserve requirement rule.

We define the asset ratio as a monitoring metric, not a regulatory rule the banks must adhere to as it was done in Türkiye, and control its value by the amount of exogenous government bond issuance. This way we still get the desired policy response effect, without the mathematics of the model going out of control.[19]

Note that the swap term is missing from the actual equation here. In our model banks carry the foreign exchange risk, differently from the real economy in which firms carry the risk. Since we do not incorporate default risk here, it made no difference which actor carried the foreign exchange risk.

We will analyze the asset ratio with detail in the next chapter. For now, we simply build the model with this extension, and leave its analysis to the following chapter.

[19]We calibrate the model using Dynare (Adjemian et al. 2011), which uses perturbation methods to find the equilibrium and would not work easily at the presence of weakly binding inequalities.

2.5. EQUILIBRIUM

Equilibrium is again very similar to the baseline model, except the addition of government funding. Total capital ownership is the sum of those owned by banks, households, and government funding:

$$K_t = K_t^b + K_t^h + K_t^g$$

2.6. MACROPRUDENTIAL POLICY ANALYSIS: PENALTIES ON RISKY ASSET HOLDING

In the years following the Great Recession, in order to keep bank balance sheets strong and to improve credit quality, credit policies were tightened. Later on in 2015-2016 and during the years following 2018 stress period, banks were discouraged to provide more loans by use of tighter credit policies, with more accomodative policies in between, as shown in figure 2.7 Similarly for foreign borrowing, banks were at times encouraged to use more international funds, and at times discouraged when the Turkish currency came under stress.

Figure 2.7: Credit Growth Between 2015-2019

In our model, we represent these policies by use of taxes on asset holdings, or bank lending to firms, and use these policies to analyze whether the shocks in the baseline economy can be mitigated. Typically, macroprudential policies are expected to help prevent a shock from happening or mitigate the impact by

keeping the economy robust, but there are cases where they were used as response, too. We will look at the policy from a few different viewpoints to see how they fit into a policy mix.

First let us look at the foreign interest rate shock and applying a 10% penalty for risky assets in figure 2.8, which in our model represents bank funding[20] to firms. With the asset holding penalty, banks are less inclined to lend out loans, and therefore require less funding themselves, leading to reduced foreign borrowing. Subsequently, bank net worths decline more than the base case, although not by much, as in balance the government feeds the penalty back to subsidize bank net worths. As a result of less lending by banks, capital price and investment declines.

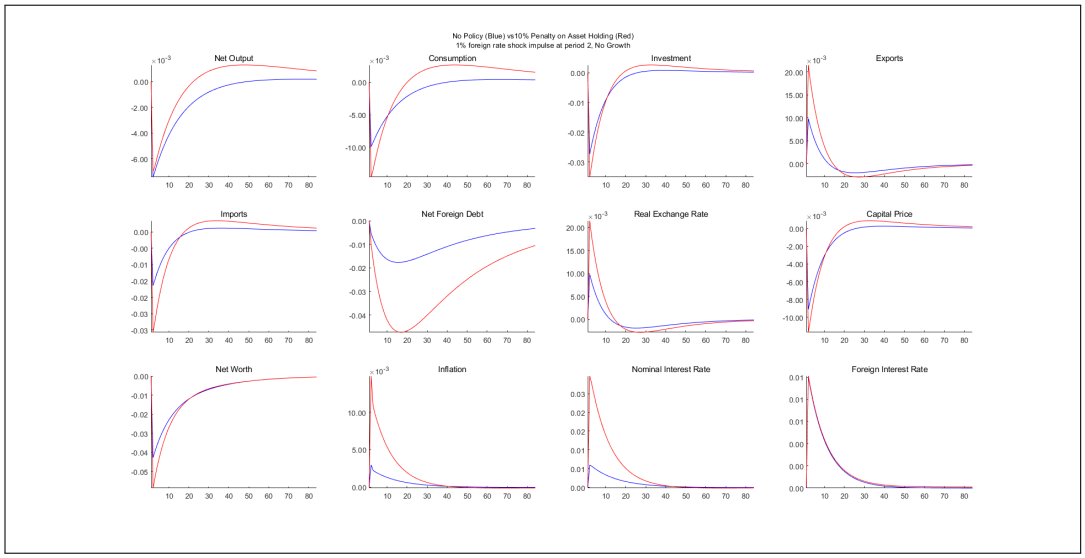

Figure 2.8: Impulse responses to 1% increase in Foreign Interest Rate - Baseline vs 10% Asset Holding Penalty

Inflation rises more than the base case (2% instead of 1%) on the back of long term expectations[21]. Inflation increases by almost 1% more than the base case, because exchange rate increases by more than 1% more as well. In response, the

[20]Normally, in a commercial banking context, bank funding comes in the form of loans rather than equities, as banks are in the business of lending and borrowing money, rather than investing in firms. We don't distinguish between the two in our model, but from a financial point of view it doesn't make much of a difference, as we can substitute capital return to loan interest rate and there is no default risk.

[21]We deduce this from the the Phillips Curve $\hat{\pi}_t = \frac{\eta-1}{\kappa}\hat{m}c_t^C + \beta E_t[\hat{\pi}_{t+1}]$. If the marginal cost of production is declining because wages, exchange rate, and capital are all cheaper in the short term, then it must be the future expectations that drive the higher inflation.

Central Bank has to increase interest rate by 3% as well.

The increase in net exports is very visible, where exports increase and imports decrease on the back of heightened exchange rate. Production isn't hit more than the base case, at 0.6%, because the 3% drop in investment is recouped partially by 1% more exports and 1% less imports, and partially by the additional 0.5% drop in consumption. This is the most prominent gain by this policy, and if kept for a long time, has the potential to further increase net exports, which is a policy aim for Türkiye.

Our model shows that, against foreign interest rate shocks, a policy penalizing bank lending brings a faster recovery from the shock on production and an improvement in current account balance; at the cost of welfare, rising inflation, rising exchange rate, and rising interest rates. We tested this with the policy as a response; if it was a permanent policy, we could have gained these benefits earlier, too. It also reduces foreign borrowing by banks, as less amount of funds are required now. Because we set the policy as an impulse, and because the shock was also an impulse, the economy eventually comes back to the steady-state.

This policy, along with other macroprudential policies, aims to strengthen the bank balance sheets against shocks to asset prices, whereby collaterals to their loans may not cover the losses if those loans are not paid back, or when the banks want the reduce the size of their balance sheets. We don't include loan defaults in our model, but by penalizing bank funding (and indirectly incentivizing household funding) to firms, we are able to limit the banks' appetite anyway.

The policy appears to achieve its aim in reducing bank lending, but also negatively impacting bank capitals. While it's not a win-win situation, we can look at the relative impact by looking at the capital adequacy ratio[22] of banks. Capital adequacy ratio is in fact a relatively complex calculation which takes into account the relative riskiness of assets, but here let us define it simply as the ratio of bank

[22]In Türkiye, capital adequacy ratios of banks ranged between 14% and 19% throughout the last decade, dropping from as high as 32% in 2003 and increasing to over 20% recently, while our model shows a baseline of just over 22%. While the model result is within range of historical values of the ratio and very close to the current value, we must recognize that it is not an exact representation of the actual ratio. This is because our definition is a simple one avoiding the complexities of CAR calculation, such as the RWA (Risk weighted assets) coefficients of different asset classes, or different types of capital.

bank net worths to their assets, or $CAR_t = N_t/K_t^b$, using our already existing variables.

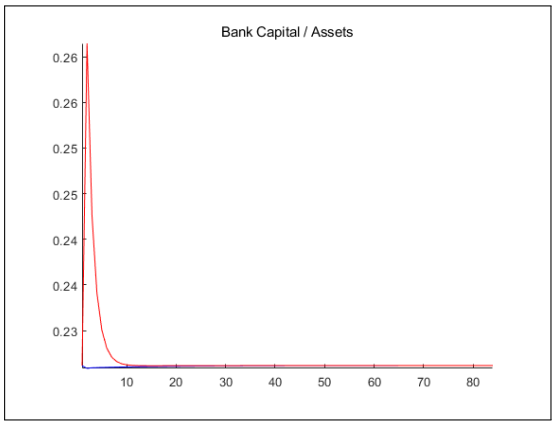

Figure 2.9: Bank net worth to assets ratio

Figure 2.9 shows that the ratio increases with the policy, whereas without policy it wasn't affected much from the shock. While bank capitals are indeed hit as a side effect by the introduction of the policy, their capital adequacies are improved for the duration of the policy.

When we look at the impulse responses against a TFP shock (figure 2.10), we observe that the policy does little to mitigate the initial impact on output, but it does provide a somewhat faster recovery. Consumption drops by 0.5% more than the No Policy scenario, as the production goes to exports. The policy still helps the current account balance by helping exports by 1% and decreasing imports by 2%, where the stable exchange rate (rather than a decreasing one) keeps exports elevated.

Bank net worths decline by 1% more, which feed the decline in capital price and investments, and caused by the reduced foreign borrowing. Inflation rises more than the base case, again coming from the expectations because the immediate effects on the production components are negatively hit, but expected to go positive soon.

In this scenario, the policy's main benefit is that it keeps the exchange rate more stable compared to the baseline scenario, keeping the exports steady, feeding into the output. While this does not stop the output from being negatively affected,

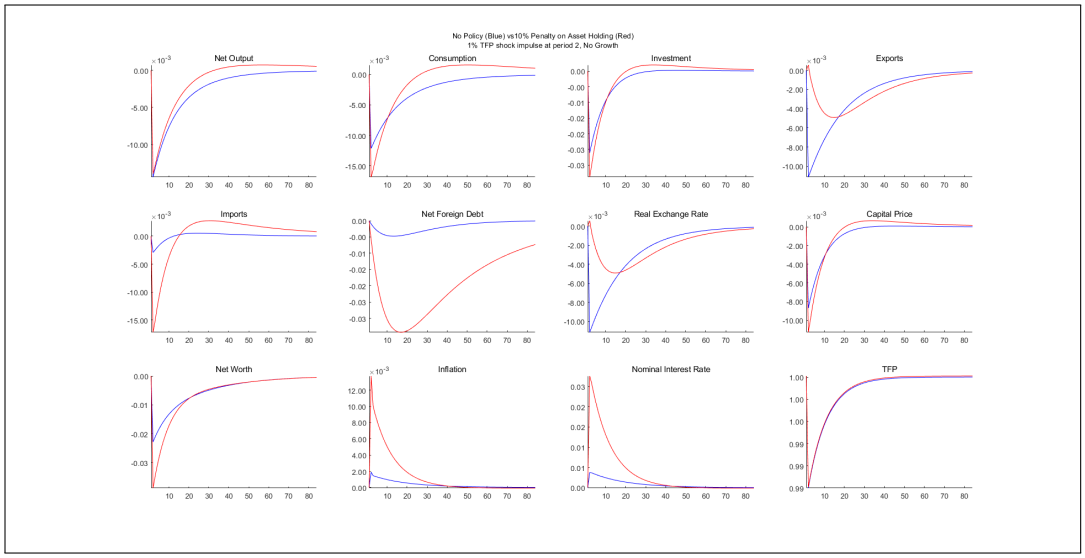

Figure 2.10: Impulse responses to 1% drop in TFP - Baseline vs 10% Asset Holding Penalty

it does help with the quicker recovery. Trade-off of the policy is that it causes the consumption and investment even more sensitive to the shock initially, even though these, too, recover more quickly; and the significantly higher inflation.

We observe that, similarly to the foreign interest rate shock, the policy results in some delayed effects that do not serve well to mitigate the initial impact, but provides faster recovery after some time passes. This situation brings the question of whether applying the policy persistently, and tuning it in either direction would provide a better result.

Figure 2.11 shows that having applied the policy proactively when the shock hits provides some buffer which can be used to mitigate the immediate effects of the shock. By use of persistent 10% asset holding penalty before the shock hits, and easing it to counter the shock, a quarter of the impact on the output is mitigated, as well as those to consumption. Impact on investment is lessened even more, because banks can generate more loans when the penalties are lower.

A side effect of this policy is net exports decline. Exports decline more than the standard case, and imports increase instead of decreasing, leading to a worse current account balance at a time output is declining. Turkish economy generally creates a worse current account deficit when growing vice versa, so under this

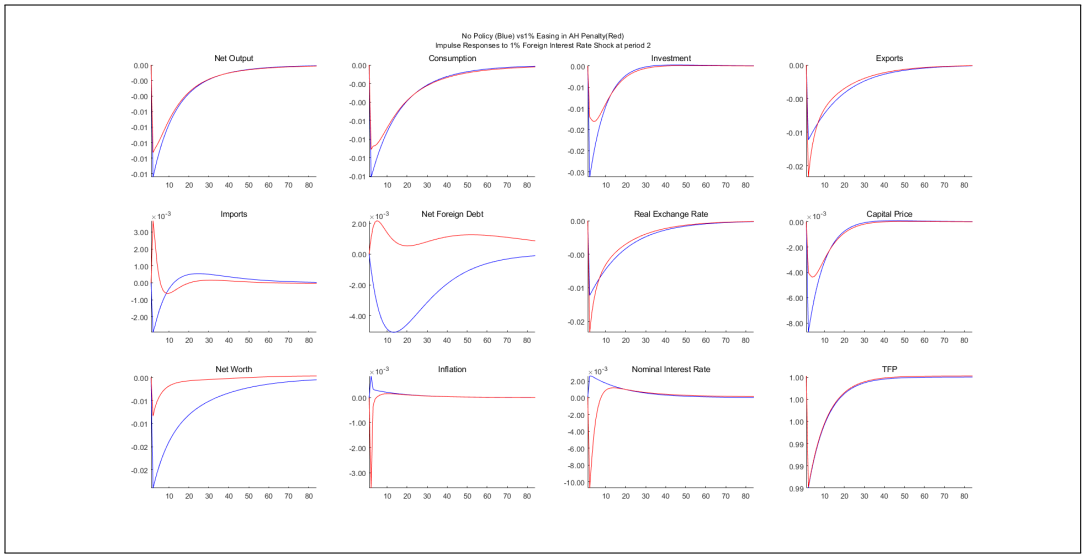

Figure 2.11: Impulse responses to 1% drop in TFP - Persistent AH Policy vs Easing

scenario, when the economy is shrinking, a hit to current account balance might be tolerable.

Lastly, let's look at the monetary policy shock[23] scenario. Impulse responses of the economy against a 1% shock[24] to monetary policy are shown in figure 2.12. Direction of the effects are the same as before, the policy largely counters the interest rate's effect on inflation, and the Central Bank ends up increasing the interest rate even more make the monetary policy work. One observation we make is that output's decline is mitigated by this policy, whereas both consumption and output are impacted greater than the baseline, thanks to the severe credit contraction that comes out of two simultaneous policy decisions aimed at reducing credit. Because of the sharp increase in exchange rates, exports increase and imports decrease in good measure; which, coupled with the worsening credit

[23]Differently from the previous two scenarios, foreign interest rate and TFP shocks, we don't interpret monetary policy shock as another exogenous shock, effects of which we try to mitigate using policy. While the shock on the policy rate is indeed technically exogenous to the model, it is wiser to think of it as a discretionary, rather than rule based, use of policy tools which is still employed as a respond to an outside shock. As such, our discussion's perspective here will be of using joint monetary and macroprudential policies together. It might well be the case that one policy is administered by the Government and the other by the Central Bank, and the independent Central Bank can have a different policy objective than the government. For the purposes of this analysis, we assume that discretionary policies will share objectives and will not discriminate between the two.

[24]Technically, the shock is 0.25% per quarter for four quarters, summing up to 1% over a year. Because of the way we calibrated the Taylor Rule in our model, Central Bank has time to normalize the model a bit, and aggregate shock turns out to be slightly less than the sum of our shocks in the baseline scenario.

conditions, feeds into the hit to consumption and investment. Applying the policy this way can be most suited to shocks that are beneficial to the economy, rather than detrimental, in order to build up reserves to use later.

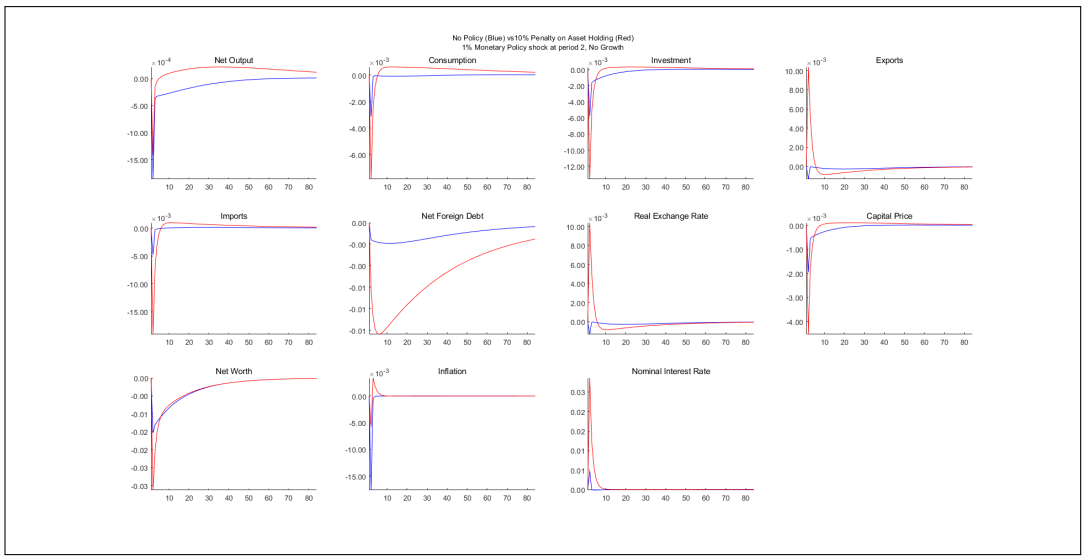

Figure 2.12: Impulse responses to 1% rise in Monetary Policy Rate - Baseline vs 10% Asset Holding Penalty

Similarly to other scenarios, again, bank net worths are negatively affected, leading to increasing exchange rate and decreasing capital price, ending up with 1% more shock to the investment. Exports rise significantly, by 1%, and imports decline by 1% more, as well, greatly helping with the balance of trade, mitigating the impact on output.

