EFFECTIVENESS OF RESERVE REQUIREMENTS ON CURRENT ACCOUNT IMBALANCES

A Master's Thesis

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July 2012

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Graduate School of Economics and Social Sciences
of
İhsan Doğramacı Bilkent University

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In Partial Fulfillment of the Requirements for the Degree
of
MASTER OF ARTS

in

THE DEPARTMENT OF
ECONOMICS
İHSAN DOĞRAMACI BİLKENT UNIVERSITY
ANKARA

JULY 2012

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Economics.

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ABSTRACT

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July 2012

Following the recent financial crisis, reserve requirements have become a policy instrument preferred in many emerging markets such as China, Brazil and Turkey for various purposes. Therefore, the formulating a theoretical framework to study the policy effectiveness remains an important issue. In this thesis, I develop a DSGE model with the financial accelerator mechanism so as to see the effectiveness of reserve requirement in small open economies, especially in influencing the external imbalances. External imbalances can either be interpreted as current account imbalances or its mirroring capital account imbalances. The main channel through which the external balances play a role is via the banking sector, which is modelled as engaging in international borrowing. This framework allows examination of the responses of the external imbalances to shocks to the reserve requirement ratio As a result, higher reserve requirements make domestic borrowing cheaper than foreign borrowing and by this way, changes in net foreign liabilities create a current account surplus. Thus, a country with current account deficit can use reserve requirements to readjust its external imbalances.

Keywords: DSGE, Financial Accelerator, Reserve Requirements, Current Account

ÖZET

MUNZAM KARŞILIKLARININ CARİ AÇIK ÜZERİNDEKİ ETKİSİ

DALKIRAN, Dilşat Tugba

M.A., İktisat Bölümü

Tez Yöneticisi: Doç. Dr. Selin Sayek Böke

Temmuz 2012

Son finansal krizden sonra munzam karşılıkları Çin, Brezilya ve Türkiye gibi birçok gelişmekte olan ülke tarafından farklı sebeplerle sıklıkla kullanılan bir para politikası aracı olmaya başladı. Bu sebeple, munzam karşılıklarının tesirliliğinin arka plandaki teorisi önem kazandı. Bu makalede munzam karşılıklarının gelişmekte olan ülkelerdeki tesirlerine, özellikle dışsal dengesizlikler üzerindeki tesirlerine, bakmak için finansal hızlandırıcılı bir DSGE model tasarladım. Dışsal dengesizlikler cari dengesizlikler olarak yorumlanabilir. Dışsal dengesizliklerin rol aldığı ana kanallar bankacılık sektörü olduğu için bu sektor dışarıdan borç alabilir şekilde tasarlandı. Bu tasarı, munzam karşılıklarının dışsal dengesizlikler üzerindeki etkilerini görmede yardımcı oldu. Sonuç olarak, yüksek munzam karşılıkları yerel kaynaklı borcu yabancı kaynaklı borca göre daha ucuz yaptı ve böylelikle net yabancı yükümlülüklerdeki değişiklik cari fazla yarattı. Bu sebeple, cari açığı olan bir ülke dışsal dengesizliklerini düzeltmek için munzam karşılıklarını kullanabilir.

Anahtar Kelimeler: DSGE, Finansal Hızlandırıcı, Munzam Karşılıkları, Cari Açık

ACKNOWLEDGMENTS

First of all, I am grateful to my supervisor Assoc. Prof. Dr. Selin Sayek-Boke and second reader Prof. Dr. Erinç Yeldan for encouragement and for conversations that clarified my thinking on developing the model. They are the ones who have taught me how to be a good academician and a productive researcher in this area.

Secondly, I would like to thank you to Harun Alp, who is a researcher in Turkish Central Bank, for his thoughtful and creative comments. His friendship and professional collaboration meant a great deal to me and will never be forgotten.

I also would like to thank you to Assoc. Prof. Refet Gürkaynak, Asst. Prof. Hüseyin Çağrı Sağlam, Asst. Prof. Tarık Kara, Assoc. Prof. Fatma Taşkın, Asst. Prof. Taner Yiğit and Prof. Dr. Hakan Berument for teaching me all the things they know and enduring me with patience for six years.

During this process, I always feel the support and encouragement of a number of friends including Deniz Konak, Elif Özcan, Meltem Topaloğlu, Nuray Mustafaoğlu and Pınar Boyacı. In this regard, I am indebted to them. I am particularly grateful to my fiancee Muhlis Kenan Özel for his patience and forbearance whilst I have spent hundreds of hours working on my thesis!

Support from TUBITAK for about seven years is gratefully acknowledged.

Last but not least, I would like to thank you to my parents Nevzat Dalkıran and Aysel Dalkıran and my brother Volkan Çağrı Dalkıran for their

unending love, patience and support. I hope that I was a very good daughter and sister as you always deserve.

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CHAPTER 1

INTRODUCTION

While many of the developed economies continue to suffer from the negative effects of the latest financial crisis, some of the emerging countries such as China and Turkey have been experiencing rapid economic growth. Although achieving large positive growth rates is a permanent goal of emerging markets, such large growth rates may cause unwarranted macroeconomic instabilities. For instance, in case of Turkey, positive economic growth has brought about a credit extension in the economy and a resulting strong rise in aggregate demand. This rise in aggregate demand also gets reflected in increased imports which refers to a widening current account deficit.

Whether be it deficits or surpluses, some economies have always been trying to rebalance their current account, as a share of GDP, to remain at least at a certain level for macroeconomic stability. This rebalancing in the external imbalances is a difficult task, for which the policy makers do not have an agreed set of instruments. During the recent phase of the recent financial crisis, with the rising importance of unconventional monetary policies, we observe that Turkey has used reserve requirements as a remedy for external imbalances. Although by using required reserves, Turkish Central Bank's primary aim is to optimize the credit structure and in the end improve the macro-prudential framework, it has also aimed to adjust country's current

account position. In this sense, Turkey has recently increased its weighted average reserve requirement ratio to 12.6% (Başçı and Kara [2011]).

As stated in the Turkish financial stability report, Turkey aimed at high reserve requirements and wide interest rate corridor to overcome the widening current account deficit. Basci and Kara [2011] state that despite the recent tendency of using required reserves as a tool to tackle for current accounts, an agreed upon theoretical framework which allows a discussion of the long-run effects of this policy is needed. Additionally, they strongly emphasize the fact that these kind of monetary policy combinations are country-focused and case-sensitive. The structure and deepness of financial system, current macroeconomic conditions and characteristics of capital movements are the factors that can change the effectiveness of reserve requirements (Başçı and Kara [2011]). Although one can predict through which channels reserve requirements may affect the current account deficit, lack of a theoretical background in the literature makes the long run implications of the policy vague.

In order to study how reserve requirements affect the external imbalances in emerging markets a framework consistent with the emerging market stylized facts should be constructed.. The external balances can be defined as the change in the net foreign assets (NFA) of the economy. However,it is not only the level of the NFA holdings that matters, but also the composition of who holds these assets. Data from Turkey shows that the financial sector borrowing has increased and its ratio to nonfinancial borrowing has approached to unity after 2009. (see figure 1.1 and 1.2). However, in most of the dynamic stochastic general equilibrium (DSGE) models, the role of financial sector is neglected (Montoro [2010]). Therefore, in order to evaluate the effectiveness of reserve requirements in Turkey, we should develop such a model that reflects this high financial sector borrowing phenomena.