Overall effect of the policy, when administered as a response to a shock rather than preemptively, is that it provides quicker recovery from the shock by keeping the exchange rate elevated and improving balance of trade, at the cost of increased inflation and higher interest rates to combat it. Using it before a shock happens, and managing it actively during the periods of stress, can give room to policymakers in managing the trade-offs without sacrificing much.

2.7. MACROPRUDENTIAL POLICY ANALYSIS: PENALTIES ON FOREIGN BORROWING

Asset holding penalties that we discussed in the previous section was a representation of policies that limited bank lending, such as LTV limits, or RWA coefficients in calculation capital adequacy, or other similar limitations, making the banks less hungry for growth, keeping their capital strong against financial shocks. This time we will look at the policies on the liability side of bank balance sheets by limiting foreign borrowing, whose interest rates are not locally managed and therefore subject to outside shocks, and at the lack of internal funding might become a burden on the banks if not managed well. The macroprudential policies limiting foreign borrowing became even more prominent during periods of high dollarization in Türkiye, particularly since 2018.

Table 2.1 shows the reserve requirement rates for Turkish Lira and foreign currency[25] denominated deposits, as of June 2022, taken from the CBRT. We will dedicate a full section to reserve requirements, but we find it valuable to show it here as well, so as to indicate how foreign currency borrowing by the banks are penalized. There were other ways of penalizing foreign borrowing as well, such as the case of Asset Ratio regulation, or the interest rates paid to required reserves, or the limitations of FX swaps, all of which we group under this one policy.

Let us first look at the effects of employing a 1%[26] penalty on foreign borrowing against 1% increase in foreign interest rates, as we did earlier for asset holding penalty.

The shock increases bank funding rate, harming bank profits and reducing their net worth. In this (by now very familiar) fashion, investment drops, production drops, and consumption drops. Because the foreign rate increase also increases foreign exchange rate, inflation increases, and Central Bank increases local interest rate to mitigate the effect. Foreign borrowing decreases as a direct result of this

[25] In this table, and many other places, precious metals are treated like currencies. In the context of foreign borrowing, the concept of a foreign interest rate increase might not translate well to precious metal deposits, a detail we take a note of, but abstract away in our calculations.

[26] Asset holding penalty was 10%, foreign borrowing penalty is 1%. This is intended, due to the way we modelled these policies, effect of a similar magnitude penalty turns out different. Rather than play with the formulation of the model, we simply applied policies at levels appropriate to the shocks.

Reserve Requirement Ratios (%)	
Turkish Lira	**Ratios**
Deposits and Participation Funds	
- Demand, notice, up to (and including) 1 and 3-month	8
- Up to (and including) 6-month maturity	6
- Up to 1-year maturity	4
- 1-year and longer maturity	3
Foreign Currencies	**Ratios**
Deposits and Participation Funds	
- Demand, notice, up to (and including) 1 - 3 - 6 months maturities and up to 1-year maturity	25
- 1-year and longer than 1-year maturity	19
Precious Metal Deposit Accounts	
- Demand, notice, up to (and including) 1 - 3 - 6 months maturities and up to 1-year maturity	26
- 1-year and longer than 1-year maturity	22

Table 2.1: TRY and Foreign Currency Reserve Requirement Ratios - June 2022

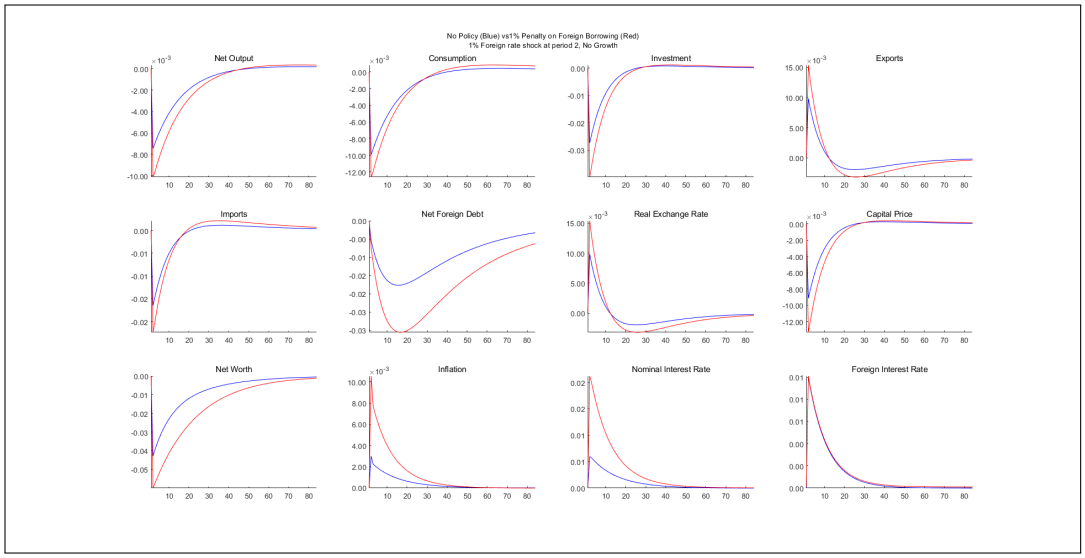

Figure 2.13: Impulse responses to 1% increase in Foreign Interest Rate - Baseline vs 1% Foreign Borrowing Penalty

policy, but curiously not as much as the asset holding policy case, and not as quickly either. Because banks still need to roll over their debt in the beginning, in order to keep funding the firms, they bear the costs of rising interest rates, and the policy penalty.

This scenario is representative of the recent years in the Turkish economy, whereby the Government policy was to gradually penalize foreign funding, first by use of differentiated reserve requirements, and later on by use of macroprudential policies, between the year of 2016 and 2019, and continues with even heavier penalties to foreign currency deposits in 2022. Government's stated aim in this policy was to keep the output growing, but transform the economy towards a current account surplus one eventually, at the cost of temporary welfare setback. In this respect, ceteris paribus, this policy appears to deliver what it was designed for, against the foreign interest rate shocks.

Here we see that it might not be advisable to apply this policy (when there was none) as a response to an increase in interest rate. It might be better suited as a permanent policy, where the banks are never allowed to get this much exposure to foreign interest rate increases begin with, and could even be accompanied by an easing in policy. We saw earlier when analyzing the asset holding penalty policy that keeping a persistent policy preemptively and managing actively when faced

with a shock may indeed help with the immediate impact of the shock. We can see it in the impulse responses that, if this policy was in place when the shock hit, foreign borrowing by the banks would already be low, and they wouldn't need to roll over the debt, and they wouldn't be hit as badly as they do with the current policy.

Effects of this policy as a response to a 1% drop in TFP can be seen in figure 2.14. There isn't anything new here, apart from observing that the policy keeps the exchange rate elevated and helps with the current account balance, while having a worsening effect in everything else. Here, again, we see that this policy is not particularly useful as a response to a TFP shock.

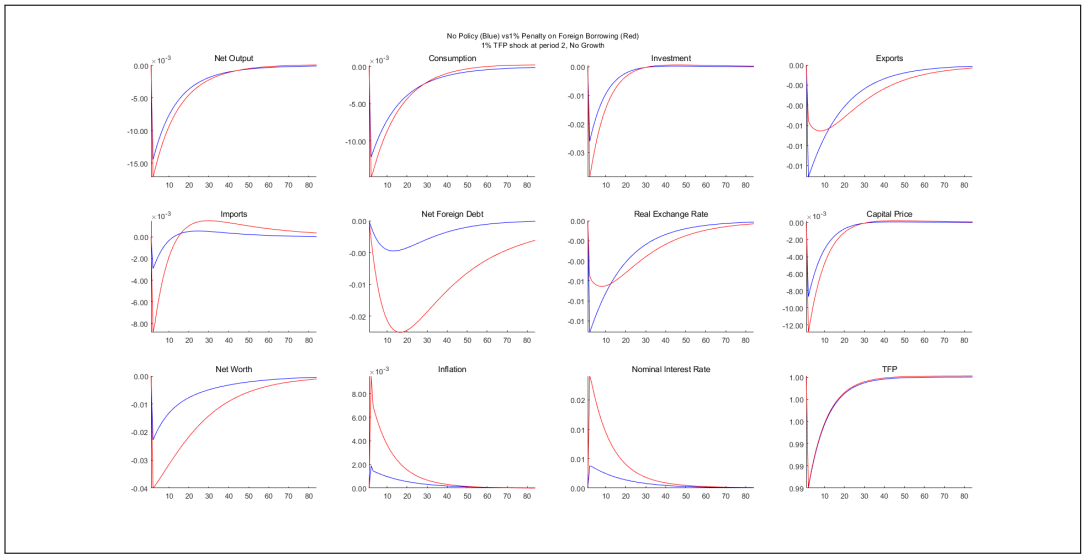

Figure 2.14: Impulse responses to 1% drop in TFP - Baseline vs 1% Foreign Borrowing Penalty

One way the policy does work well is if it is used permanently before the shock, and the policy is to *reduce* the penalty in response to a shock, which can be seen in figure 2.15. The decline in output is dramatically reduced, and so was the decline in consumption. Investment isn't affected at all, because the banks can now borrow in higher quantities, even if it's less profitable to do so and will lead to a drop in their net worth. Inflation drops, though, which might not be as desirable if the inflation isn't already high, and the interest rate follows, which again might not be possible if it's already very low. In the Turkish case, or any emerging market that can be considered a small open economy, both inflation and interest

rates are sufficiently high and the policymakers have room, and even desire, for the reduction in them. This has indeed been the case for the last decade in Türkiye, where the Government pushed for growth policies, asking for interest rate cuts, and their policies at times conflicted with the CBRT's.

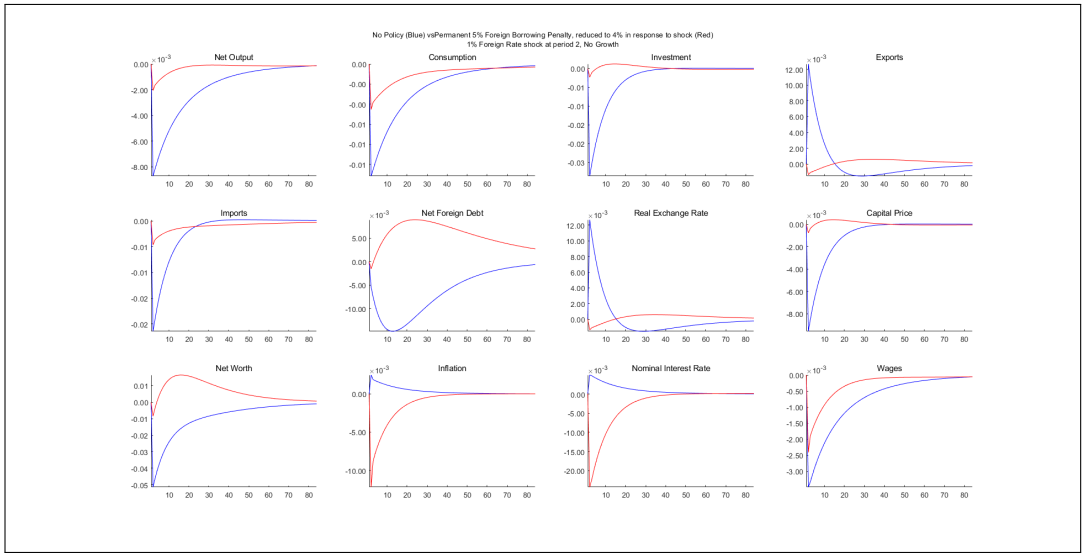

Figure 2.15: Impulse responses to 1% drop in TFP - Baseline vs Permanent 5% Foreign Borrowing Penalty, reduced to 4% in response to shock

Effects of this policy as a response to a 1% shock to monetary policy can be seen in figure 2.16. We see that, economy behaves almost identically with a foreign borrowing penalty to a no policy scenario. The policy amplifies the monetary policy shock, leading to amplified effects in other processes as well. Overall, the monetary policy shock is short-lived due to its nature, and the effects originating from the shock are similarly short-lived.

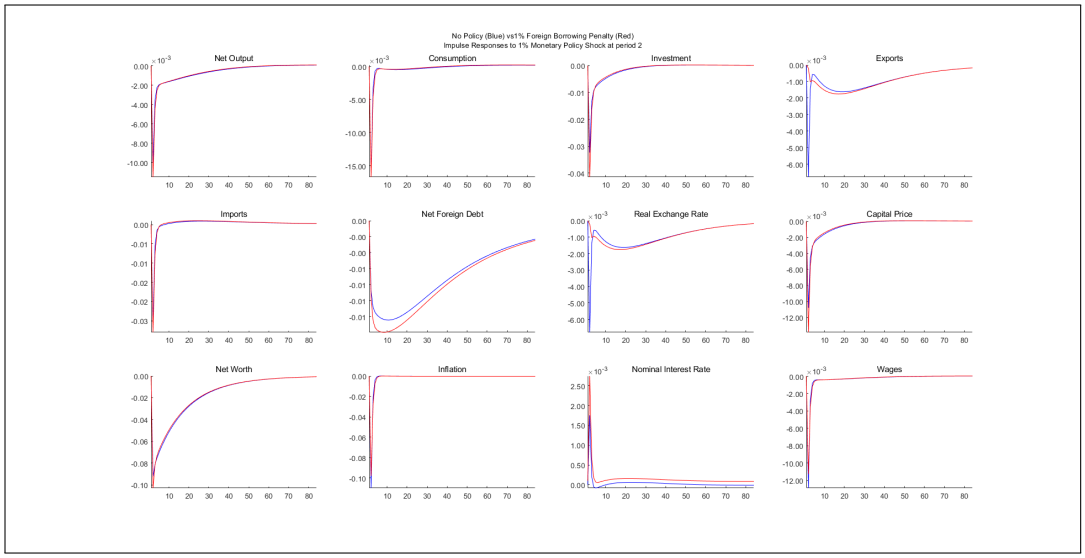

Figure 2.16: Impulse responses to 1% shock to Monetary Policy - No Policy vs 1% Foreign Borrowing Penalty

2.8. MACROPRUDENTIAL POLICY ANALYSIS: RESERVE REQUIREMENTS

Reserve requirement as part of the monetary policy toolkit exists to put a limit on the money supply: If banks can only convert a portion of their deposits into loans, it creates a hard limit on how much money can be created through lending. Typically the reserve requirement rate is a single rate that's applied on the funding of the banks and it isn't changed very often. Until the end of the Great Recession, this was the case for the Turkish economy too.

Its use a macroprudential policy forces banks to keep liquidity buffers against deposit drawdowns, which protects banks in cases high deposit drawdowns. Because in most of Europe and in the US the reserve requirement rates are low, similar to the interest rates, its ability to mitigate liquidity shocks were limited and other liquidity measures such as LCR[27] and NSFR[28] were introduced. In Türkiye, though, reserve requirement rates are sufficiently high, to the point that any bank that holds these reserves usually doesn't have to worry much about the LCR, as the reserves account for most of the buffer needs of LCR.

[27]Liquidity Coverage Ratio
[28]Net Stable Funding Ratio

Figure 2.17: Reserve Requirement Rates History

However, in the case of Türkiye, it was used in the last decade frequently to supplement monetary policy, control credit growth and money supply directly, often in order to delay an interest rate hike by the Central Bank, even though when banks couldn't convert as much of their deposits into loans they raised loan rates anyway. Lately, it was also used as a tool to incentivize loan growth, by giving faster growing banks higher returns because they also paid interest.

We introduce reserve requirement rates as a policy instrument which serves two purposes: First, it places a limit on bank lending through fractional reserves; and second, it gives us a tool to manage credit growth, similarly to how it was by CBRT during 2019 and 2020.

The way it was implemented in Türkiye in 2019 was to provide banks bonuses once they hit a threshold, mathematically a step function. We replicate this step function using a steep enough logistic function (2.18), so that we won't have trouble with differentiation.

Let RR_t be the fraction of funds[29], home and foreign, which has to be held in the central bank, and has zero return. Then the flow of funds constraint becomes:

$$n_t = (Z_t + \lambda Q_t)k_{t-1} - (1 - RR_t)(R_t d_{t-1} + \epsilon_t R^*_{t-1} d^*_{t-1})$$

[29]Here we place the reserve requirements' cost on the asset side of the balance sheet. It was also possible to model it as a tax on total deposits, only difference being on the asset side the multiplier is $1 - RR_t$ and on the liability side the multiplier would be $1 + RR_t$.

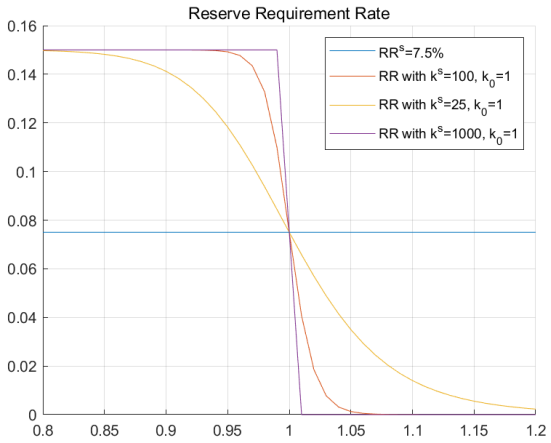

Figure 2.18: Reserve Requirement Rates

We define the reserve requirement rate as an inverted logistic function, higher when credit growth is low and lower when credit growth is high

$$RR_t = \frac{2 \cdot RR_t^s}{1 + e^{-k^s(\frac{K_{t-1}^b}{K_t^b} - K^0)}}$$

where RR_t^s is the base level of reserve requirement rate, K^0 is the parameter governing credit growth target, and k^s is the coefficient of subsidization.