This thesis examines the effectiveness of required reserves on the current account imbalances in Turkey. The most distinct feature of this model is

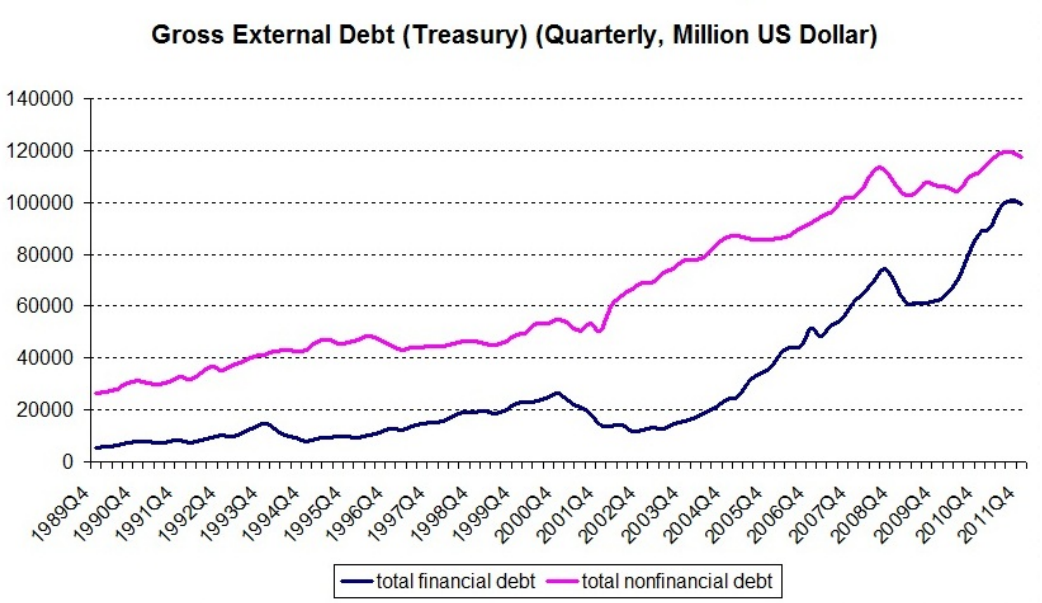

Figure 1.1: Gross External Debts

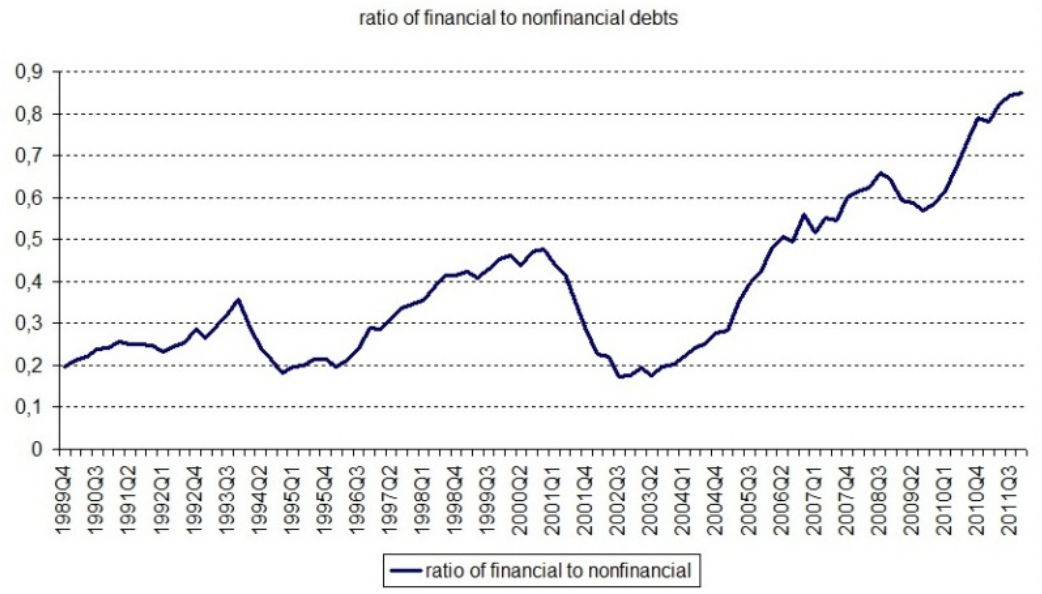

Figure 1.2: Ratio of Financial to Non-Financial Debts

the banking sector with costly banking activities and the existence of substitutable sources of intermediated funds: domestic banks loans and funds obtained directly from abroad.

In Chapter 2, the literature on the external imbalances and reserve requirements is reviewed. Chapter 3 outlines the model. Chapter 4, reports the quantitative analysis. Conclusions and future research questions are discussed in Chapter 6.

CHAPTER 2

LITERATURE REVIEW

There are several papers examining the effectiveness of monetary policies on current account adjustment. For example, Ferrero, Svensson and Gertler examine the monetary policy effectiveness on the aggregate economic behaviours on the economy with the given current account adjustment scenarios (Ferrero et al. [2008]). First of these is the slow burn where the rebalancing of current account is slow and smooth. There are no major shocks but the steady dollar depreciation puts pressure on CPI inflation. The second one is fast burn where we see rapid reversals in the current account balance of a country. These reversals are modelled as changes in the beliefs about the future productivity of the home country. They use simple interest rate rule, producer inflation targeting rule, consumer price inflation targeting rule, exchange rate targeting rule but not required reserves or any other unconventional monetary policy. Additionally, the model is for developed countries but not for developing countries. They do not allow any movements in risk premium because in developed countries the risk premium does not play as important role as in developing countries. However, in this paper, the existence of external finance premium creates the accelerator mechanism in the system and this mechanism amplifies the shocks to the economy. Among the results they reach, the most important one is that monetary policy works poorly

against international variables such as current account. As a contribution, I will extend the model into developing country case and use different monetary policies. I assume that the existence of an accelerator mechanism makes monetary policies more effective on international variables.

Secondly, Glocker and Towbin [2012] examine the situations in which reserve requirements are suitable for achieving price and financial stability. They use a small open economy DSGE model with financial accelerator mechanism. They use such a mechanism in order to ensure that endogenous developments in credit market amplify and propagate the shocks to the economy (Bernanke et al. [1999]). They find that with the existence of financial frictions, reserve requirements can support the price stability objective. Also, reserve requirements have substantial effects on economic stability if central banks have financial stability objective. Though it is not their main focus, they find (but do not discuss) that increase in reserve requirements creates a surplus in current account. As a contribution to this paper, I will discuss the mechanism reserve requirements affect external imbalances. Additionally, an the most importantly, I will add a more realistic financial sector to the model.