This implementation is different from the single reserve requirement rate that's applied by most central banks, favoring banks when they have stronger loan growth. When $k^s > 0$ and $K^0 = 1$, reserve requirement policy is in its conventional form.

Applying a 10% reserve requirement rate on the otherwise baseline economy, in other words shocking[30] the economy with the reserve requirements, we find the policy[31] responses shown in Figure 2.20. We can see that the new equilibrium is formed differently: Output is lower in the new equilibrium, consumption is lower even more, which is mitigated by the increases in investment and net exports.

[30] We find this valuable to analize at least in the beginning, because it takes policy a while to get to its equilibrium, and a lot can happen on the way.

[31] Note that this is different from the impulse responses, where we apply an impulse and then let the economy go back to normal. Rather, we examine the results of the applied policy on the baseline economy. The y axes of the graphs are in nominal values, rather than percentage or log deviations, in order to be able to see that there is a new, different, equilibrium.

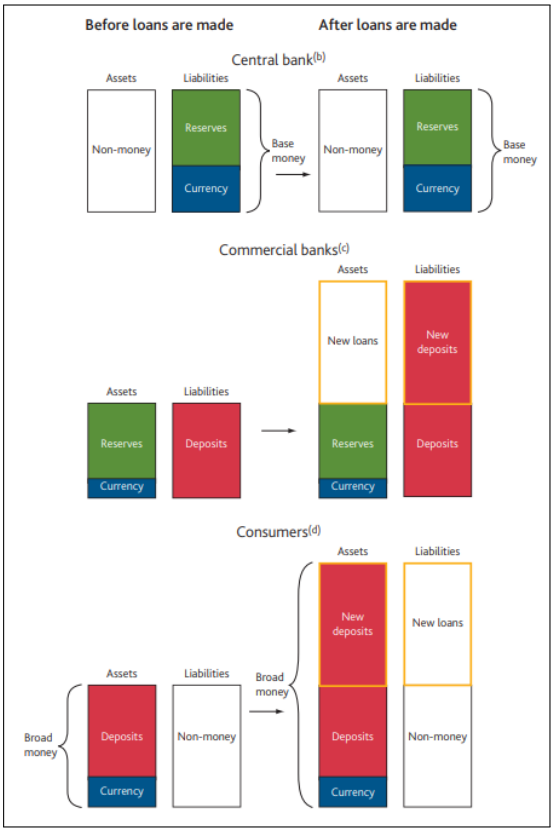

Figure 2.19: Money Creation by Banks (Figure from McLeay, Radia, and Thomas 2014)

The effects are, comparatively to the previous two policies, more sudden because we designed the policy (larger converge parameter) to move similar to monetary policy, as it is often used complementary to monetary policy. Inflation increases by a small amount, and exchange rate also increases.

The effect of reserve requirements is basically putting a cap on bank lending, such that they have to borrow more to be able to provide the same amount of loans, and then convert even more deposits to reserves, converging when the cycle creates $1/RR$ multiple of the initial money supply, capping otherwise infinite money creation by banks shown in figure 2.19.

While in equilibrium banks do not create all the money they can through loan creation, effects of this policy is still reflected in the bank borrowings, which increase to cover the portion of deposits held in reserve requirements; as well as

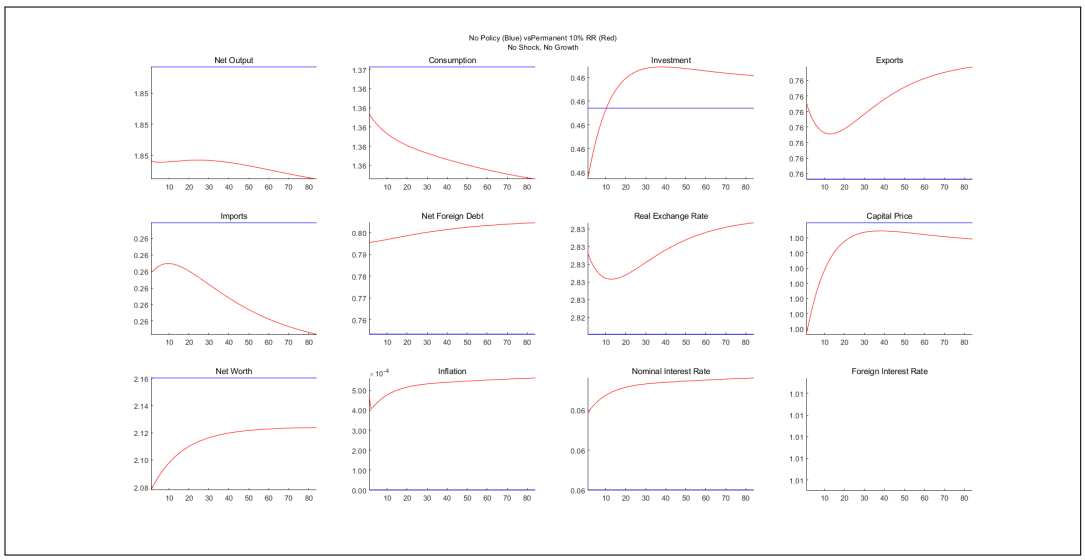

Figure 2.20: Responses of No Policy vs Persistent 10% RR Response, No Shock, No Growth

the bank net worths, where they decline significantly in the beginning and later recovering to a new steady-state which is still lower than the non-policy scenario.[32] It also has an increasing effect on both capital price (which can be a proxy to loan rates), and nominal interest rates. This last finding is curious, since in Türkiye reserve requirement rates are sometimes used to avoid an interest rate hike, but ended up being a precursor to one.

From this point on, we set the reserve requirement rate to 10% as a baseline, and we will analyze the effects of different policies on top of this one. Because the effects are relatively tame and still representative of the Turkish economy as far as economic growth is considered, we keep the parameter values intact, without modifying them to compensate for policy.

Against a TFP shock of 1%, responses the economy with the reserve requirements is shown in Figure 2.21. Because banks can generate less loans now, they need to borrow more from foreign creditors to compensate in case of a shock

[32]Since in our model reserve requirements are essentially non-remunerated assets that the banks have to hold regardless, they have a reducing effect on bank net worths. This is close to the reality, but not exactly so: The immediate impact of a reserve requirement increase is actually an increase in loan rates, because banks need to fund the reserves not by reducing loans but by collecting more deposits and have to pay more interest initially, followed by the loan closures by those businesses who don't want to pay the cost.

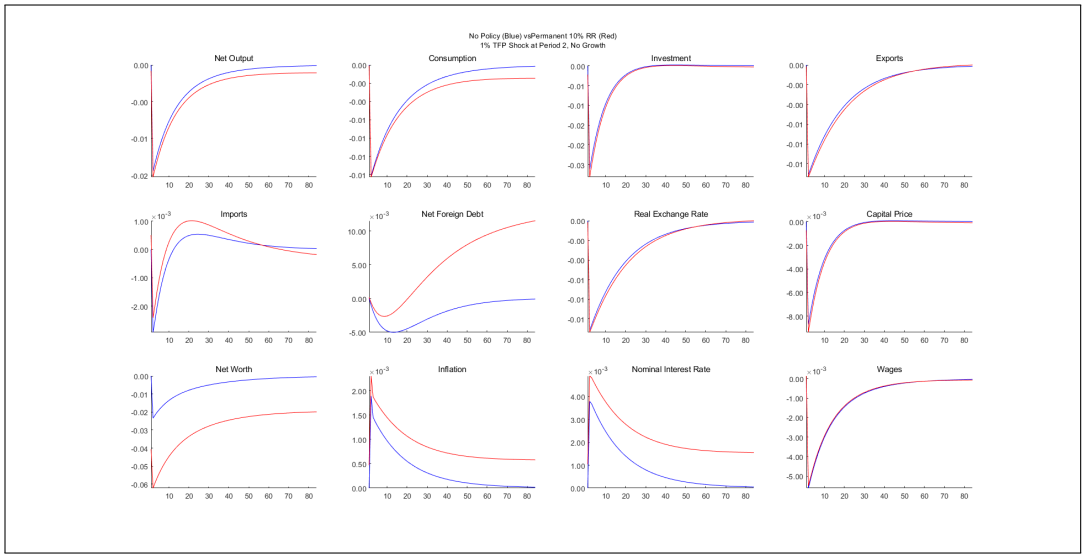

Figure 2.21: Responses of No Policy vs Permanent 10% RR Response, 1% TFP Shock, No Growth

to productivity. Inflation rises slightly more and Central Bank counters it by an interest rate increase. Production and output are slightly worse off, but not by too much, mostly fueled by slightly increased imports because investment and exports are very similar under two scenarios. It appears that the permanent reserve requirements do not provide much protection against a TFP shock, ending up increasing inflation and interest rates even more. On the other hand, reducing the reserve requirement rates at times of TFP shocks may help contain the situation, which of course requires reserve requirement rates to be positive at first.

Using the same reserve requirement policy against a 1% increase in foreign interest rates creates similar results as seen in Figure 2.22. It appears that intorducing reserve requirements, just by introducing a buffer, doesn't do much to mitigate the damage coming from shocks, it even harms the recovery in output and consumption and leads to increases in both inflation and interest rates.

It might be a better idea to use them as active policy tools, such as the case depicted in figure 2.23, where the policy of reducing the reserve requirement rate when faced with a foreign rate shock helps mitigate the impact on output, whereas consumption still declines and so does the investment. Reducing the reserve requirement ratio jumps the bank net worths because they are now allowed to lend more loans, and reduces foreign borrowing. As bank lending increases, so does

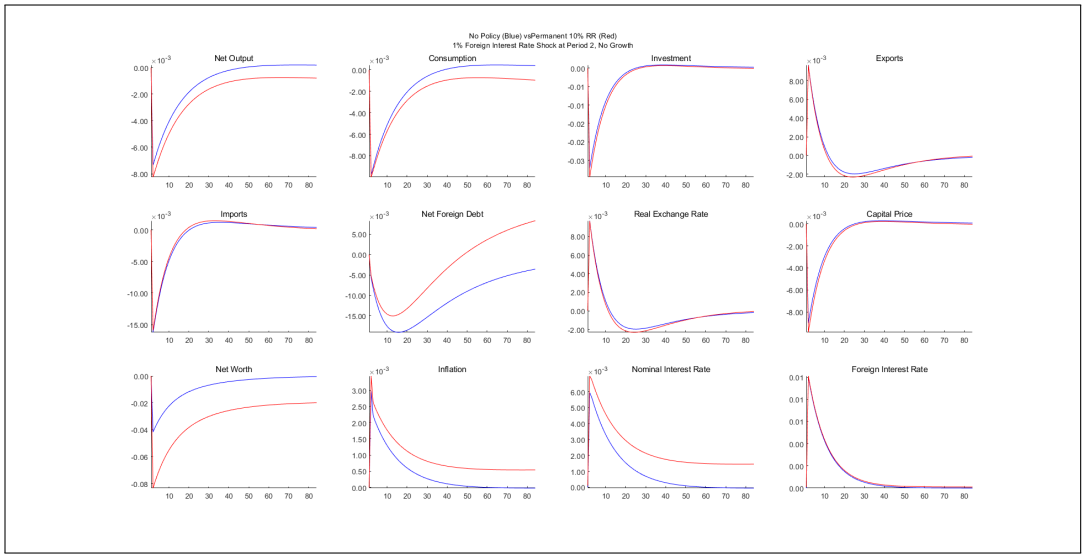

Figure 2.22: Responses of No Policy vs Permanent 10% RR Rate, 1% Foreign Interest Rate Shock, No Growth

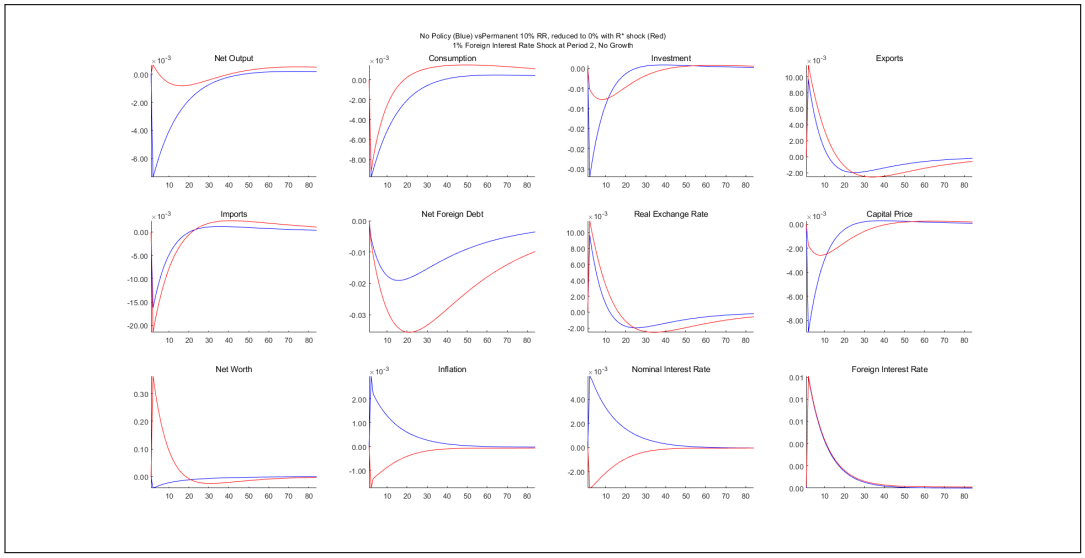

Figure 2.23: Responses of No Policy vs Permanent 10% RR Rate reduced to 0%, 1% Foreign Interest Rate Shock, No Growth

capital price, contributing to the recovery of investment. Reducing the banks' dependency on foreign borrowing contributes heavily in mitigating the impacts of the shock.

Responses of the economy with the reserve requirements against a monetary policy shock of 1%, is shown in Figure 2.24. We don't set the reserve requirement permanent this time, as monetary policy shocks are supposed to be short term

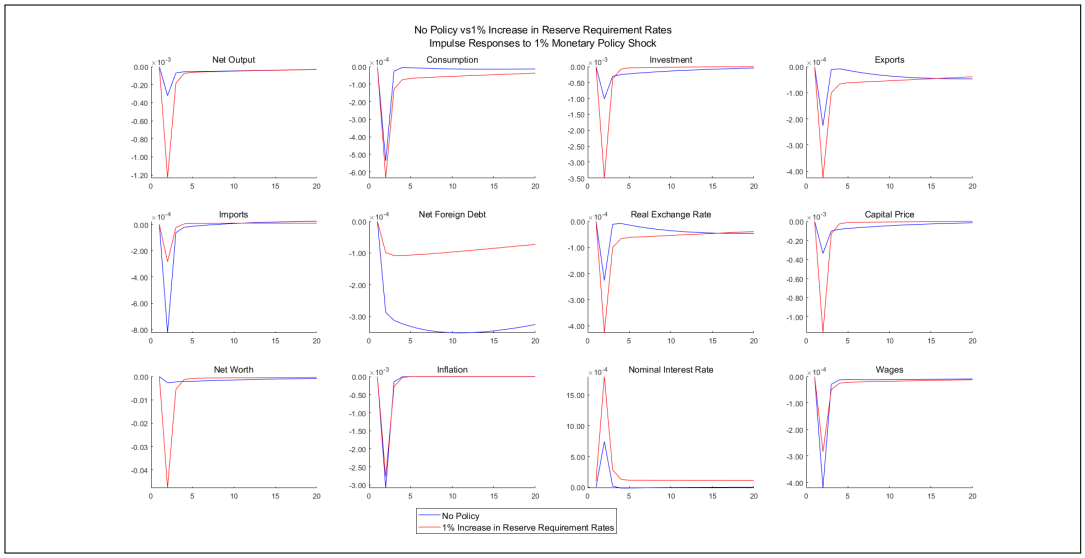

Figure 2.24: Responses of No Policy vs Permanent 10% RR Rate, 1% Monetary Policy Shock, No Growth

themselves and do not warrant a long term policy response. Increasing the reserve requirements when the monetary policy is also tightening compounds the interest rate increase, without negating the inflation all that much.

Bank net worths are significantly impacted, going down by 4%, because of them having to hold more of their assets in reserves. By now we know that this is a pretty typical result of increasing reserve requirement rates. As a result, capital price and consecutively investment drops. The shock creates significant drops in output and consumption as well, led by the declining investment. Because the exchange rate decreases, exports decline and imports rise, contributing negatively to the current account balance.

These results are all in line with our expectations from the policy. Increasing reserve requirement rate takes money out of loans and into the Central Bank accounts, reducing usable money supply by the firms, effectively tightening the monetary policy. Coupled with a direct tightening in monetary policy, it is natural that the effects are compounded. We should not, however, assume that the reserves are not fed back into the system through Central Bank funding. If the Central Bank provides unlimited funding to banks, such as the case it has been for Türkiye since 2016, then increasing the reserve requirement rates doesn't pull money out of the banking system, it merely makes the loans more expensive for banks to lend out,

increasing loan interest rates and indirectly causing a monetary contraction, but not to the amount the reserve requirement policy would.

One common theme that we see here and before in the asset holding penalty and foreign borrowing penalty case is that these policies impact consumption more than they impact output, since they either boost investment or, more likely, net exports. For instance, we saw in figure 2.23 earlier that reducing reserve requirements against a foreign interest rate increase keeps the output elevated, but does not help with the consumption too much. This suggests that, upon using this policy in response to a shock, wage share in output would drop more than it would otherwise. This re-distributive effect of the policy may help explain some of the shifts in the wage share (Figure 2.25). Macroprudential policies were used in early 2010s to keep loan growth under control, mostly in the form of high reserve requirement rates, and the reserve requirements were reduced sharply after 2019, with the interest rates of commercial loans reaching historically low levels in 2020. This period also coincides with the significant drop in wage share, which was partially related to COVID19 policies after 2020.

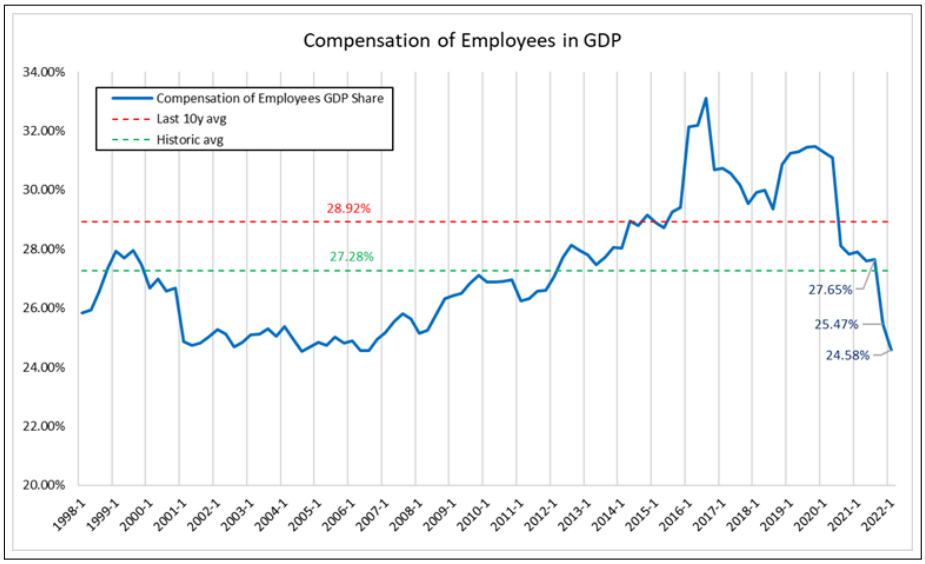

Figure 2.25: Wage Share in GDP

2.9. COMBINED POLICIES

We have defined the reserve requirement policy in our model to follow the credit growth, but so far haven't used this property yet. Throughout most of 2019, reserve requirement rates were used to actively promote credit growth, where the banks with high loan growth were required to hold less reserves. This was to follow the contraction in late 2018, when the Turkish economy was hit by sanctions and higher funding costs following a diplomatic crisis.

In order to reproduce this scenario, we put together the shock scenario first, and then formulate the policy response to it.

First, the shock was a combination of a foreign interest rate shock, because following the increasing CDS[33] premiums rose and borrowing costs of banks in foreign currencies rose with it; and a foreign demand shock as the sanctions hit Turkish exports, as well as tourism. During this period the borrowing costs of banks rose by around 2%, and the exports declined by around 3%, so we pick these as our exogenous shocks.

Second, policy response consisted of a rate hike, aforementioned dynamic reserve requirement rates which on average corresponded to around 6% reserve requirement rate cut, and easing in fiscal policies as well. Penalties in foreign borrowing were not strongly enforced yet, but as part of the accommodative credit policies asset holding regulations were eased, so we factor that part in.

Figure 2.26 shows the impulse responses to the shock for baseline and accommodative policies. We observe that the accommodative policy set provides some protection against the shock, mitigating the impact on both output and consumption. Impact on consumption is mitigated better in terms of percentages, but it was shocked more as well. This is in line with our earlier results, where consumption is more volatile than production.

With the easing, bank net worths first see an immediate 10% jump to the positive, then quickly return to a low of -2%, and then stabilize around the steady

[33]Credit Default Swap, derivative contracts in which investors pay a premium to protect themselves against an entity's default, the entity in this case being Türkiye.

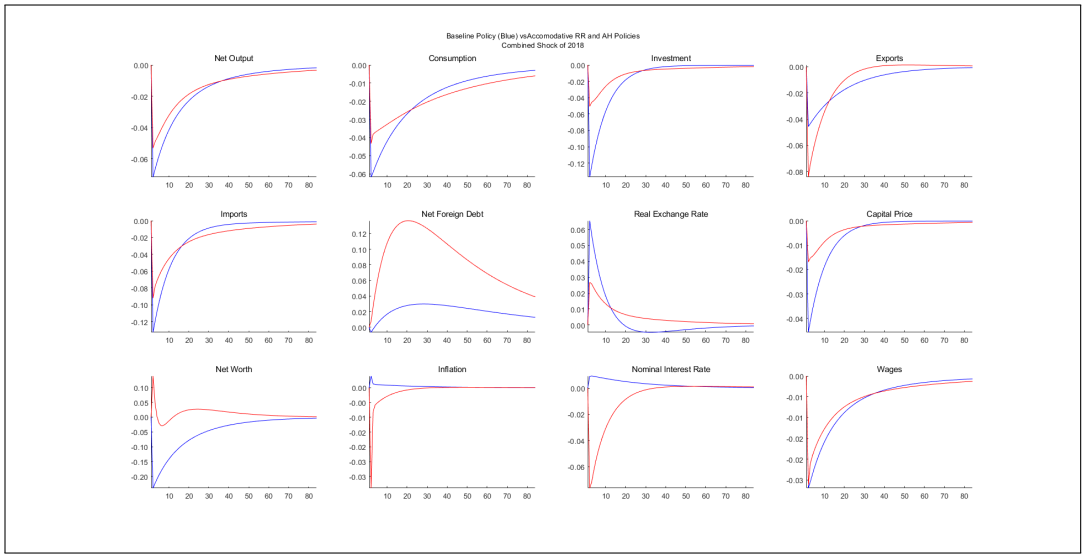

Figure 2.26: Responses of Baseline Policy vs Accommodative RR+AH Policies Against Combined Foreign Interest Rate and Foreign Demand Shocks

state. Bank borrowings greatly increase as the policy comes into effect, which help with the firm funding and investments.

Exports are hit harder than the imports, adversely affecting the current account balance, because the policy keeps the exchange rate in check. This situation creates a trade-off: The way of supporting the economy is by borrowing more from foreign investors and reducing net exports, a path the government is trying to move away from in their latest policies. It is indeed true that the policy set employed here burns policy buffers, and creates a larger foreign currency denominated debt, in turn creating an even larger exposure to foreign shocks. This policy set works as a shock response[34], but is unlikely to be employed for long term. This is also what came to pass, these policies were abandoned quickly after a short while.

This analysis assumes that the borrowing conditions are unchanged with the shock, and banks are still able to borrow without direct borrowing limits. In reality, this wouldn't be the case, banks would in fact have their borrowing capabilities greatly reduced, not just because of the prohibitively high interest rates, but also because of the credit lines getting revoked. Our model allows us to

[34]President Erdoğan once called a similar set of measures "bitter medicine", a necessary but unpleasant treatment, after being forced to implement them during the COVID19 period showing his distaste for such policies.

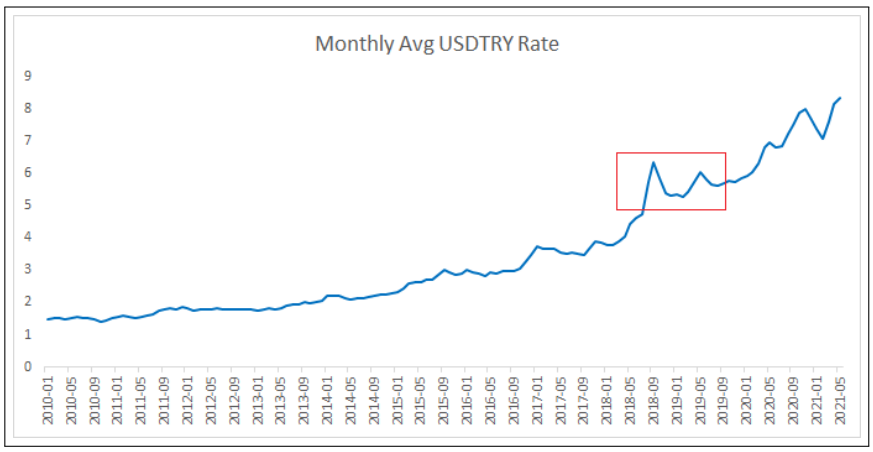

Figure 2.27: USDTRY Rate between 2010 and 2022 - 2018 Highlighted

play around this, by changing θ and λ parameters. For instance, we could make foreign borrowing more expensive as the share of foreign borrowing in bank funding increase by introducing a credit spread in the form of $\hat{R}^* = R^*(1 + \Theta(x_t)s^c)$, where s^c is a measure of credit spread steepness. We didn't find much value in this, however, and decided to not include in the model in our work. A study that focuses on credit spreads, perhaps with exogenous shocks representing political conflicts, could make good use of such an extension.

Our model captures some of the developments of this era, but fails to capture others. For instance, throughout the year exchange rate increased slightly, but at the moment of the crisis it had increased dramatically, as seen in figure 2.27. Of course, we know that this was mostly a political phenomenon, and the worries of investors were exaggerated by the political environment. We also know that the events negatively affected the production output, because the increasing funding costs (because the CBRT had to hike rates) as well as frictions in doing business (in the form of sanctions) got in the way.

It might be argued that, without the policies that were employed throughout the era, effects of these sanctions might have spiraled out of controlled, because investors would compete with each other in reclaiming their funds, leading to an even more severe shock. While that might be the case, our model doesn't include a mechanism which could have simulated a positive feedback mechanism like this, nor is it completely convincing that this is an acceptable policy response as every time a crisis happened, policymakers adopted to the situation.

CHAPTER 3: COVID EPISODE

3.1. INTRODUCTION

In this chapter we will use the model we developed in the previous two chapters, with key extensions to allow for additional shock processes, to analyze the evolution of Turkish economy during the COVID19 episode. We have mentioned a few times in previous chapters that Turkish economy faced the COVID19 shock at a time when it was already stressed by the previous shock period of 2018-2019, and the response policies to COVID19 had to be designed with these constraints in mind. Therefore, when re-performing the the crisis, we will take these serial shocks within the larger definition of COVID19 shock.

COVID19 was first officially diagnosed in November 2019, in China. Within a few months it spread to most of the world, with the United Kingdom, Italy, and Spain being hit exceptionally hard. In these countries, as well as in China before them, the disease was extremely disruptive to the healthcare systems, to the point that hospitals were overwhelmed with COVID19 patients and were not able to provide care for other patients. In order to prevent this from happening, lockdowns and travel restrictions were applied, with cascading effects on the economies.

The disease was declared a pandemic in March 2020, by which time it had spread to the entire globe. Europe was hit badly, particularly Italy and Spain early on (Goumenou et al. 2020), and later including the UK, France and Germany, countries which constitute a large part of overall Turkish export market.

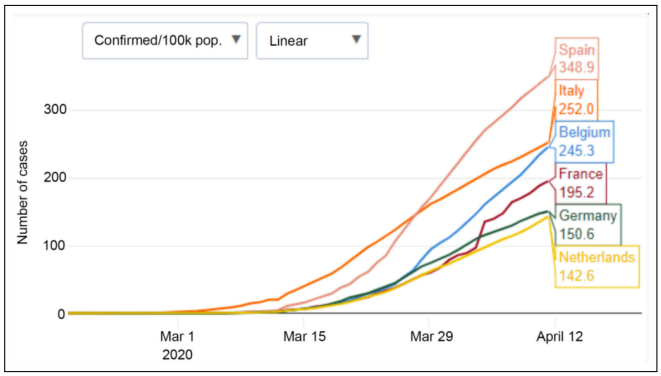

Figure 3.1: Europe Early Covid Spread (Goumenou et al. 2020)

By the time COVID19 pandemic hit, Turkish economy was already under stress. By 2018, it was overheating due to the policies implemented since 2017, with inflation on the rise, and a balance of payments stress looming on the horizon. Political conflict in August with the United States led to a currency crisis, in which rapidly declining Turkish Lira created extra stress firms with foreign debt, and also contributed to an increase in inflation. Within a month, Turkish Lira lost 20% of its value.

The CBRT responded with a crisis rate hike of 6.25% to respond to the spiraling FX exchange rate and inflation, following a period of series of other monetary and financial easing actions, mostly aimed at protecting the Lira and continued flow of transactions, as the sanctions announced by the US . Tables 3.1 and 3.2 show a selected collection developments and policy actions throughout these months.

In this period, international trade of Türkiye suffered, with the exports taking a direct hit under the US sanctions. Inflation rose to over 25% for the first time in over a decade. The interest rate hike move made to control inflation and FX exchange rate resulted in slowdown in economic growth, an outcome that was opposite of what the government wanted.

Türkiye was able to keep out the disease until March, after which it arrived and spread throughout the country quickly, similarly to other countries, although the healthcare system fared relatively better. The country was not caught unprepared, since it had a few months to learn from other countries and its healthcare system was not overwhelmed at any point throughout the course of the pandemic, but it did have to introduce similar restrictions to keep the spread under control, reducing both the demand of several goods and services and the labor supply.

Figure 3.2 shows the annual change in employment statistics. It shows that the employment rate only slightly changed, but he hours worked and gross wages declined significantly, with the hours worked dropping by almost 30%[35], and gross wages dropping by almost 10%, at a time annual inflation was 10.94%. At the same time, we can see in Figure 3.3 that labor cost increases at the same period, indicating that the fewer hours worked per worker corresponded to an increase in

[35]According to Turkstat data, PMI also dropped by 31.4% at its worst, quickly recovering later.

Developments	Effects
06.08.2018 - CBRT adjusts ROM coefficients	USD 2.2 bio liquidity released
10.08.2018 - US President vows to fight over Pastor Brunson	Strictly negative, start of the currency crisis
12.08.2018 - BRSA caps shorting TRY	Limited FX buying swap transactions with 50% of equity
13.08.2018 - The treasury opens 3-month bill auction	TRY 545 mio nominal sold with avg 24.28 compound
13.08.2018 - The CBRT takes some liquidity measures	USD 10.5 bio excess liquidity released.
13.08.2018 - No 1 week repo auction from CBT for 4 days	No more low rate TRY liquidity from CBRT with 17.75
14.08.2018 - BRSA new exchange rate assumptions favorable for CAR	Increased Banks' capital adequacy ratios, allowing room for credit growth
15.08.2018 - Qatar says to make direct investment worth $15 bln in Türkiye	Generic positive sentiment
15.08.2018 - CMB reduces leverage in FX platform deals from 1:10 to 1:1	Increased control over shorting TRY
15.08.2018 - BRSA caps shorting TRY	Limited FX buying swap transactions with 25% of equity
16.08.2018 - Finance Minister Berat Albayrak meets investors in London in a conference call, targets low inflation and modest growth	Positive sentiment, but opposite of overall government policy, did not carry much weight
17.08.2018 - S&P and Moody's downgraded credit rating of Türkiye	Negative impact
27.08.2018 - Finance Minister Berat Albayrak convenes with France Economy Minister Bruno Le Maire	Positive political development
29.08.2018 - CBRT limits bank ON borrowing at the Interbank Money Market to 44 bio TRY (was unlimited since 13 Aug, double of pre-13 Aug amount)	Can be interpreted as a sign of possible tightening, with a positive effect
31.08.2018 - CBRT set to launch TRY swap market (vs FX)	Allowed banks to borrow cheaper money
31.08.2018 - By presidential decree,TRY deposits tax rates are decreased, FX deposits tax rates are increased	Increased demand in TRY

Table 3.1: Selected Developments from 2018 - August

Developments	Effects for the Sector
03.09.2018 - Türkiye CPI and PPI are released (Aug CPI : 2.30% MoM)	Negative impact on exchange rate
03.09.2018 - CBRT started transactions in BIST VIOP Future contracts	CBRT using derivative instruments new development
10.09.2018 - CBRT swap settlement facility for transaction in TL depo vs FX depo auctions	CBRT gave an option to Banks to book 1 week tenor TL depo vs FX depo auctions transactions as swap with CBRT.
13.09.2018 - Decree to use TL in purchase,sales and rental contracts	Created uncertainty in Markets as details were not clear - impact expected to be minimal if regulation affects just a limited range of sectors like shopping malls etc
13.09.2018 - CBRT MPC Meeting, One Week Policy Rate Hike ; From 17.75% to 24.00%	CBRT Hiked more than expectations and put emphasis on ”Tight stance” until inflation outlook displays a significant improvement - Perceived Positive
17.09.2018 - Planned Turkish Government measures to help banks about bad loans resulting from rapid TL depreciation and increase in TL rates	Positive effects to the sector as this will increase transparency in corporate and bank balance sheets.
20.09.2018 - New Economy Program Announced by Ministry of Treasury and Finance	Perceived positive, with tight fiscal policy measures and control on expenditures.
06.10.2018 - Details and exemptions of the Presidential decree (on the limitations to sign FX contracts for locals) announced in official gazette.	The details started to be evaluated on related contracts base. Potential effects on operational FX position generation will be clear after the analysis.
12.10.2018 - Turkish court releases US pastor Brunson - The court did not adopt a travel ban, enabling Brunson to leave Türkiye	Positive effects on markets in general, TL gained against USD. Possible sign of thawing relations between US and Türkiye.
02.11.2018 Türkiye-US mutually lift sanctions on ministers	Positive effect on markets. Strong sign to restore confidence between two countries. Formal end of political crisis.
05.11.2018 Türkiye given exemption on US oil sanctions against Iran	Positive news that reinforces better US-Türkiye relationship for the future.
01.11.2018 CBRT Starts Swap transactions	CBRT starts one week tenor swap transactions with banks. CBRT receives USD and gives TL.