Since the latest financial crisis, unconventional monetary policies become very widely used, especially given the increasing ineffectiveness of interest rates as a monetary policy tool. For example, as an unconventional monetary policy, FED has helped private credit banks to prevent them from collapsing. This monetary policy caused balance sheet deterioration as well as tightened borrowing-lending standards. Gertler and Karadi [2010] capture the key elements of central banks financial intermediation and try to model it. Before them, neither Bernanke et al. [1999] nor other conventional monetary policy models have considered central bank intermediation. Gertler and Karadi [2010] analysis fills this gap. As a conclusion, they state that central bank intermediation (credit policy) become efficient during the crisis because the existing balance sheet constraints on private intermediaries tighten lending

standards. Especially, under zero lower bound case, this effect doubles. One important point here is as the economy returns to normal, the effects of using unconventional monetary policy diminishes. Therefore, they claim that, other than crisis times, using unconventional monetary policy is meaningless. They also conclude that, for certain types of lending such as CI loans that require constant monitoring of borrowers, capital injections may be preferred compared to intermediation. Apart from analysing the effectiveness of an unconventional monetary policy and using the DSGE model with financial accelerator mechanism, Gertler and Karadi [2010] paper do not have any common feature with my question. However, since the paper holds a very important place in unconventional monetary policy literature, I find it appropriate to include it in this section.

This kind of country-specific studies are not limited to the USA. Mimir et al. examine the effects of reserve requirements, as a macroprudential policy tool, on the transmission mechanism of monetary shocks and productivity in Turkey. It is a closed economy with aggregate uncertainty due to money growth shocks and productivity shocks. In order to understand the role of time varying reserve requirement (rr), they solve the model for three alternative cases: no rr case, constant rr case, time varying rr case. Banks are constructed as in Gertler and Karadi [2010] and they incorporate the banking sector explicitly. Different from Gertler and Karadi [2010], the central bank does not issue government debt, its intervention to the market is constrained with changing rrr. Central bank controls the supply of money and determines the rr rate according to deviations of bank leverage from steady state.One of the main findings is that rr rate dampens the effect of financial accelerator in response to productivity shock with the cost of high inflation. Negative productivity shock causes bank credit to decline due to demand and supply channels in deposit markets. Once the time varying rr is introduced (a decrease in rrr), credit declines and equity financing declines have stopped.

When there is a monetary shock, on the other hand, the story will be saving and investment based but result is the same. In this market all the shocks work through deposit markets.

As it is seen, the movements of current account in response to monetary policy shocks and the effectiveness of reserve requirements have been examined by various paper. However, when we look at the these highly selective literature, we see that the there is not any paper which explicitly discuss the effectiveness of reserve requirements on external imbalances (current/capital account imbalances). Therefore, this thesis fills this gap. Additionally, despite the prominent role of financial sector, the papers which study on reserve requirements use a simple financial sector. Hence, the most distinct feature of this thesis will be the more realistic financial sector for Turkey case.

CHAPTER 3

MODEL

Central banks' main aim at increasing the reserve requirement levels is to affect the credit growth in the country, so that people stop consuming more and government prevents large current account imbalance. In my opinion, in order to observe through which channels required reserves affect current account, we should reflect country specific features. In this sense, I will add a banking sector with multiple borrowing channels. Therefore, I develop a DSGE model with financial accelerator mechanism and sticky prices which was first developed by Bernanke, Gertler and Gilchrist [1999]. Following Glocker and Towbin [2012], I allow multiple intermediaries. Different from them, I modify the role of financial sector by adding a foreign borrowing channel to the system.

There are five types of agents, including households, entrepreneurs, intermediate goods producers, final good producers and capital good producers. The model includes two types of banks one that functions only as a lending institution, while the other functions as a deposit bank. Lastly, the model includes a government which sets both fiscal and monetary policies. The details of the fiscal and monetary policy will be provided below.

Households consume, save, work and live forever. They keep their savings at the deposit banks and these savings constitute loans to the entrepreneurs.

Entrepreneurs' duty entails renting capital to intermediate goods producers by purchasing capital from capital goods producers. They purchase capital at the beginning of the period and resell them at the end of the period. This purchase of capital is financed by entrepreneurial worth and borrowing from lending banks. They are assumed to be risk neutral and have constant probability γ of surviving next period. Such kind of surviving probability is assumed to ensure that entrepreneurs cannot continuously accumulate their net worth over time. Also, this kind of assumption guarantees that the entrepreneurs will always need to borrow.

Intermediate good producers use labor input from households and capital from entrepreneurs. They sell their intermediate goods to final goods producers who produce final goods and sell them to households as consumption good and to capital goods producers as investment good.

As mentioned above, there are two types of banks in the economy. Deposit banks are subject to reserve requirements set by the government and their liabilities that allow asset accumulation is provided by deposits from households. They lend part of their deposits to lending banks which allow us to introduce interbank interest rate as a monetary policy instrument for an interest rate rule. Lending banks do not have a relationship with households. They only provide loans to entrepreneurs by issuing foreign denominated bonds and lending from deposit banks. There is one kind of reserve requirement which is the requirement in domestic currency. Although the bonds hold by lending bankers are foreign currency denominated, they are converted to domestic currency immediately so that required reserves can only in domestic currency.

Before proceeding with the details of the model, the main framework of the model is provided in figure 3.1 to make the model clear for the reader.

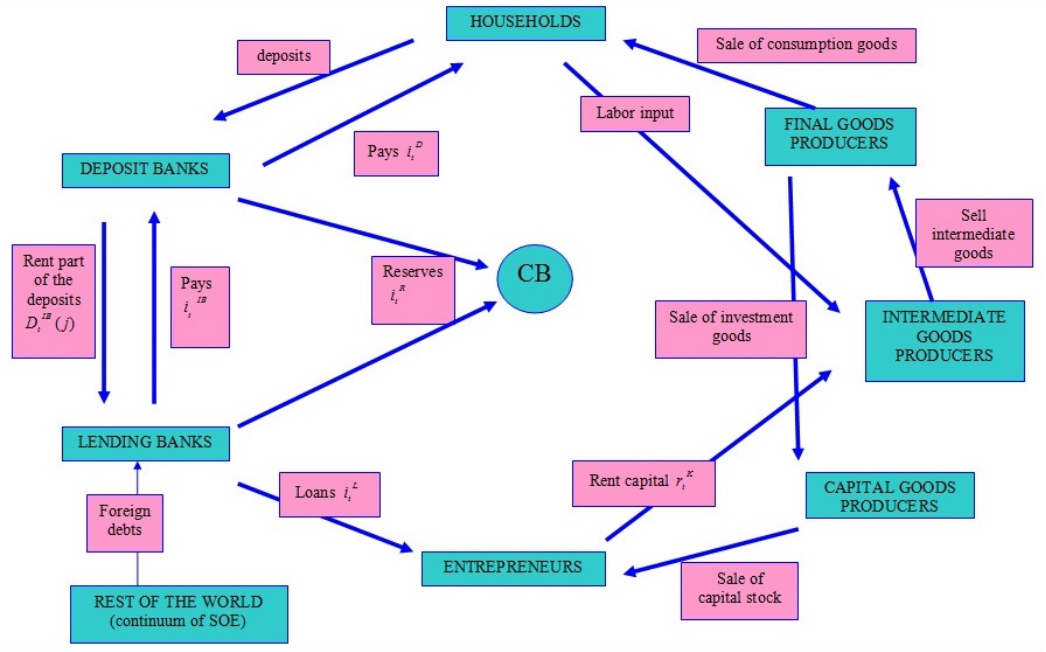

Figure 3.1: Framework of the Model

3.1 Households

There is a continuum of households. They get utility from consumption and disutility from working. Their utility function is

$$u(C_t, h_t) = lnC_t - \Psi \frac{h_t^{1+\phi}}{1+\phi} \tag{3.1}$$

Here, C stands for consumption, h is working hours whereas ϕ is inverse of Frisch labor supply elasticity.

$$C_t = (C_t^H)^\gamma (C_t^F)^{(1-\gamma)} \tag{3.2}$$

$$P_t = (P_t^H)^\gamma (P_t^F)^{(1-\gamma)} \tag{3.3}$$

Consumption and resulting price levels are Cobb-Douglas. γ share of their consumption is on domestic goods and the rest is on imported goods. C_t^H denotes domestic consumption while C_t^F denotes foreign good consumption. Additionally, P_t^H is domestic price level while P_t^F is foreign price level. Foreign currency price is normalized to one: $P_t^F = S_t$

Households consume and save by investing deposits at deposit banks. Their income includes labour income, taxes (or transfers), dividends from deposits banks Div_t^S and intermediate good producers Div_t^R and gross interest payments on their deposits. Thus, their period budget constraint is as follows:

$$P_t C_t + P_t D_t \leq i_{t-1}^D P_t D_{t-1} + P_t W_t h_t + P_t \sum_{j \in S,R} Div_t^j + P_t T_t \tag{3.4}$$

Here, W_t is nominal wage rate while T_t is taxes.

Thus, households maximize 3.1 subject to 3.4 which gives the following standard optimality conditions for consumption/saving and labour supply:

$$1 = E_t \Lambda_{t,t+1} \frac{i_t^D}{\pi_{t+1}} \tag{3.5}$$

$$W_t = \Psi h_t^{\phi} C_t \tag{3.6}$$

where the stochastic discount factor is $\Lambda_{t,t+1} = \beta \frac{C_t}{C_{t+1}}$ and the gross inflation rate is $\pi_{t+1} = \frac{P_{t+1}}{P_t}$.

3.2 Capital Goods Producers

Capital good producers buy investment goods, I_t, from final good producers at the price of 1 and combine them with previously installed capital stock, K_{t-1}, and sell them as capital, K_t, to entrepreneurs at the price of Q_t. The production technology of firms producing capital goods exhibits constants returns to scale:

$$\Upsilon_t(I_t, K_{t-1}) = I_t - \frac{X}{2} \left(\frac{I_t}{K_{t-1}} - \delta \right)^2 K_{t-1}. \tag{3.7}$$

Investment goods and consumption goods are the same. Capital de-

preciates at the rate of δ and is subject to a quadratic adjustment cost of $\frac{X}{2}\left(\frac{I_t}{K_{t-1}}-\delta\right)^2 K_{t-1}$. The parameter X measures the sensitivity of changes in the price of capital to changes in the investment to capital ratio. Since the capital is sold under the competitive equilibrium, in the long run each producer makes zero profit. Capital evolves according to:

$$K_{t+1} = I_t + (1-\delta)K_t \tag{3.8}$$

Capital good producer maximize his profit by choosing I_t:

$$\max_{\{I_t\}_{t\in Z}} (Q_t - 1)I_t - \frac{X}{2}\left(\frac{I_t}{K_{t-1}}-\delta\right)^2 K_{t-1} \tag{3.9}$$

The resulting first order condition provides us with the capital supply curve (that is the price of a unit of capital stock):

$$Q_t = \left[1 + X\left(\frac{I_t}{K_t}-\delta\right)\right] \tag{3.10}$$

3.3 Banking Sector

3.3.1 Deposit Banks

This section follows Glocker and Towbin [2012]. Deposit banks operate in perfectly competitive input and output markets. $(1-\varsigma_t(j))$ share of deposits collected from households are rented to lending banks on the interbank rate and the remainder is held as reserves at the central bank which is paid back at the reserve rate i_t^R. A representative deposit bank pays a deposit interest rate $i_t^D(j)$ to households and earns a gross return equal to i_t^{IB} from renting some fraction of his funds to lending banks. Therefore, the balance sheet of deposit bank is as follows:

$$D_t(j) = Res_t(j) + D_t^{IB}(j) \tag{3.11}$$

Here, $D_t(j)$ is the amount of the j'th bank's deposits collected from the households. Res_t is the reserves which is hold at the central bank. Lastly, D_t^{IB} is the loans to the lending banks.

Holding reserves has a convex cost $G_t^{\varsigma}(j)$ for deposit banks. There are two motivations of this convexity: first, due to decreasing returns to scale, benefits of holding reserves may decline over time. Secondly, the central bank may have the incentive to punish banks with larger penalties as the deviations from target value increase.

$$G_t^{\varsigma}(j) = \psi_1(\varsigma_t(j) - \varsigma_t^{MP}) + \psi_2/2(\varsigma_t(j) - \varsigma_t^{MP})^2 \tag{3.12}$$

Given the target level of reserve requirement ratio ς_t^{MP}, deposit banks has a cost of deviating from the steady state. If the deposit bank holds less reserve than the required level, it increases the cost of liquidity management.On the other hand, in case of holding excess reserves decreases this cost. Therefore, the cost function parameter $\psi_1 < 0$. The other cost function parameter $\psi_2 > 0$ because it guides dynamics around the steady state.

Therefore, the optimization problem of the deposit bank is as follows:

$$\max_{\varsigma_t(j), D_t(j)_{t\in Z}} Div_t^s(j) \tag{3.13}$$

subject to

$$Div_t^s(j) = [(1 - \varsigma_t(j))i_t^{IB} + \varsigma_t(j)i_t^R - i_t^D(j) - G_t^{\varsigma}(j)]D_t(j) \tag{3.14}$$

The first order conditions are:

$$-[i_t^{IB} - i_t^R] - \psi_1 = \psi_2(\varsigma_t(j) - \varsigma_t^{MP}) \tag{3.15}$$

$$i_t^D(j) = (1 - \varsigma_t(j))i_t^{IB} + \varsigma_t(j)i_t^R - G_t^{\varsigma}(j) \tag{3.16}$$

Equation 3.15 determines the bank's optimal reserve ratio, ς.*Asthespreadbetweeninterba*

3.3.2 Lending Banks

As stated before, the main contribution of this paper is to allow banks to borrow from abroad. Lending banks are the only agents which can obtain funds from abroad as well as from the deposit banks. I assume that apart from being denominated in foreign currency, both deposit bank funds, D_t^{IB}, and foreign funds, B_t, can be used in similar means to generate loans in the domestic economy. Therefore, we do not need to specify a technology that combines both funds to generate a loan. The model does not include any set limitations, however when numerically solving the model I adjust all the parameters in such a way that the total amount of loans needed is always greater than what they collect from deposit banks. By doing so, the remainder will always be obtained from abroad no matter what the foreign interest rate is . Lastly, lending banks are also subject to reserve requirements in domestic currency and holding foreign bonds is costly. Thus, lending banks balance sheet reads:

$$L_t + R_t = S_t B_t + D_t^{IB} \tag{3.17}$$

$$R_t = \varsigma_t^{MP} * (S_t B_t + D_t^{IB}) \tag{3.18}$$

$$D_t^{IB} = (1 - \varsigma_t) D_t \tag{3.19}$$

Here, if we write both loans to the entrepreneurs, L_t and reserves, R_t, in terms of deposits, D_t, this gives us the following equations:

$$L_t = (1 - \varsigma_t^{MP}) S_t B_t + (1 - \varsigma_t^{MP})(1 - \varsigma_t) D_t \tag{3.20}$$

$$R_t = \varsigma_t^{MP} S_t B_t + \varsigma_t^{MP}(1-\varsigma_t) D_t \tag{3.21}$$

Therefore, a one percent rise in deposits increases the amount of loans by $(1-\varsigma_t^{MP})(1-\varsigma_t)$ whereas reserves by $\varsigma_t^{MP}(1-\varsigma_t)$ percent.