Table 3.2: Selected Developments from 2018, September-December

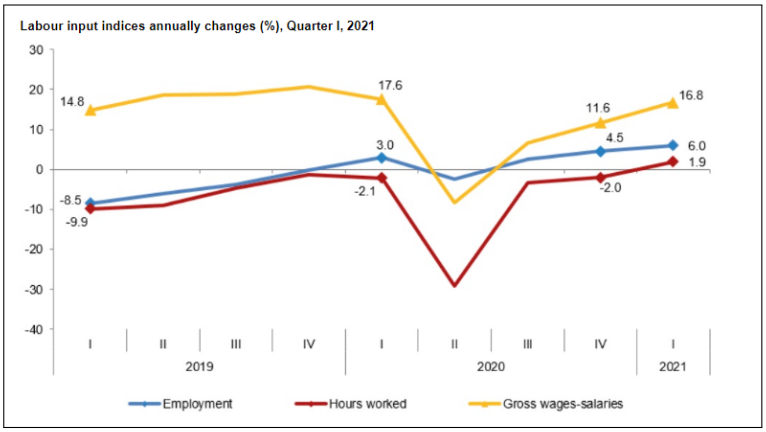

Figure 3.2: Türkiye Labor Input Indices 2019-2021 (Source:Turkstat)

hourly labor costs.

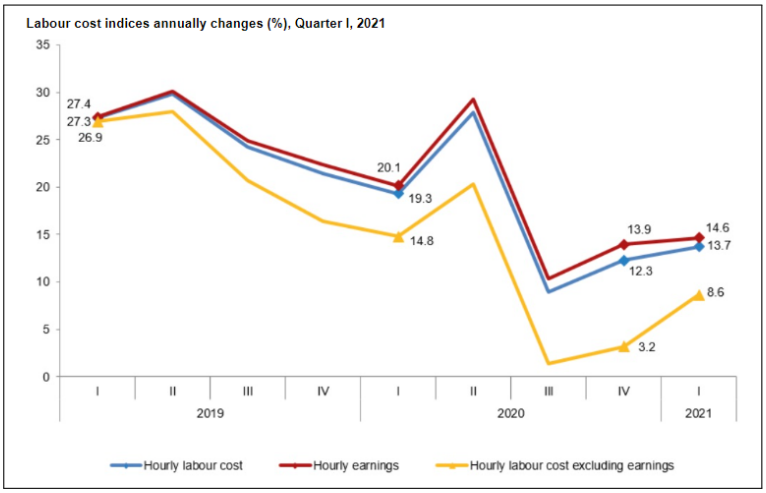

Figure 3.3: Türkiye Labor Cost Indices 2019-2021 (Source:Turkstat)

Another shock came from the export demand channel. The restrictions that negatively impacted the economies around the world impacted trade between nations as well. This shock came both from reduced aggregate demand around the globe, and also from the stressed supply chains' inability to deliver trade goods. This second part was analogous to TFP shocks in the domestic economy, where frictions in the flow of trade create a reduction in sales volumes, reducing productivity. Figure 3.4 shows the export and import volumes of Türkiye in the last decade. Two periods draw our attention: In 2018 the imports declined sharply during the political crisis with the United States, following the currency crisis and the accompanying monetary and fiscal measures, and in 2020 both exports and

imports declined during the COVID19's initial shock, with the decline in exports leading by a few months. We also observe that both imports and exports have been increasing since this shock, with both exports and imports reaching historically high amounts. This suggests a rebound period following the shock, one that might partially come from the prevailing policies of this era, or the long term effects of the previous policies, something we will try to decouple within our analysis.

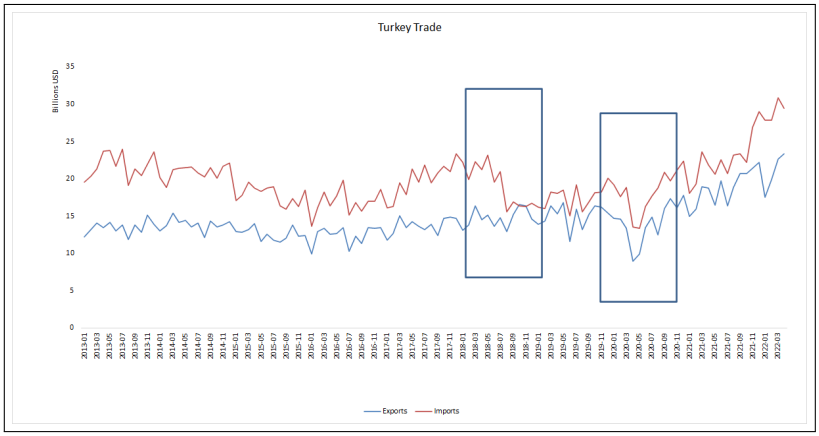

Figure 3.4: Türkiye Exports and Imports, 2018 and 2020 Shocks Highlighted

Related to the perceived risk stemming from the pandemic, risk premiums around the globe increased, and even more so for Türkiye, effectively acting as a foreign interest rate shock despite both the US and EU adopting incredibly loose monetary policies, including large quantitative easing packages, leading their interest rates to historically low levels. Increasing CDS premiums over-weighed the declining interest rates, resulting in higher overall interest rates for foreign debt holders.

In response to the prospect of slowing economy, as was seen in China and later in Europe, Central Bank of Türkiye quickly loosened[36] monetary policy, cutting their rates in March and again in April, and doubling down on the accommodative dynamic reserve requirement policy. It also opened up swap lines with even cheaper rates, and eased collateral requirements for Central Bank funding, effectively providing unlimited funding to banks so that they wouldn't be liquidity-stressed during a time where they were expected to be creating credit

[36]CBRT had been slashing interest rates since July of previous year, as the diplomatic crisis had ran its course. They were already on the trajectory of cutting rates further, pandemic just hastened the process.

quickly. Change in reserve requirement policy before COVID19 was already accommodative, and with the introduction of Asset Ratio on top of it, credit growth increased immensely, funding the firms.

Macroprudential policy was also eased, but it too was already loose, most of the buffer it provides having been spent during the 2018's currency crisis. Reserve requirement rates had already been lowered, and reserve option mechanism had been eased for banks. LTV ratio limits of mortgage and auto loans were increased, in some cases allowing the full value of the purchase to be made by credit. Loan maturities were already short, both structurally and by regulation. Fortunately, though, banking sector as a whole had been prudently managed, with decent NPL and capital adequacy ratios. Helped by the CBRT on the liquidity front, where the CBRT pledged to provide banks unlimited liquidity, banks had room to shoulder the burden, which they had to, because the government was unwilling to increase the budget deficit further and the foreign currency reserves had been used up prior to this, leaving little room to maneuver for government alone.

From the fiscal policy aspect, the stimulus package was similar to those of other countries'. Taxes on imported goods were increased in order to boost demand on domestic goods and also because it was undesirable to keep imports at pre-crisis levels when exports plunged. Taxes of many sectors were deferred until later, and some saw tax breaks as well. Limits on Credit Guarantee Fund were increased to make room for even more bank lending. Overall expenditure by the government has been limited to around 5% of GDP, a comparatively small number given most of the advanced economies spend well over 10% of their GDP, lead by Germany which spent 32% of its GDP to COVID19 relief.

As of 2022, COVID19 is in decline and is no longer a big economic concern in most of the world, with some exceptions in China and some parts of Africa. Throughout 2020 and most of 2021, however, it created great disruption in economies all over the world, impacting production and trade alike, because of the restrictions put in place by governments. The lockdown measures taken by most governments led to great shocks to aggregate supply and aggregate demand, creating structural shifts in sectoral divisions, and forcing governments to respond to all these shocks.

3.2. RELATED LITERATURE

COVID19 was first seen in late 2019 in China, and within three months covered the entire globe. It was declared a pandemic by World Health Organization on March 11, 2020 (Cucinotta and Vanelli 2020); and it is still the case as of end of 2021. It killed over 5 million people in the past two years, hospitalized many more, and caused great disruption to all aspects of human life. While the human cost of the disease has been great, we will take one step back to focus on our field. We will study the effects of COVID19 from a macroeconomic perspective, and examine the effectiveness of monetary policies in response to it.

Analysing the pandemic in the earlier days, (Cakmakli et al. 2020a) and (Cakmakli et al. 2020c) builds epidemiological SIR models, formulating a potential lifespan of the disruptions in the economy. They find that while lockdowns do cause some economic disruption, larger problems arise from the collapse in domestic and foreign demand, or the "fear factor" that the pandemic causes; therefore the lockdowns should not be avoided. Looking back, we see that these risks largely did not materialize because the pandemic was indeed contained via the lockdowns, it is valuable in its analysis of domestic and foreign demand shocks nonetheless. They also find that economic costs of the pandemic are larger for an open economy, by amplifying shocks through international production, as well as decreasing foreign demand; in addition, declining capital flows contributing to capital shortages for firms. They draw from the 2001 crisis of Türkiye, formulating optimal policy to deal with a triple crisis of balance of payments, banking, and sovereign debt. Thankfully none of these risks materialized, but it came at a cost of high inflation, spiraling exchange rate, and increasing interest rates.

One thing we need to do is to find a way to model the COVID shock. COVID19 was a demand shock because people staying home meant that a lot of economic activity was suspended; but it was also a supply shock because of the reduced labor input, and if sustained for a long period, because of reduced capital input as well. In the literature, (Brinca, Duarte, and Castro 2020a) measures the COVID19 effect and finds that it was more of a (labor) supply shock and less of a demand shock, but it was not uniform throughout different sectors. For instance, for manufacturing the impact was comparatively small and led by supply shock,

while for leisure and tourism the impact was very large, with demand and supply shocks closer. On the other hand, information and e-commerce sectors faced positive demand shocks. (Rio-Chanona et al. 2020a) has similar findings for the US economy, showing major disruptions in entertainment and tourism, and also finding that high-wage earners in office jobs are relatively less effected.

In terms of modelling the shocks, (Caballero and Simsek 2020) has some complex findings in which supply shocks create larger demand shocks under incomplete markets through a Keynesian mechanism. They also offer lockdown measures and fiscal policy solutions to mitigate the shocks. While we will not include a similar endogenous supply and demand interaction in our model, we can use their results to check against our model.

(Brodeur et al. 2021) provides an extensive literature review of COVID19-related economic research, and divides the areas of research into five broad areas: Measurement of COVID19 spread, social distancing regulations, economic impacts of COVID19 and mechanisms of them, socioeconomic consequences of lockdowns, and policy measures and regulations implemented in response. They purposely stay away from its effects on the financial markets. These two points are where we want to make our contribution. I) how effective the policy measures in Türkiye were, and II) how interest rates and exchange rates were affected.

3.3. COVID19 SHOCK

The year of 2020 was remarkably different from other years, for it was the first year where the world had a deadly pandemic that threatened to overwhelm healthcare sectors throughout the world, and countries had to implement varying degrees of lockdown measures. It's not the first modern pandemic, swine flu was also one, but it is the first one that had a significant effect on economies because of the burden it put on healthcare systems, and the severity of measures that followed.

The measures governments took varied in practice, along with their aims. In order to provide some relief to the healthcare systems, policies were first developed to address the spread of the disease. Initial regulations would target

reducing contact, also causing less interactions among the populace. They halted most air traffic, closed down most restaurants, and declared varying levels of lockdowns. All of these measures, directly or indirectly, reduced demand for most goods and services (although increased some of them); and because the workers themselves stayed at home, reduced labor supply and consequently finished goods supply.

The negative effect of these measures were severe, some countries saw their GDP drop as much as 40% in a single quarter. Looking at the contributing factors to this GDP loss, both supply and demand shocks are present. On one hand people staying at homes didn't consume many of the products they previously consumed, on the other hand they also worked and produced less.

There are emerging studies on how large the supply and demand shocks are. Studies such as (Baldwin and Tomiura 2020) examines different sectors to see how badly they were affected, (Rio-Chanona et al. 2020b) looks at the first order effects of the restrictions and find that sectors such as transport suffer from demand shocks and manufacturing, mining, and services suffer from supply shocks, also noting that feedbacks of these shocks will persist throughout years. On whether supply or demand shocks are larger, (Brinca, Duarte, and Castro 2020b) finds that the drop in labor supply is significant, and (Brinca, Duarte, and Castro 2020a) has the same findings (figure 3.5), hinting that three quarters of the total shock came from supply shocks.

In light of these studies, we implement the COVID19 shock in two ways in our model: On the supply side, we add an exogenous variable to the production function to shock the labor supply; and on the demand side, we add an exogenous variable to the demand function.

Intermediate goods production function becomes

$$y_{it} = A_t \left(\frac{k'_{it}}{\alpha_K}\right)^{\alpha_M} \left(\frac{m_{it}}{\alpha_M}\right)^{\alpha_m} \left(\frac{\hat{l}_{it}}{1-\alpha_K-\alpha_M}\right)^{1-\alpha_K-\alpha_M}$$

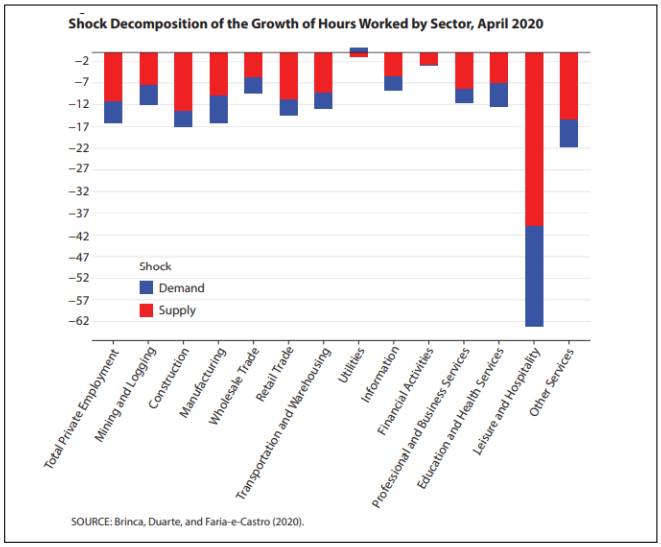

Figure 3.5: Sectoral Labor and Demand Shocks of COVID19

where

$$\hat{l_{it}} = (1 - \phi_l) l_{it}$$

and ϕ_l is the percentage shock given to the labor supply.

As the labor input the intermediate goods is shocked, household labor supply is also shocked to the same amount. Household utility therefore becomes

$$E_0 \left[\sum_{t=0}^{\infty} ln \left(C_t - \frac{\zeta_0}{1+\zeta} \hat{L}_t^{1+\zeta} \right) \right]$$

where

$$\hat{L_t} = (1 - \phi_l) L_t$$

Shock to labor follows an AR(1) process, $\phi_l = (1 - \rho^{\phi_l})\bar{\phi_l} + \rho^{\phi_l}\phi_{l\prime} + \varepsilon^{\phi_l}$,

where $\bar{\phi_l}$ is the steady-state average of the shock, commonly zero, and $\phi_l\prime$ is the shock of previous period, dropping time subscripts for simplicity. We choose $\rho^{\phi_l} = 0.7$, such that labor recovers most (95%) of the shock within two years.

We represent the demand shock as a pseudo taste shock on labor-consumption preferences of households, by shifting the baseline labor constant:

$$E_0 \left[\sum_{t=0}^{\infty} ln \left(C_t - \frac{\zeta_0 (1 + \phi_d)}{1 + \zeta} \hat{L}_t^{1+\zeta} \right) \right]$$

where ϕ_d is the shift in preference, reducing the negative contribution to utility from labor if $\phi_d > 0$, and increasing consumption demand. Similarly to labor shock, shock to demand follows an AR(1) process, $\phi_d = (1 - \rho^{\phi_d})\bar{\phi_d} + \rho^{\phi_d}\phi_l\prime + \varepsilon^{\phi_d}$, where $\bar{\phi_d}$ is the steady-state average of the shock, commonly zero, and $\phi_d\prime$ is the shock of previous period. Again similarly to labor shock, we choose $\rho^{\phi_d} = 0.7$, such that demand recovers 95% of the shock within two years.

Foreign demand already exists as an exogenous variable in our model. Export demand for final goods is

$$E_{X_t} = \left(\frac{P_t}{e_t P_t^*} \right)^{-\varphi} Y_t^* = \epsilon_t^{\varphi} Y_t^* \tag{24}$$

where e_t and $\epsilon_t = e_t P_t^* / P_t$ are the nominal and real exchange rates, P_t^* is foreign price nominal level, φ is a constant price elasticity of foreign demand, and Y_t^* is an exogenous variable of foreign demand, using a decreasing function of relative price of the export foreign income.

Foreign interest rates, which we want to shock when creating the COVID19 shock, also already exist in our model and we have been using them extensively as a key part of our analyses.

One key issue with the COVID19 policies is that we cannot easily use regular optimization methods because the shocks are so large. It is also difficult to use higher order solutions because of the computational complexities. Still, we are able to simulate the shock paths and the policy responses together for a given policy, even though the solution might not be mathematically elegant and might require brute force computations.

Now, we briefly go over the effects of the shocks labor and demand shocks that we recently introduced, then look at the combined shocks, before we move forward to policy responses.

Impulse Responses to Labor Shock

We first analyze the effects of labor supply shock, laying the groundwork in recreating the COVID19 shock, and will continue with the demand shock next. Restrictions around the country, particularly the lockdowns and travel restrictions, caused the workers to stay at their homes to some degree and reduced their contribution to production, which we believe is best[37] represented by a shock to labor supply.

Figure 3.6 shows the impulse responses to 1% shock to labor supply, compared to the steady state. Because labor declines, it directly translate into declining output and consumption, because less labor translates into both less contribution to production and at the same time less wages earned by workers. Output drops by less than consumption because the increases in investment and net exports mitigate some of the effect.

Inflation drops with the declining consumption, to which monetary policy responds with cutting domestic interest rates. Exchange rate increases along with these, contributing to more exports and less imports, resulting in better net exports. Because more capital is required to counteract the reduction in labor, its price also

[37] We also considered that we could represent it with a TFP shock, in which labor's mobility reduces and therefore productivity declines, rather than the nominal amount of labor. This would feed into the production function similarly, as both TFP and labor are multiplicative factors in the same equation. We consider that our choice represents the shock better, as indeed it was the workers themselves that were affected by the disease, rather than total productivity of labor, imports, and capital.

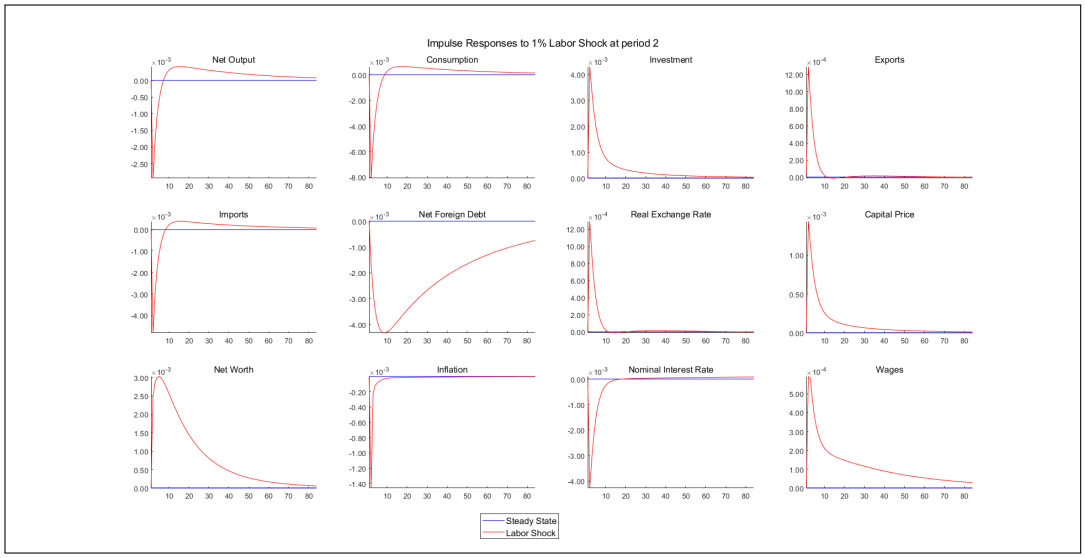

Figure 3.6: Impulse Responses to 1% Labor Shock

increases, which also increases bank profits and their net worth.

Figure 3.7: Labor and Wages Under Labor Supply Shock

Because labor is now more scarce, wages increase to complement it, but not to the degree that it recovers the lost income of the workers. One could expect that the scarcity of labor could lead to increasingly higher wages and lower firm profits, but in our model firms respond by reallocating their resources to capital investment, even if it has a higher cost as well. In fact, the wage increase is marginal compared to the labor shock itself (figure 3.7), and this process ends up transferring net worth from workers to banks and firms.

Impulse Responses to Demand Shock

Next, we look at the effects of a domestic[38] demand shock, which was the second part of the COVID19 shock. Same restrictions that negatively impacted labor supply also negatively impacted demand, since consumers locked in their houses or otherwise limited in their mobility tended to consume less. The effect wasn't the same for all sectors, of course, necessities were not impacted much, while leisure and travel were greatly impacted. We don't have the sectoral breakdowns in our model, and we look at the aggregate demand.

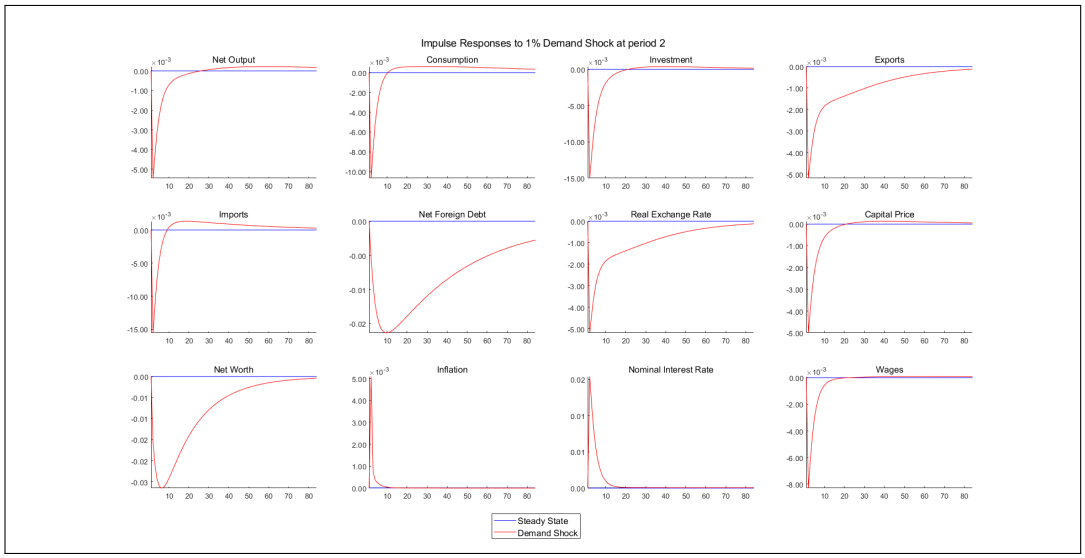

Figure 3.8: Impulse Responses to 1% Demand Shock

Figure 3.8 shows the impulse responses to a shock to domestic demand. Under the demand shock scenario, all processes in the economy are impacted negatively. Demand is proportional to consumption, so it is hit directly. Output drops by half the rate of consumption as even though consumption and investment are impacted badly, net exports remain neutral.

While production is slowed down by reduced demand, so do the components of production: Wages go down, capital price goes down, and bank lending goes down. Because the demand for imported goods decline as well, exchange rate also

[38]Foreign demand, or export demand, is a different process in our model, already included it in the baseline model.

goes down. Curiously, inflation rises despite declining marginal costs of production, coming from future expectations as the consumption goes slightly into the positive before returning to steady state, and central bank responds by increasing interest rates.

The demand shock is felt across the entire economy, as it causes a shock to production from the demand side, and because our model doesn't have inventories moving from one period to another, firms respond by reducing production. This is not the case for most products in the economy, an aspect of the model that can be extended in a future study. Size of the impact is comparatively not as severe as the labor supply shock, however.

Impulse Responses to Combined Labor Supply, Demand, and Foreign Demand Shock

At this step, we look at the combined labor supply, domestic demand, and foreign demand shock. For simplicity, we assumed that these shocks happen simultaneously, although we know that the shocks arrived gradually throughout the earlier months of 2020.

Impact of the combined shock can be seen in figure 3.9. All three of the shocks are negative, so the output is impacted directly. While the output turns positive eventually, it goes deeply into the negative in the first few periods. As before, consumption is impacted even more, as the effect on output is mitigated by investment and net exports.

Combined impact on wages is initially negative, indicating that the effect by the demand shocks is larger than that of the labor shock, but it turns positive quickly and remains positive for a long time. Still, even though wages increase by a small amount, the impact on labor supply (we could interpret this similarly to employment) is significantly higher and the net effect on wage income is strictly negative.

Increasing investment is funded by increasing bank borrowings, which improve the bank balance sheets, and increases capital prices as well. At the same time, share of imports in production decline, and this reduces the need for foreign borrowing by banks. This is comparatively a good development for the economy,

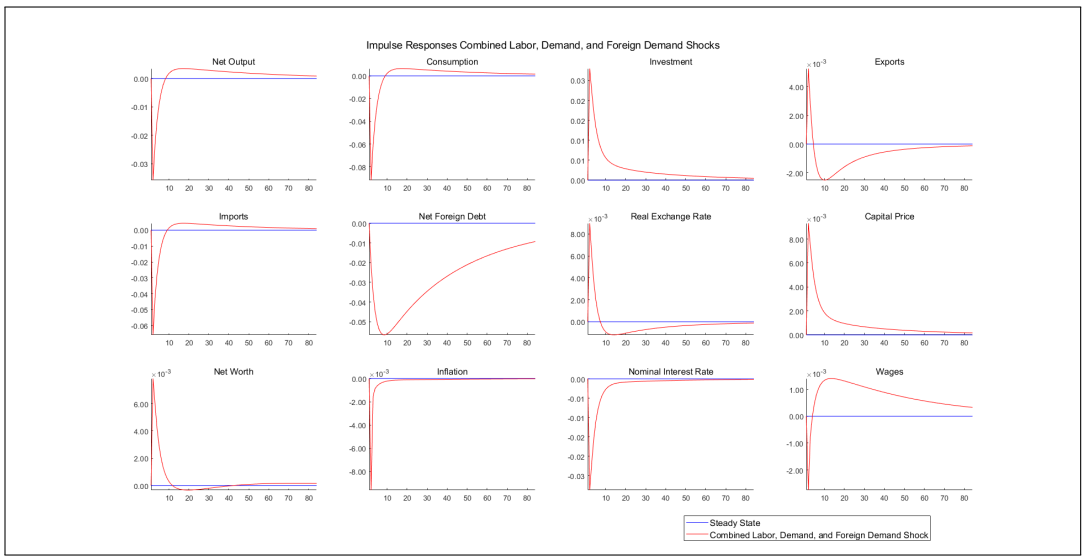

Figure 3.9: Impulse Responses to Combined Labor, Demand, and Foreign Demand Shocks

as the following year after the COVID shock, foreign interest rates will rise to combat inflation, and the economy will be subject to a financing shock, now mitigated by the lesser foreign borrowing.

Finally, we define the full COVID19 shock as it occurred historically in the Turkish economy. As we previously mentioned, COVID19 shock didn't happen in a vacuum, but came at the backdrop of another large shock to the economy. In order to best represent the events, we defined to COVID19 shock as a combination of events shown in table 3.3.

We will analyze the combined effect of these shocks[39] as the COVID19 shock. Developments continue to unfold as we write this study: Inflation is on the rise throughout the world, central banks are raising interest rates, trade is obstructed partially because of the stress on supply chains and partially because of armed conflict. Türkiye, on the other hand, implements opposite policies, cutting monetary policy rates and allowing inflation to rise, moving away from the Taylor Rule and adopting a more discretionary policy. For now, we do not go into these developments in our shocks and policy responses, but will try to comment on what

[39]Note that monetary policy shock is missing from this list. While in our prior analyses we considered it a shock to the economy at large, at this point we find it more logical to use it as part of our policy set.

Shock	Actual	Model Period	Source
2% foreign borrowing rate	2018Q3	2	CDS +200
-5% foreign demand	2018Q4	3	Inferred from GSCPI (New York FED)
-2% foreign borrowing rate	2019Q4	7	CDS -200
-5% foreign demand	2020Q1	8	GSCPI (New York FED)
2% foreign borrowing rate	2020Q2	9	CDS +200
-5% domestic demand	2020Q2	9	Brinca, Duarte, and Faria-e-Castro (2020)
-15% labor supply	2020Q2	9	Brinca, Duarte, and Faria-e-Castro (2020)

Table 3.3: COVID19 Shock, including the preceding 2018 shock

our model predicts for the next periods, and what actually is happening.

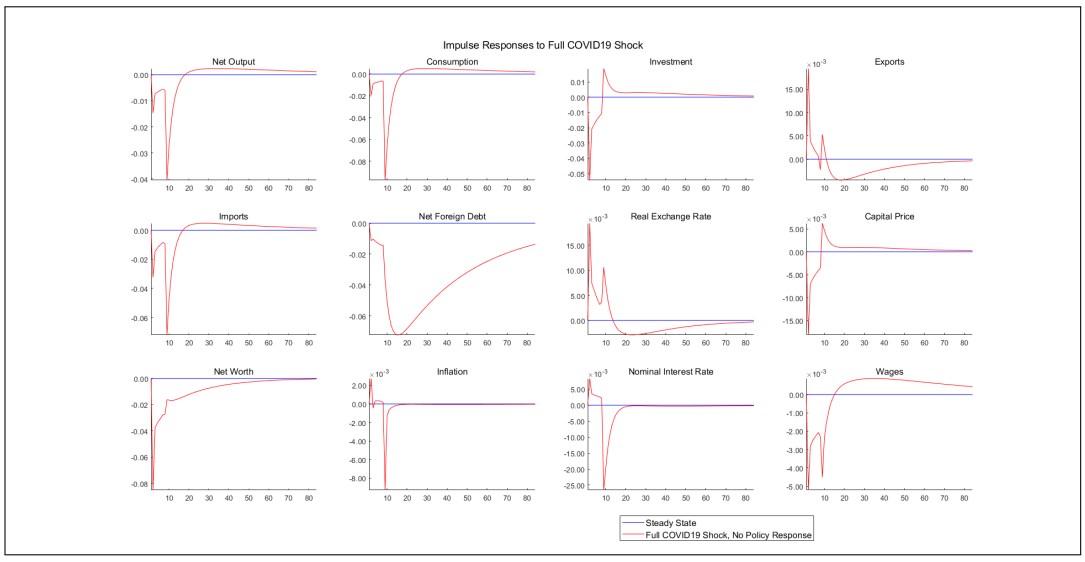

Figure 3.10: Impulse Responses to Full Covid Shock

Impulse responses to the full COVID19 shock is shown in figure 3.10. We can see that the earlier shock hits first, economy starts recovering in the following periods, and the rest of the shock its at period 9, creating the COVID19's economic environment. These results largely represent the sum of all the shocks, with some limited second order effects. We establish this scenario as the baseline which we will compare our policies on.

3.4. ANALYSIS OF COVID POLICIES: DYNAMIC RESERVE REQUIREMENTS

Earlier in Chapter III, we saw the effects of changing reserve requirement rates on the economy under different shock scenarios, and mentioned that we would look at the dynamic reserve requirements later on. This is where we look at the effects of dynamic reserve requirements.

A main difference of the dynamic implementation of reserve requirements is the cyclical nature of them: If loan growth is high, reserve requirements reduce, and if loan growth is low, reserve requirements increase, with caps on both high and low levels. A direct result of this procyclicality is that we cannot test its response to a linear shock, as it is path dependent. This is why we decided to wait until we have a complex shock to test it, and the COVID19 is one such shock.

Figure 3.11 shows the effect of applying dynamic reserve requirements against the COVID19 shock. We can immediately see on the bank net worths that changing reserve requirement rates based on loan growth creates volatility in bank balance sheets, ranging from -20% to 20% at its extremes. This volatility is reflected to capital prices and investments, with little lasting effect on other metrics. Consumption in particular is almost not affected at all, while exports and imports are only slightly different between the two scenarios.

We observe that the reserve requirement rates based on loan growth does slightly mitigate the impact on output, but doesn't recover any of the consumption. Banks increase their loan production to get lower reserve requirement rates initially, but quickly hit a plateau and decline immediately from there, and jump back up again, creating a cycle independent of the rest of the economy. This dynamic causes the reserve requirement rate to be low for a short amount of time, then high for a short amount of time, alternating between the two, and not deviating too much from the mean.

Dynamic reserve requirement regulation was applied for less than a year, and was discontinued before we could observe its medium term effects. We can comment Policymakers at the time probably knew that the economy was going to be hit by a strong shock, and asked the banks to increase their loan production

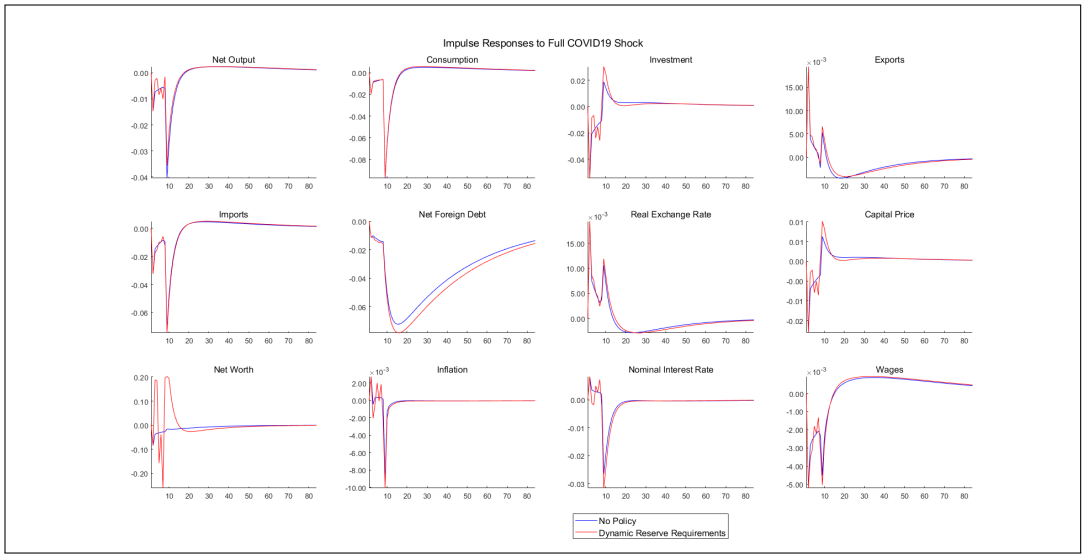

Figure 3.11: Impulse Responses to Full Covid Shock, No Policy vs Dynamic RR

almost to their limits, knowing that this would only be a temporary relief, and could not be sustained in the long run.