Lending banks maximize their expected profit subject to balance sheet equation above:

$$\max_{B_t, D_{tt\in Z}} i_t^L L_t + i_t^R R_t - i_t^{IB} D_t^{IB} - \frac{S_{t+1}}{S_t} i_t^* B_t - \frac{\psi_B}{2} P_t \left(\frac{S_t B_t}{P_t} - \frac{SB}{P} \right)^2 \tag{3.22}$$

Here, S, B and P are the steady state values. Thus, at steady state, cost of holding bond is zero.

Resulting optimality condition gives us uncovered interest parity condition and the definition of interest rate on loans:

$$i_t^{IB} - \psi_B \left(\frac{S_t B_t}{P_t} - \frac{SB}{P} \right) = i_t^* \frac{S_{t+1}}{S_t} \tag{3.23}$$

$$i_t^L = \frac{i_t^{IB} - i_t^R \varsigma_t^{MP}}{1-\varsigma_t^{MP}}. \tag{3.24}$$

where

$$\frac{\partial i_t^L}{\partial \varsigma_t^{MP}} > 0$$

Equation 3.24 is important because it gives us the relationship between required reserves and the lending rate, i_t^L. When deposits obtained from deposit bankers increase by one percent, this will generate

$$(1-\varsigma_t^{MP}) i_t^L + \varsigma_t^{MP} i_t^R \tag{3.25}$$

marginal benefit to the lending banker. This marginal benefit will be equalized with a marginal cost of interbank rate.

3.3.3 Financial Contract Between Lending Banks and Entrepreneurs

The financial contract between lending banks and entrepreneurs constitutes an important role in creating the financial accelerator mechanism in the economy. As it is mentioned above, at the end of time t, entrepreneurs finance themselves with their net worth and borrowings from lending banks and abroad. The borrowing mechanism is based on a contract between lending banks and entrepreneurs. Assuming a continuum of risk-neutral entrepreneurs indexed by $j \in (0,1)$, let $N_t(j)$ be the net worth, $L_t(j)$ be stock of loans, $B_t(j)$ be foreign assets, $K_t(j)$ be the end of time t capital stock and $Q_t(j)$ be current market price of one unit of capital. Then, entrepreneurial balance sheet is,

$$Q_t K_t(j) = N_t(j) + L_t(j) \tag{3.26}$$

Capital is responsive to both aggregate and idiosyncratic shocks and idiosyncratic shocks are private information for entrepreneurs. Therefore, when the entrepreneur buys capital at time t, an idiosyncratic shock drawn by the entrepreneur changes $K_t(j)$ to $\omega(j)K_t(j)$ at the beginning of t+1. Here, $\omega(j)$ is i.i.d across firms and time and $ln(\omega(j)) \sim N(\mu_\omega, \sigma_\omega^2)$. Moreover, the cumulative and density functions are respectively $Pr(\omega(j) < x) = F(x)$ and $f(x) = F'(x)$.

The financial contract is similar to standard debt contract. In this sense, when the entrepreneur draws an idiosyncratic shock $\omega(j)$, we have two scenarios. If the realized idiosyncratic shock is above a threshold value $\overline{\omega}(j)$, then he pays $i_t^L L_t(j)$. Otherwise, he will go bankrupt.

Therefore, $\overline{\omega}(j)$ should satisfy the following equation:

$$\overline{\omega}(j) Q_t K_t(j) E_t r_{t+1}^K = i_t^L \frac{P_t}{P_{t+1}} L_t(j) \tag{3.27}$$

According to the equation, expected market value of capital purchased this period under the threshold idiosyncratic shock is at least equal to debt payments.

Additionally, I make the costly state verification assumption which is proposed by Townsend [1979] and used by both Bernanke et al. [1999] and Glocker and Towbin [2012]. According to this assumption, when the entrepreneurs go bankrupt (the case where $\omega(j) < \overline{\omega}(j)$), the financial intermediary must pay an auditing cost in order to observe the entrepreneurs realized return. They must give everything they have to the bank but the bank recovers only $(1-\mu)$ fraction of the value of such firms. Here, μ is the degree of monitoring cost. The smaller the μ is the lesser effective financial accelerator mechanism is. Therefore, after the monitoring cost is paid, what is left from the entrepreneur is as follows:

$$(1-\mu)\omega(j)r_{t+1}^{K}K_t(j)Q_t \tag{3.28}$$

Therefore, expected return to the entrepreneur is maximized in the optimal contract by

$$E_t\left[\int_{\overline{\omega}(j)}^{\infty}\left(\omega(j)Q_tK_t(j)E_tr_{t+1}^{K}-i_t^{L}\frac{P_t}{P_{t+1}}L_t(j)\right)f(\omega)d\omega\right] \tag{3.29}$$

Also, the participation constraint of the bank is

$$\left(1-F(\overline{\omega}(j))\right)z_t^{L}\frac{P_t}{P_{t+1}}L_t(j)+(1-\mu)\int_0^{\overline{\omega}(j)}\omega E_tr_{t+1}^{K}K_t(j)Q_tf(\omega)d\omega=\frac{i_t^{L}}{E_t\pi_{t+1}}L_t(j) \tag{3.30}$$

In equation, the first term on the left hand side is the amount lending bank receives once the entrepreneur does not default, the second term, on the other hand, is the amount received when he defaults. The term on the right hand side is bank's cost of raising funds.

3.4 Entrepreneurs

Entrepreneurs play an important role between intermediate good producers and capital good producers. By using their net worth and loans from the lending banks, they buy capital goods from the capital good producers and rent it to intermediate good producers at the rental rate z_t. Following [Bernanke et al., 1999], if we define premium on external funds as $s = \frac{E_t r^K_{t+1}}{i^L_t / E_t \pi_{t+1}}$, the first order condition of optimal contracting problem with non-stochastic monitoring cost is as follows:

$$K_t(j)Q_t = f\left(\frac{E_t r^K_{t+1}}{i^L_t / E_t \pi_{t+1}}\right) N_t(j) \tag{3.31}$$

where $f'(.) > 0$. This equation shows that the ratio of capital expenditures to the net worth increases with the discounted return to capital. An equivalent way of expressing this equation is:

$$E_t r^K_{t+1} = h\left(\frac{N_t(j)}{Q_t K_t(j)}\right) \frac{i^L_t}{E_t \pi_{t+1}} \tag{3.32}$$

where $h'(.) < 0$. This equality says that if an entrepreneur is not fully self-financed, the expected return to capital has to be equal to the marginal cost of external finance. Here, entrepreneur's real return on capital depends on rental rate and depreciation of capital adjusted for capital price valuation effects:

$$r^K_t = \frac{z_t + Q_t(1-\delta)}{Q_{t-1}} \tag{3.33}$$

Entrepreneurs' surviving probability is v so they leave the market with a probability $(1-v)$. If they leave, they just consume their net worth. Departing entrepreneurs bequeath a small transfer $\overline{g}$ to the new ones. Gertler et al. [2007] and Bernanke et al. [1999] specify this small transfer as the managerial wage of departing entrepreneurial workers. For simplicity, I do not define entrepreneurial worker. Instead, I equalize it to zero since it will not change

the main implications of the model. Giving a small number does not change the main implications of the model, as well. Therefore, the aggregate net worth is:

$$N_t = vV_t + (1 - v)\overline{g} \tag{3.34}$$

where V_t is the net worth of surviving entrepreneurs. Following Glocker and Towbin [2012], I assume a fixed lending rate so net worth of surviving capital will be:

$$V_t = (1 - \mu)r_t^K Q_{t-1} K_{t-1} - i_{t-1}^L \frac{P_{t-1}}{P_t} L_{t-1} \tag{3.35}$$

Equilibrium in the Financial Sector

Since all deposit banks face the same interbank and reserve interest rate, first optimality condition of deposit banks states that $\varsigma_t(j) = \varsigma_t$. All real seigniorage revenue is distributed as a lump-sum transfer to the households and it is defined by:

$$T_t^s = \varsigma_t D_t - \frac{i_{t-1}^R}{\pi_t} \varsigma_{t-1} D_{t-1} \tag{3.36}$$

3.5 Intermediate Good Producers

Intermediate good producers rent capital from entrepreneurs and buy labor from households. They operate in a perfectly competitive market. With these factors, they produce intermediate goods, y_t which are later sold to final good producers in the monopolistic market. A representative producer i's production function is Cobb-Douglas with constant returns to scale:

$$y_t(i) = A_t K_{t-1}(i)^{\alpha} h_t(i)^{1-\alpha} \tag{3.37}$$

Here, A_t is the production technology which is driven by an $AR(1)$ process.

$$A_t = \rho A_{t-1} + u_t^A \tag{3.38}$$

The main objective of intermediate goods producers is maximizing their profits. Therefore, their objective function is as follows:

$$max A_t K_{t-1}(i)^{\alpha} h_t(i)^{1-\alpha} - h_t(i) w_t - z_t K_{t-1}(i) \tag{3.39}$$

The resulting optimality condition implies $\frac{h_t(i) W_t}{z_t K_{t-1}(i)} = \frac{1-\alpha}{\alpha}$ and marginal cost (mc) is

$$\frac{1}{A_t} w_t^{1-\alpha} z_t^{\alpha} \left[\left(\frac{1-\alpha}{\alpha} \right)^{\alpha} + \left(\frac{1-\alpha}{\alpha} \right)^{(\alpha-1)} \right] \tag{3.40}$$

3.6 Final Good Producers

Final goods producers buy intermediate goods in a monopolistic market and sell them to households as consumption goods and to capital goods producers as investment good in a perfectly competitive market. Before proceeding with the optimality conditions of final good producers, I will first cover the optimality condition between intermediate good producer and final good producer.

Intermediate good producers adjust their prices according to Calvo-type price staggering condition. The probability that a firm can adjust its prices at period k is $(1-\theta)^k$. Therefore, final goods producer adjust its prices by maximizing its life-time profits:

$$\max_{p_t^* \, t \in Z} E_t \left[\sum_{k=0}^{\infty} (\beta\theta)^k \Lambda_{t,t+k} Div^R_{t+k|t}(i) \right] \tag{3.41}$$

where $Div^R_{t+k|t}(i) = \frac{p_t^*}{P_t} y_t(i) - mc_{t+k|t}(i) y_{t+k|t}(i)$. The first order condition is

$$E_t \left[\sum_{k=0}^{\infty} (\beta\theta)^k \Lambda_{t,t+k} y_{t+k|t}(i) \left(\frac{p_t^*}{P_{t+k}} - \frac{\epsilon}{1-\epsilon} mc_{t+k|t}(i) \right) \right] = 0 \tag{3.42}$$

3.7 Equilibrium

In equilibrium,

$$Y_t = \frac{P_t}{P_t^H}[C_t + I_t + G_t] + \frac{S_t}{P_t^H}X_t + \frac{P_t}{P_t^H}\Psi_t \tag{3.43}$$

where X_t stands for net exports expressed in foreign currency and total adjustment cost is:

$$\Psi_t = K_{t-1}\left(\frac{X}{2}(\frac{I_t}{K_{t-1}} - \delta)^2 + \mu\omega(j)r_t^K Q_{t-1}\right) + G_t^{\varsigma}(.) + \frac{\psi_B}{2}(\frac{S_t}{P_t}B_t)^2 \tag{3.44}$$

Evolution of bond holdings is defined as follows:

$$NX_t = i_{t-1}S_tB_{t-1} - S_tB_t \tag{3.45}$$

In this model, I define bonds as liabilities rather than assets, so the current account is the net foreign liabilities:

$$CA_t = B_{t-1} - B_t \tag{3.46}$$

Finally, the balance of payment identity is as follows:

$$i_{t-1}^* S_tB_{t-1} = P_t^H Y_t - P_t[C_t + I_t + G_t] + S_tB_t - P_t\Psi_t \tag{3.47}$$

3.8 Government Sector

Now, suppose that hat denotes the percentage deviations of a variable from steady state while tilde denotes level deviations. In this framework, suppose that the monetary policy rule obeys the following rules:

$$\hat{i}_t^{IB} = \phi_{\pi,i^{IB}}\pi_t + \phi_{Y,i^{IB}}\hat{Y}_t \tag{3.48}$$

$$\tilde{\varsigma}_t^{MP} = \phi_{L,\varsigma^{MP}} \hat{L}_t \tag{3.49}$$

According to deviations in price level and income, central bank adjusts interbank interest rate and according to the deviations in stock of loans it plays with reserve requirements. The reason of why I use this kind of monetary policy is as follows: This policy regime has both financial and price stability objective Glocker and Towbin [2012]. As it is known the reserve requirement is a financial tool and it is expected to be effective mostly in financial sector. Therefore, I find it convenient to make reserve requirements sensitive to only a financial variable. I may add variations in income and price levels to equation 3.49, but this would make it hard to differentiate the effects of interbank rate and reserve requirements.

In order to analyse the effectiveness of reserve requirement on external account imbalances, I will introduce reserve requirements to the system as a transitory shock, and observe how the current/capital account responds accordingly.

CHAPTER 4

CALIBRATION

Most of the parameters of the model are from the papers which study open economy DSGE models with financial accelerator mechanism such as Glocker and Towbin [2012], Bernanke et al. [1999] and Gertler et al. [2007]. Table 4.1 provides the values of the parameters:

Table 4.1: Calibration of Parameters

Param.	Value	Description
δ	0.025	Depreciation Rate of Capital
β	0.985	Discount Factor
α	0.33	Capital Share in Production
ϕ	1.00	Inverse of Frisch Labor Supply Elasticity
θ	0.75	Degree of Price Stickiness
v	0.97	Survival Rate of Entrepreneurs
X	0.25	Capital Adjustment Cost
η	0.05	Elasticity of External Finance Premium to Entrepreneurs' level of leverage
ψ_B	1	Adjustment Cost for Net Foreign Assets
γ	0.75	Share of Domestically Produced Goods in Domestic Absorption
ϵ	6.5	Elasticity of Substitution
μ	0.12	Fraction of Auditing Cost
ψ_2	0.01	Cost of Deviating from target reserve requirement

Other than these parameters, I adjust ψ_1 such that it implies an interest rate spread $i_{IB} - i_t^R$ equal to 150 basis points on quarterly basis and a steady state share of reserve ratio of 0.10. Here, 0.10 percent required reserve is

the average level for Turkey before the recent increase in 2011. Following, Bernanke et al. [1999] and Glocker and Towbin [2012], I choose external finance premium as 50 basis points. Combined with the steady state level of interest rate on lending, this gives us the real return of capital, r^K.