3.5. ANALYSIS OF COVID POLICIES: ASSET RATIO

Earlier, we introduced the asset ratio as a metric that promotes bank lending to businesses and penalize foreign borrowing.

$$AR_t = \frac{K_t^b + \zeta_t^{AR_B} B_t^g}{D_t + \zeta_t^{AR_{D^*}} D_t^*}$$

The asset regulation aimed to increase credit supply by forcing banks to quickly increase their loan books and to buying government bonds with high volumes, where even a very loose monetary policy wouldn't create a fast enough loan growth. It also penalized foreign currency borrowing by banks, in an attempt to increase Turkish Lira liquidity of banks and also to discourage households from keeping their money in foreign currency denominated assets. It was a multi-faceted regulation with a composite structure, which we replicate in our model by extending the model a bit by including government funding, as well as using our previous policies such as penalties on foreign currency liabilities.

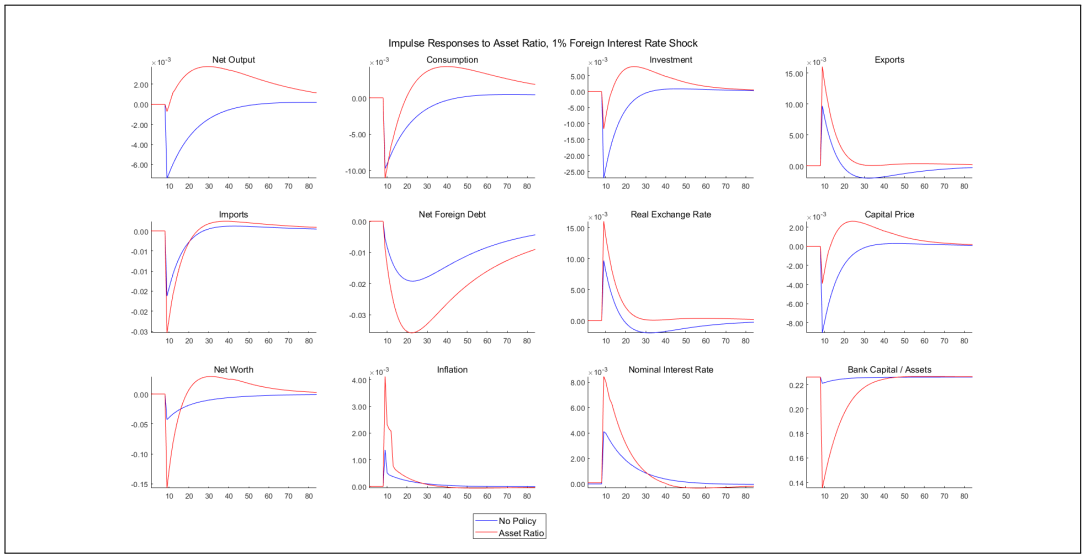

Figure 3.12: Responses of No Policy vs AR Rule, Foreign Interest Rate Shock

Foreign Interest Rate Shock

Our aim is to analyze the effectiveness of the Asset Ratio policy against the COVID19 shock, but let us first check its responses to some basic shocks. Figure 3.12 shows[40] the impulse responses of the economy to a 1% foreign interest rate shock, under no policy and asset ratio policy.

Forcing banks to lend out loans help with the investments, reducing some of the shock, and mitigating the impact on output as well. On the other hand, bank net worths decline significantly as their profitability suffer, and their capital adequacies decline significantly from 22% to below 14% at the peak of the shock, worryingly low and close to the legal minimum[41] of 12%. In our model banks don't default, but this much stress on the banking sector in the actual economy may lead to bank failures or at least a contraction in the financial sector, if combined with other shocks that put a stress on bank profits. While part of the shock to bank

[40]COVID19's demand and labor supply shocks will come at period 9, and asset ratio rule will be implemented in that period as well. We will give the shocks at this period by the end of our analysis, so we start with them now. As the economy starts at steady state, this doesn't make a difference as far as the analysis is concerned.

[41]In order to relieve the bank balance sheets, BRSA relaxed some details of the capital adequacy regulation during the stress period, preventing their capital adequacy ratios from dipping too low. Banks still faced the risk of a liquidity squeeze, and this was prevented by the CBRT pledging nearly unlimited funding to banks.

profits come from the policy, part of of comes from the increase in foreign interest rate increase as it increases the cost of bank liabilities. Banks reduce their foreign borrowing relatively fast, both because they are willing to and also because the policy forces them to, and their profits from the credit production also catch up, recovering their net worth rather quickly; however, capital adequacy takes longer to recover.

While the shock's impact to production is avoided, impact on consumption largely remains. Banks keep funding the firms to keep them going, but because we don't have consumer loans in our model or multi-period savings, consumers cannot do the same. Consumption is only funded by current revenues and savings from previous period, which, when shocked, consumption drops sharply and does not recover soon. It recovers gradually as the labor returns to steady state level with the shock's effect dissipating in time.

The economy avoids a direct hit to production, paying for this with stressed bank balance sheets, and also a rising inflation and rising exchange rate. The exchange rate makes the imports more expensive, but also the exports, and helps with the current account balance. Rising inflation at a time of severely impacted consumption is counterintuitive, but can be explained by the increased marginal cost of production. The inflationary pressure comes from the supply side, where price of imported goods and capital increase the marginal costs despite the declining wages. Inflation drops quickly as capital and imported goods prices return to their steady state values.

Labor Shock

Looking at the impulse responses of Asset Ratio rule against the labor supply shock (15% as defined), as shown in figure 3.13, we see that the policy helps the production slightly, through higher investment and better net exports, as expected, and similarly to the foreign interest rate shock scenario.

There isn't much else to discuss in this scenario, as the policy acts almost identically, generating investment for firms and helping out production, but not much else.

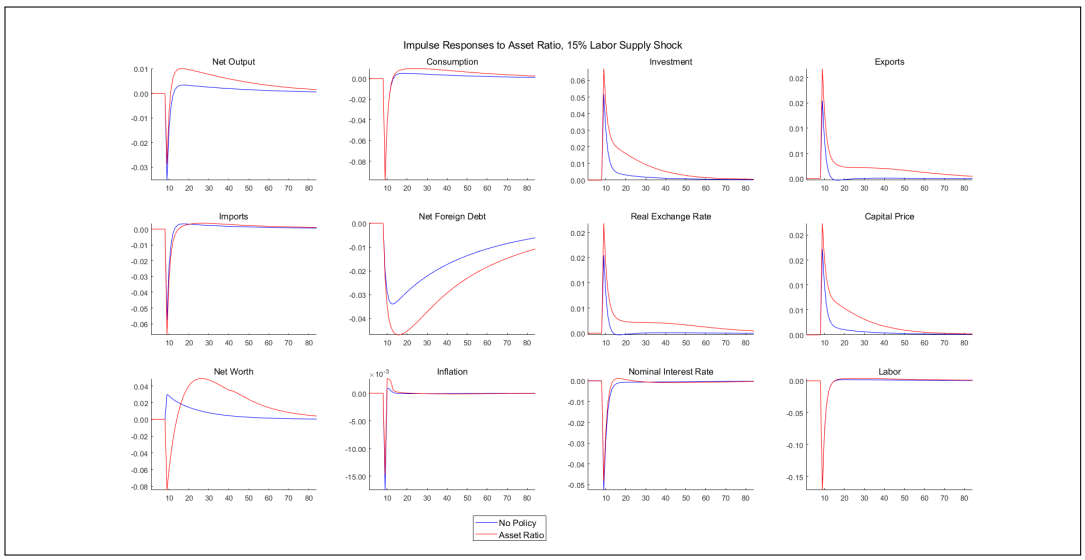

Figure 3.13: Responses of No Policy vs AR Rule, Labor Shock

One notable aspect is, we observe that labor is pretty much unaffected by the policy. The asset ratio rule is imposed on the banks who lend out to firms, and consumer loans do not exist in our model. Therefore, there is only the second-order effect to labor supply through the consumption-labor choice in the utility function, which has negligible effect on labor.

Domestic Demand Shock

Demand shock is smaller than the labor shock, therefore the impact of the shock isn't as large and we see that the asset ratio policy could easily overcome the impact of the shock if it wasn't for the other shocks contributing to it, shown on Figure 3.14. We again observe the familiar effects of the policy: Increased net imports, impact on bank net worths and capital ratios, and as a result increased production.

Despite the positive impact on output, the improvement comes from investment and exports, while labor and consumption drops in the meanwhile, as expected from the shock. In turn, inflation increase with the increasing marginal cost, which itself driven up by increased labor and capital costs.

Full Covid Shock

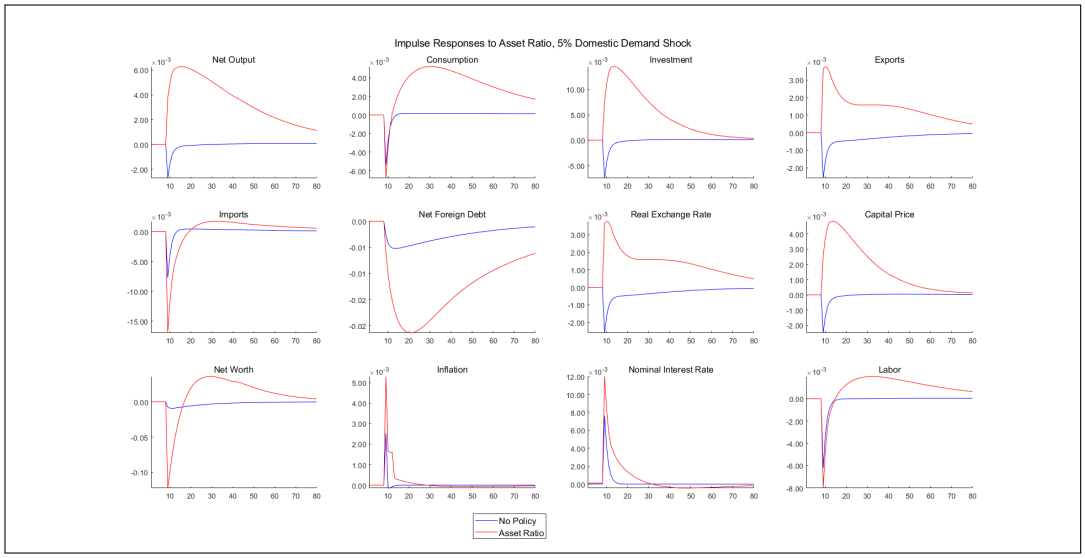

Figure 3.14: Responses of No Policy vs AR Rule, Demand Shock

We see the effects of Asset Ratio policy in Figure 3.15, in response to the full COVID19 shock we have defined, starting with period 9. We see that the policy managed to keep the production from dipping too low, mitigating the impact slightly, and helping the recovery in following periods. Impact on consumption is very similar under two scenarios, with the asset ratio policy helping minimally.

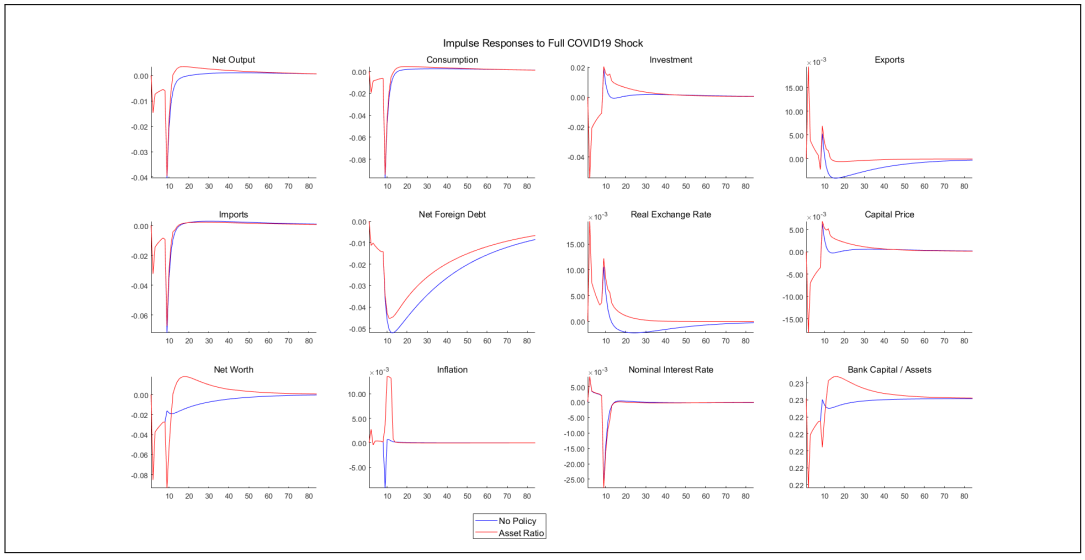

Figure 3.15: Responses of No Policy vs AR Rule

Banks profits and therefore net worths initially decline, from the already low point they found themselves in following the earlier shock, but they recover

quickly and go over the no policy scenario. This result makes a good parallel with the actual banking sector balance sheets: They did, indeed, have bad profits during the periods following the asset ratio regulation, but their profits picked up immensely afterwards. On the other hand, in our model, bank profits rise because of the asset price increases, while the real reason they shot up was the inflation that followed the money creation by asset ratio and the following monetary policy rate cuts. While the transmission mechanism is different, similar results are observed. Following a similar process, banks' capital ratios initially decline and then quickly increase.

Inflation increases dramatically following the policy's implementation, mostly linked to lower interest rates by monetary policy being kept very loose during the period, but also because the marginal cost of production increases by increased wages and capital price. Exchange rate also slightly increases compared to the no policy scenario.

One last comment that we may add is that, while it was a very dramatic and consequential policy at the time, Asset ratio was short-lived. It was an emergency measure which was structured around the fact that COVID19 was hitting the world, creating both labor and supply shocks, and it was understandable that it was discontinued after the shocks somewhat dissipated. There was surprisingly little experimentation we could do around it on its own.

CONCLUSION

Following the Great Recession of late 2000's, numerous policy instruments emerged to supplement the traditional monetary policies of short term Central Bank funding rates. These policies included those that directly controlled the money supply, such as the case of quantitative easing by the US and EU, multiple interest rate regimes in other places, as well as some macroprudential policies and rols that aim to strenghten the financial system as a whole, while also supplementing the monetary policies.

Last decade of Turkish economy has seen numerous monetary policy instruments as well, ranging from a variety of interest rate regimes, including the traditional inflation-targeting single short term rate policy, interest rate corridors, increased usage of late-liquidity-window rates, to different reserve requirement regimes, and a wide range of macroprudential policies to control credit growth, in the form of subsidies, incentives, or penalties. We wanted to look at them from a monetary point of view, while also examining their effects on the overall economy.

In order to analyze the effectiveness of these policies, we built an economic model that can represent an emerging market economy, exemplified by Turkish economy throughout the study, which includes these policies. We required properties to allow for the lasting effects of shocks and policies, particularly when simulating the frictions in changing prices and production, which is why adopted a New Keynesian model. In addition, we picked up a model of a small open economy, one that cannot impact foreign interest rates by itself, but is impacted by the changes thereof, most accurately representing the place of Türkiye, the economy that we wish to focus on, in the international economics. Macroprudential policies are often used in tandem with monetary policies, and we analyzed them together with the interest rates. These policies are often implemented to strengthen the economy against shocks that come through financial channels, where banks play a major role. In addition, we wanted to see the transmission mechanisms of these processes and the role of banks in this transmission mechanisms, therefore used a model with banks in it.

We find that the economy is susceptible to foreign interest rate changes and foreign demand changes, given the parametrization of our model, at the existence

of foreign borrowing by banks and exports to foreign economies. A foreign interest rate shock leads to a reduction in output as the banks become strained in their ability to fund their assets, because they are forced to roll over their foreign currency denominated debt, and their profits decline under the weight of more expensive liabilities in their balance sheets. A foreign demand shock generates a current account deficit with declining exports, and ends up reducing welfare as consumption is hit. Declining exports lead to a supply surplus domestically, reducing local prices and as a result, inflation.

In order to mitigate the effects of these shocks, as well as other systemic and idiosyncratic shocks that we introduce to the economy, the policymakers can use traditional, rule-based monetary policies as well as non-conventional, discretionary monetary policies with the side effects in inflation and exchange rates.

Macroprudential policies that we used in our model, grouped under penalties on asset holding by banks, penalties on foreign borrowing, and reserve requirement rates, can work in mitigating the impact. However, they also have side results which might not be desirable. Asset holding penalty, if used as a precautionary measure, helps limit the impact on production, but cuts consumption, while increasing net exports, decreasing the income share of wage earners and increasing the share of capital, making it a re-distributive policy. Penalties on foreign borrowing has similar results, but also leading to higher inflation and higher interest rates, something they were used to avoid in the Turkish case.

We find that the reserve requirement rates, and indeed other macroprudential policies as well, work best when they are used counter-cyclically: By keeping them at moderate levels when the economy is close to the steady-state levels, and reducing them when the economy is under stress. Use of these policies as a response to shocks create unintended consequences in the economy, particularly a rise in inflation, and structurally benefiting credit users.

One recurring effect we see in the macroprudential policies is that they have redistributive effects. Policies that increase bank lending to firms also tend to have an indirect effect in increasing interest rates and exchange rates, leading to increased net exports, while negatively impacting consumption and household utility. This observation in the model also matches the developments of post-covid

period, where rising inflation deflated the debts of away, benefitting agents that could borrow cheaply and in large volume.

Analyzing the COVID19 policies, we put emphasis on the fact that COVID19 didn't hit the Turkish economy when it was close to its steady state, but rather when it was recovering from an earlier stress. This made the response of the Turkish policymakers different from that of other countries, but also since Türkiye had a few extra months to prepare for the pandemic, it wasn't caught off-guard. Then we re-perform the series of shocks to the economy in this period, first foreign interest rate and foreign demand shocks in 2018-2019, then the domestic demand and labor supply shocks in 2020, and then the foreign interest rate shock in 2021; and the policy responses to these developments, analyzing the effectiveness of the policies.