In order to study the effects of Turkeys recent monetary policy on its external imbalances , I choose parameter values to match Turkish facts as much as possible. The data are obtained from Turkish Central Bank database. After I collect all the data from 1988 to 2011, I calculate ratios I need. Instead of using the values of recent years, I took the averages of all ratios. Also, in order to be comparable with the other emerging market papers in the literature, I choose not to use some of the extreme values such as consumption and government shares. In Turkey, these ratios are 70

In order to solve the model, I first log-linearise the system around the steady state and then hit the system with six type of shocks. These are productivity shock, foreign interest rate shock, government spending shock, export shock and shocks to reserve requirements and monetary policy.The reason of why I need six different shocks is as follows: In this model, as in Glocker and Towbin [2012] model, government expenditures, foreign interest rates and exports are exogenously given to the system. Since omitting all of these exogenous values makes the model hard to solve, I find it more convenient to hold them in the system. All of them, except the monetary policy shock, follow AR(1) processes. Monetary policy shock hits the policy interest rate i_t^{IB}. Both reserve requirement and monetary policy shocks are seen on the policy functions below. The values below are taken from Christoffel et al.

[2008]:

$$A_t = 0.89A_{t-1} + u_t^A \tag{4.1}$$

$$i_t^* = 0.88i_{t-1}^* + u_t^{i^*} \tag{4.2}$$

$$g_t = 0.86g_{t-1} + u_t^g \tag{4.3}$$

$$x_t = 0.80x_{t-1} + u_t^x \tag{4.4}$$

where variance of the shock processes are 1.13, 0.43, 4.63 and 5.01 respectively. Lastly, I choose the variance of monetary policy shock as 1.50 and that of reserve requirement shock as 1.63.

CHAPTER 5

RESULTS

As it is stated, there are six type of shocks in this model. However, since my main aim is to observe the effectiveness of reserve requirements on current account deficit, I will only analyse productivity shock, monetary policy shock and reserve requirement shock. The others are beyond the scope of my thesis and can be analysed for future work.

5.1 Positive Productivity Shock

The figure 5.1 and 5.2 show impulse responses to an expansionary productivity shock. Analysing the response of the model economy to a productivity disturbance provides a good way to evaluate my framework since a wide literature has reached a consensus on how an economy reacts to this kind of shock. The above mentioned figures provide supporting evidence while presenting some new evidence on the behaviour of some other variables which are specific to the current model.

According to the figure 5.1, increasing output due to productivity shock raises the interbank rate because of the simple Taylor rule. Then, lending banks borrow less from the deposit banks. Since I assume a constant spread between interbank rate and interest rate on reserves, it is normal to see higher interests on reserves. Additionally, uncovered interest parity condition (see

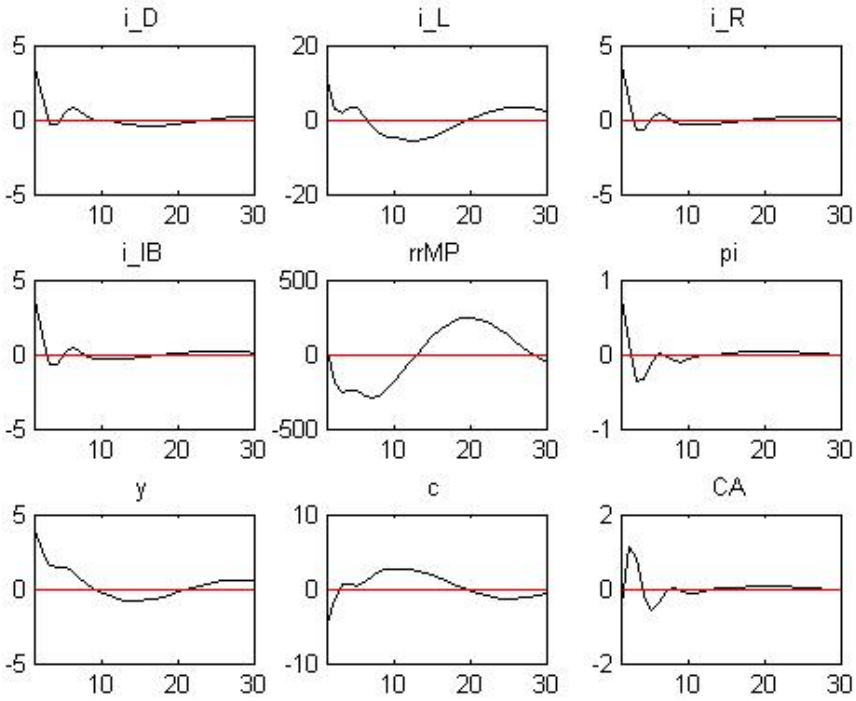

Figure 5.1: Positive Productivity Shock

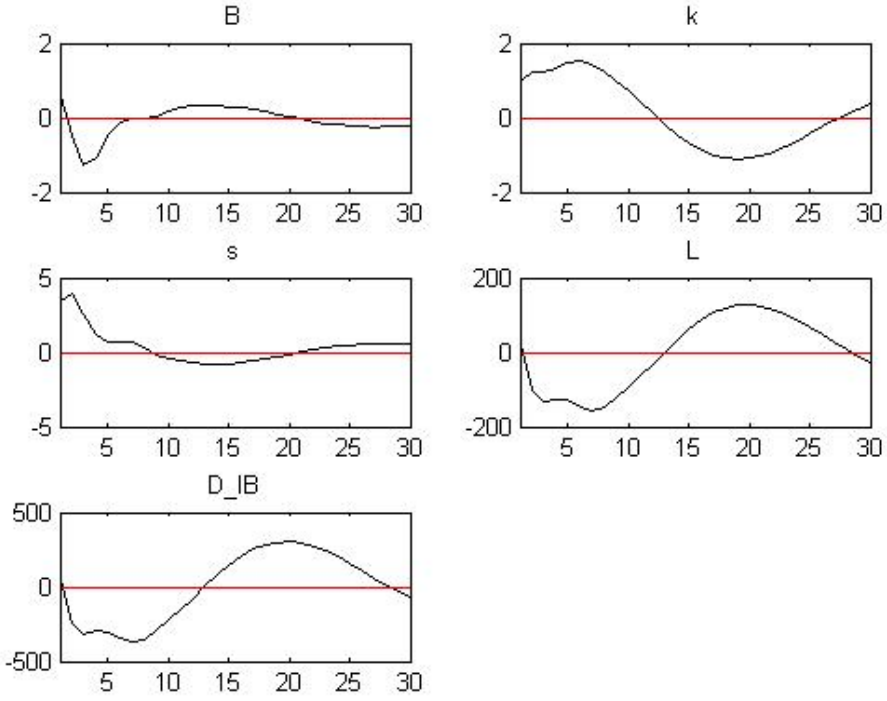

Figure 5.2: Positive Productivity Shock

equation 3.23) suggests a depreciation of exchange rate due to higher interbank rate. Therefore, it is now more expensive for lending banks to borrow from abroad, as well. That is why we observe a decrease in foreign debts. Overall, lending banks borrow less from the two channels of borrowing.