Looking at the impact of the shock and the two major policies applied in response to COVID19, we find that the dynamic reserve requirement regime is hard to measure and overall not that different from applying the standard reserve requirement ratios, while the asset ratio policy was very strong, pushing the banks to their limits, while providing some protection from the hit on production. We also observe that labor's share in the economic output decline since the labor shock was significant, despite modest increases in wages themselves, consistent with other macroprudential policies that leveraged banks to help fund firms.

The model is very extendable, and improvements for a better representation of the Turkish economy can be done with relative ease. For instance, we have implemented the reserve requirements as a loss of deposits during loan creation. It could have been equally simple to implement them as taxes on all deposits, or differentiate between local and foreign currency denominated deposits, as it is done in Türkiye nowadays.

Another aspect of the model that can be improved is the inclusion of consumer loans. In our model only firms[42] can borrow, and through this mechanism we can explain some of the inflation changes, but the inflationary episode of 2022 is hard to analyze with our model's mechanics. In order to best explain this period, the model would need to include (imperfectly rational) consumers who can leverage

[42]Technically the banks as well, but we count them out as borrowing and lending is their main activity.

their investments, savings, and consumption through credit. Such a model would include a few different choices: How should the banks allocate their loans between firms and consumers? How should the households allocate their assets between firm funding, bank deposits, consumption; and how much should they borrow? What is a good credit limit for households from the banks' perspective, and how should the government control the supply of consumer credit? While these are all valid and important questions, they are also mathematically complex, and we limited our scope to banks and firm funding at a time of stress, focusing on the monetary effects of the policies.

We believe the model structure we use here work very well to analyze the impact on bank balance sheets. The hazard function implemented to limit foreign borrowing can be replaced with a more commonly used metric such as hard limits on Capital Adequacy Ratio or Leverage Ratio, but it's very easily interpreted in reflecting the credit spread shocks. Another element that's missing from our analysis is the term structure of loans and deposits, and the resulting interest rate risk on bank balance sheets. The frictions of firm price changes could be expanded to bank loans to represent the bank loans' term structures, where the maturity mismatch between long term loans and short term deposits create interest rate risk for banks.

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APPENDIX

Scenario	Shock	Growth	AH FB	Duration	Production		Consumption		Inflation		Exchange Rate		Interest Rate	
					Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
25	TFP	Yes	0 0	Permanent	2.26	2.24%	1.55	1.51%	-0.41	26.27%	1.25	1.15%	5.43	35.84%
26	TFP	Yes	10 10	Permanent	2.33	3.22%	1.61	2.34%	0.94	46.56%	1.35	1.75%	7.36	38.38%
27	TFP	Yes	10 20	Permanent	2.40	3.80%	1.65	2.73%	2.33	69.87%	1.45	2.67%	9.35	50.48%
28	TFP	Yes	10 30	Permanent	2.46	4.50%	1.70	3.23%	3.72	95.29%	1.54	3.69%	11.34	70.92%
29	TFP	Yes	10 40	Permanent	2.53	5.27%	1.74	3.78%	5.11	121.51%	1.64	4.73%	13.33	94.44%
30	TFP	Yes	20 10	Permanent	2.34	3.81%	1.62	2.92%	0.89	50.58%	1.36	1.82%	7.30	44.63%
31	TFP	Yes	20 20	Permanent	2.40	4.36%	1.66	3.28%	2.28	73.20%	1.46	2.76%	9.29	54.38%
32	TFP	Yes	20 30	Permanent	2.47	5.02%	1.71	3.73%	3.67	98.20%	1.55	3.78%	11.28	73.00%
33	TFP	Yes	20 40	Permanent	2.54	5.75%	1.76	4.24%	5.06	124.16%	1.65	4.83%	13.27	95.44%
34	TFP	Yes	30 10	Permanent	2.35	4.42%	1.63	3.51%	0.84	54.81%	1.37	1.89%	7.24	51.17%
35	TFP	Yes	30 20	Permanent	2.41	4.93%	1.68	3.84%	2.23	76.75%	1.47	2.85%	9.23	58.94%
36	TFP	Yes	30 30	Permanent	2.48	5.56%	1.72	4.26%	3.62	101.30%	1.56	3.87%	11.22	75.74%
37	TFP	Yes	30 40	Permanent	2.54	6.26%	1.77	4.74%	5.01	126.96%	1.65	4.93%	13.21	96.98%
38	TFP	Yes	40 10	Permanent	2.36	5.03%	1.64	4.10%	0.80	59.20%	1.38	1.96%	7.18	57.90%
39	TFP	Yes	40 20	Permanent	2.42	5.52%	1.69	4.41%	2.19	80.48%	1.47	2.94%	9.17	64.02%
40	TFP	Yes	40 30	Permanent	2.49	6.12%	1.73	4.80%	3.58	104.57%	1.57	3.97%	11.15	79.06%
41	TFP	Yes	40 40	Permanent	2.55	6.79%	1.78	5.25%	4.97	129.92%	1.66	5.02%	13.14	99.05%

Table A.1: Asset Holding and Foreign Borrowing Policy Intensity, TFP Shocks

Scenario	Shock	Growth	AH FB	Duration	Production		Consumption		Inflation		Exchange Rate		Interest Rate	
					Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
41	No	No	None	NA	2.22	0.00%	1.53	0.00%	0.00	0.00%	1.23	0.00%	6.00	0.00%
42	No	No	0	NA	2.22	0.00%	1.53	0.00%	0.00	0.00%	1.23	0.00%	6.00	0.00%
43	No	No	FB	Permanent	2.29	0.93%	1.57	0.68%	1.39	27.25%	1.33	1.08%	7.99	26.52%
44	No	No	AH	Permanent	2.23	0.63%	1.54	0.60%	-0.05	5.24%	1.24	0.11%	5.94	7.34%
45	No	No	AH+FB	Permanent	2.29	1.28%	1.58	1.02%	1.34	29.26%	1.34	1.19%	7.93	25.45%
46	No	No	FB	Impulse	2.22	1.19%	1.53	0.89%	0.02	38.48%	1.24	1.22%	6.02	11.89%
47	No	No	AH	Impulse	2.22	0.03%	1.53	0.01%	0.00	1.21%	1.23	0.12%	6.00	0.41%
48	R*	No	AH+FB	Impulse	2.22	1.17%	1.53	0.90%	0.01	39.68%	1.24	1.34%	6.02	12.30%
49	R*	No	None	NA	2.22	0.00%	1.53	0.00%	0.00	0.00%	1.23	0.00%	6.00	0.00%
50	R*	No	0	NA	2.22	0.00%	1.53	0.00%	0.00	0.00%	1.23	0.00%	6.00	0.00%
51	R*	No	FB	Permanent	2.29	0.93%	1.57	0.68%	1.39	27.25%	1.33	1.08%	7.99	26.52%
52	R*	No	AH	Permanent	2.23	0.63%	1.54	0.60%	-0.05	5.24%	1.24	0.11%	5.94	7.34%
53	R*	No	AH+FB	Permanent	2.29	1.28%	1.58	1.02%	1.34	29.26%	1.34	1.19%	7.93	25.45%
54	R*	No	FB	Impulse	2.22	1.19%	1.53	0.89%	0.02	38.48%	1.24	1.22%	6.02	11.89%
55	R*	No	AH	Impulse	2.22	0.03%	1.53	0.01%	0.00	1.21%	1.23	0.12%	6.00	0.41%
56	R*	No	AH+FB	Impulse	2.22	1.17%	1.53	0.90%	0.01	39.68%	1.24	1.34%	6.02	12.30%
57	R*	Yes	None	NA	2.26	1.53%	1.56	1.10%	-0.49	13.80%	1.26	0.82%	5.31	24.37%
58	R*	Yes	0	NA	2.26	1.53%	1.56	1.10%	-0.49	13.80%	1.26	0.82%	5.31	24.37%
59	R*	Yes	FB	Permanent	2.33	2.01%	1.60	1.40%	0.90	33.10%	1.35	1.51%	7.30	21.78%
60	R*	Yes	AH	Permanent	2.27	2.13%	1.57	1.68%	-0.53	18.68%	1.26	0.83%	5.25	30.98%
61	R*	Yes	AH+FB	Permanent	2.34	2.57%	1.61	1.95%	0.86	36.61%	1.36	1.59%	7.24	27.03%
62	R*	Yes	FB	Impulse	2.26	1.77%	1.56	1.30%	-0.47	42.79%	1.26	1.30%	5.34	31.97%
63	R*	Yes	AH	Impulse	2.26	1.54%	1.56	1.09%	-0.49	14.03%	1.26	0.80%	5.31	24.59%
64	R*	Yes	AH+FB	Impulse	2.26	1.76%	1.56	1.31%	-0.47	43.94%	1.26	1.40%	5.34	32.28%

Table A.2: Asset Holding and Foreign Borrowing Policy Responses to Foreign Interest Rate Shocks

Scenario	Shock	Growth	AH FB	Duration	Production		Consumption		Inflation		Exchange Rate		Interest Rate	
					Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
65	R*	Yes	10 10	Permanent	2.34	2.57%	1.61	1.95%	0.86	36.61%	1.36	1.59%	7.24	27.03%
66	R*	Yes	10 20	Permanent	2.40	3.22%	1.66	2.39%	2.25	61.78%	1.45	2.59%	9.23	43.68%
67	R*	Yes	10 30	Permanent	2.47	3.99%	1.70	2.92%	3.64	88.20%	1.55	3.64%	11.22	67.03%
68	R*	Yes	10 40	Permanent	2.53	4.81%	1.75	3.51%	5.03	115.00%	1.64	4.70%	13.21	92.12%
69	R*	Yes	20 10	Permanent	2.35	3.15%	1.62	2.53%	0.81	40.50%	1.37	1.67%	7.18	33.08%
70	R*	Yes	20 20	Permanent	2.41	3.76%	1.67	2.92%	2.20	64.83%	1.46	2.68%	9.17	46.50%
71	R*	Yes	20 30	Permanent	2.48	4.47%	1.71	3.40%	3.59	90.83%	1.56	3.73%	11.16	68.10%
72	R*	Yes	20 40	Permanent	2.54	5.26%	1.76	3.94%	4.98	117.41%	1.65	4.80%	13.15	92.30%
73	R*	Yes	30 10	Permanent	2.35	3.75%	1.64	3.11%	0.76	44.66%	1.38	1.75%	7.12	39.57%
74	R*	Yes	30 20	Permanent	2.42	4.31%	1.68	3.47%	2.15	68.15%	1.47	2.78%	9.11	50.24%
75	R*	Yes	30 30	Permanent	2.49	4.99%	1.73	3.91%	3.54	93.69%	1.56	3.83%	11.10	69.93%
76	R*	Yes	30 40	Permanent	2.55	5.74%	1.77	4.42%	4.93	119.99%	1.66	4.90%	13.09	93.07%
77	R*	Yes	40 10	Permanent	2.36	4.36%	1.65	3.70%	0.72	49.03%	1.38	1.84%	7.06	46.32%
78	R*	Yes	40 20	Permanent	2.43	4.89%	1.69	4.03%	2.11	71.69%	1.48	2.87%	9.05	54.72%
79	R*	Yes	40 30	Permanent	2.49	5.53%	1.74	4.45%	3.50	96.75%	1.57	3.93%	11.04	72.45%
80	R*	Yes	40 40	Permanent	2.56	6.24%	1.78	4.92%	4.89	122.75%	1.67	5.00%	13.03	94.41%

Table A.3: Asset Holding and Foreign Borrowing Policy Intensity, Foreign Interest Rate Shocks

Scenario	Shock	Growth	AH FB	Duration	Production		Consumption		Inflation		Exchange Rate		Interest Rate	
					Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
81	No	No	None	NA	2.22	0.00%	1.53	0.00%	0.00	0.00%	1.23	0.00%	6.00	0.00%
82	No	No	0	NA	2.22	0.00%	1.53	0.00%	0.00	0.00%	1.23	0.00%	6.00	0.00%
83	No	No	2.5	Permanent	2.22	0.00%	1.53	0.00%	0.00	0.00%	1.23	0.00%	6.00	0.00%
84	No	No	5	Permanent	2.23	0.13%	1.53	0.19%	0.13	2.06%	1.24	0.27%	6.18	4.03%
85	No	No	7.5	Permanent	2.23	0.26%	1.53	0.37%	0.26	4.12%	1.24	0.54%	6.37	8.05%
86	No	No	10	Permanent	2.24	0.39%	1.53	0.56%	0.39	6.18%	1.25	0.81%	6.55	12.08%
87	No	No	12.5	Permanent	2.24	0.52%	1.53	0.74%	0.52	8.25%	1.25	1.09%	6.74	16.11%
88	No	No	15	Permanent	2.25	0.65%	1.53	0.93%	0.65	10.31%	1.25	1.36%	6.92	20.14%
89	No	No	2.5	Impulse	2.25	0.78%	1.53	1.11%	0.78	12.37%	1.26	1.63%	7.11	24.16%
90	No	No	5	Impulse	2.22	0.11%	1.53	0.06%	0.00	1.99%	1.23	0.01%	6.00	0.65%
91	No	No	7.5	Impulse	2.22	0.22%	1.53	0.12%	0.00	3.98%	1.23	0.01%	6.01	1.31%
92	No	No	10	Impulse	2.22	0.32%	1.53	0.18%	0.01	5.96%	1.23	0.02%	6.01	1.96%
93	No	No	12.5	Impulse	2.22	0.43%	1.53	0.24%	0.01	7.95%	1.23	0.03%	6.01	2.62%
94	No	No	15	Impulse	2.22	0.54%	1.53	0.31%	0.01	9.94%	1.23	0.03%	6.01	3.27%

Table A.4: Reserve Requirement Policy Intensity, No Shocks, No Growth

Scenario	Shock	Growth	AH FB	Duration	Production		Consumption		Inflation		Exchange Rate		Interest Rate	
					Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
95	TFP	No	2.5	Permanent	2.22	0.65%	1.53	0.37%	0.01	11.93%	1.23	0.04%	6.02	3.93%
96	TFP	No	5	Permanent	2.21	0.74%	1.52	0.44%	0.07	14.09%	1.23	0.34%	6.11	11.95%
97	TFP	No	7.5	Permanent	2.22	0.65%	1.52	0.31%	0.20	13.57%	1.23	0.59%	6.29	9.75%
98	TFP	No	10	Permanent	2.22	0.58%	1.52	0.26%	0.33	13.35%	1.24	0.85%	6.48	8.93%
99	TFP	No	12.5	Permanent	2.23	0.53%	1.52	0.32%	0.46	13.45%	1.24	1.11%	6.66	9.85%
100	TFP	No	15	Permanent	2.24	0.51%	1.52	0.46%	0.59	13.85%	1.25	1.38%	6.84	12.11%
101	TFP	No	2.5	Impulse	2.24	0.52%	1.52	0.62%	0.72	14.55%	1.25	1.65%	7.03	15.12%
102	TFP	No	5	Impulse	2.25	0.57%	1.52	0.80%	0.85	15.48%	1.25	1.92%	7.21	18.52%
103	TFP	No	7.5	Impulse	2.21	0.73%	1.52	0.45%	0.07	15.39%	1.23	0.35%	6.11	12.36%
104	TFP	No	10	Impulse	2.21	0.74%	1.52	0.46%	0.08	16.82%	1.23	0.35%	6.11	12.79%
105	TFP	No	12.5	Impulse	2.21	0.77%	1.52	0.48%	0.08	18.36%	1.23	0.35%	6.12	13.24%
106	TFP	No	15	Impulse	2.21	0.81%	1.52	0.51%	0.08	19.98%	1.23	0.36%	6.12	13.70%

Table A.5: Reserve Requirement Policy Intensity, TFP Shock, No Growth

Scenario	Shock	Growth	AH FB	Duration	Production		Consumption		Inflation		Exchange Rate		Interest Rate	
					Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
107	TFP	Yes	2.5	Permanent	2.26	0.92%	1.55	0.58%	0.08	23.39%	1.23	0.36%	6.12	14.68%
108	TFP	Yes	5	Permanent	2.26	2.24%	1.55	1.51%	-0.41	26.27%	1.25	1.15%	5.43	35.84%
109	TFP	Yes	7.5	Permanent	2.26	2.15%	1.55	1.34%	-0.28	25.17%	1.26	1.41%	5.62	32.24%
110	TFP	Yes	10	Permanent	2.27	2.06%	1.55	1.17%	-0.15	24.19%	1.26	1.67%	5.80	28.76%
111	TFP	Yes	12.5	Permanent	2.27	1.98%	1.55	1.01%	-0.02	23.35%	1.26	1.93%	5.99	25.44%
112	TFP	Yes	15	Permanent	2.28	1.90%	1.55	0.85%	0.11	22.68%	1.27	2.20%	6.17	22.35%
113	TFP	Yes	2.5	Impulse	2.28	1.83%	1.55	0.71%	0.24	22.17%	1.27	2.47%	6.35	19.60%
114	TFP	Yes	5	Impulse	2.29	1.77%	1.55	0.59%	0.37	21.85%	1.27	2.73%	6.54	17.37%
115	TFP	Yes	7.5	Impulse	2.26	2.22%	1.55	1.51%	-0.40	27.24%	1.25	1.15%	5.44	36.25%
116	TFP	Yes	10	Impulse	2.26	2.21%	1.55	1.51%	-0.40	28.33%	1.25	1.16%	5.44	36.68%
117	TFP	Yes	12.5	Impulse	2.26	2.20%	1.55	1.51%	-0.40	29.50%	1.25	1.16%	5.44	37.11%
118	TFP	Yes	15	Impulse	2.26	2.19%	1.55	1.51%	-0.40	30.76%	1.25	1.16%	5.44	37.54%

Table A.6: Reserve Requirement Policy Intensity, TFP Shock, Growth