It is an undoubted fact that it would be more deductive story if we observe increasing foreign debts when the domestic borrowing become expensive compared to foreign borrowing. In my model, when the productivity shock hits the economy, increasing interbank rates makes foreign borrowing cheaper than domestic borrowing. One can observe it from the initial impulse response of the bonds (B in figure 5.2) but it is not a remarkable increase compared to the reduction in domestic debts. Moreover, even that small increase in foreign borrowing starts to decrease as exchange rate adjusts next period.

On the other hand, as it is seen from figure 5.2, transitory productivity shock has caused an output growth which eventually increases the rental rate and real return on capital. As expected, this will trigger capital accumulation in the country. Moreover, rising wage rates bring about high labour supply. Since it is a transitory shock, households know that this prosperity will not last forever, so they start to consume less and save more. This decrease in consumption can also be explained by increase in deposit rates. When the deposit rates increase, saving become more attractive than consuming for households. This is another reason of why we see a consumption reduction. Keeping in mind that current account is the difference between savings and investments, higher savings causes a rise in current account.

Therefore, these impulse responses suggest that this model is a decent laboratory which is able to capture the basic facts such as increasing interest rates and output as a result of a productivity shock.

5.2 Monetary Policy Shock

Figures 5.3 and 5.4 report the impulse responses of several variables to a monetary policy shock. A contractionary monetary policy raises interbank rates by Taylor rule. As mentioned above, this makes foreign debts cheaper than domestic debts. Thus, it is expected to see a rise in bonds as well as a fall in deposits. However, fall in domestic debts is more than the rise in foreign debts, so total stock of loans declines. Therefore, entrepreneurs demand less capital than before.

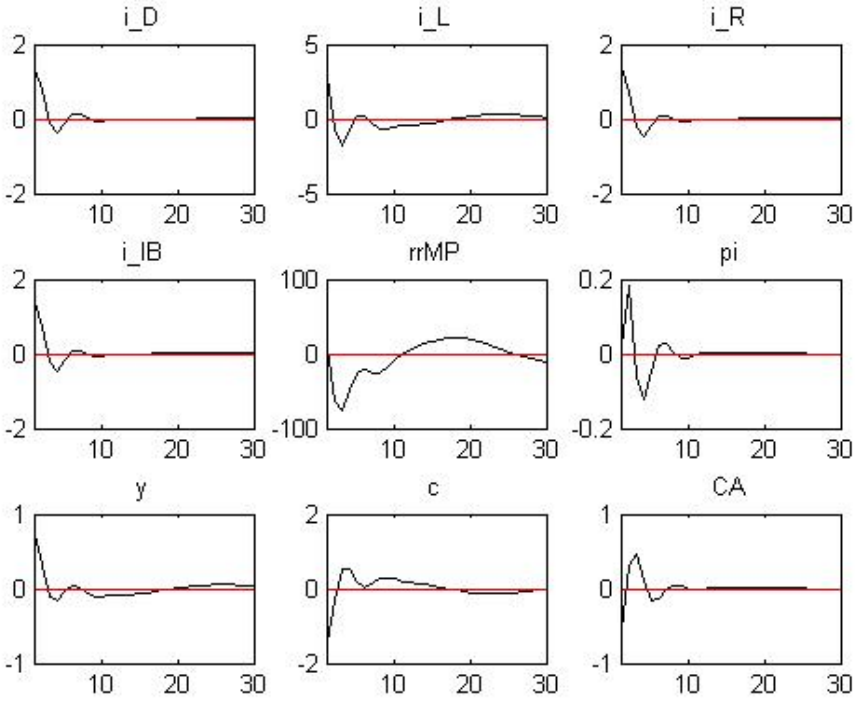

Figure 5.3: Monetary Policy Shock

On the other hand, the economy will have higher interest rates on loans. By external finance premium, it increases the real return on capitals and so does the capital accumulation. Lastly, as the current account is the net foreign liabilities between two periods, rise in foreign debts decreases the current account. From here, we can say that contractionary monetary policy deepens current account deficit in a country.

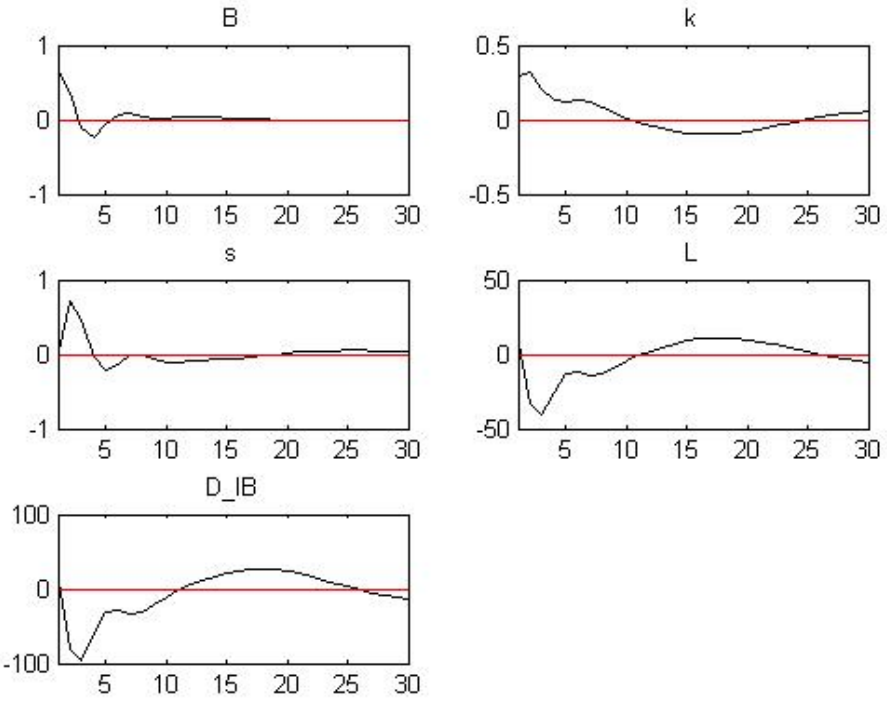

Figure 5.4: Monetary Policy Shock

5.3 Reserve Requirement Shock

The main contribution of this thesis is discussed in the subsection, where we are able to show that the use of reserve requirements to adjust current account imbalances may be a correct choice of policy. Figure 5.5 and 5.6 report the impulse responses of several variables to one percentage increase in required reserves.

As it is seen from equation 3.25, higher reserve requirements increases the marginal benefit of obtaining one percent deposit more from deposit bankers. On the other hand, by external finance premium, it decreases marginal return to capital, so capital supply decreases. By equation 3.37, GDP level declines and it brings about lower interbank rates by Taylor rule. Now, if we examine these two different forces by looking at the lending bankers' optimization, we realize that, marginal cost of domestic borrowing decreases while its benefit increases. Since, lending bankers cannot influence the movements of interbank

rate, they equalize their marginal benefit and marginal cost by decreasing the lending rate (see Figure 5.5). This is striking because it suggests that increasing reserve requirements decrease the lending rates. However, it can be explained. If lending banks had a direct influence on interbank rates, or else if central bank actively increased the interbank rates, lending banks would not optimally decrease their lending rates but instead they would increase it. However, in this case, they lower it because decreasing capital accumulation affects GDP level and so does the interbank rate.

Lastly, given exogenously determined foreign interest rates, higher interbank rates make domestic borrowing cheaper than foreign borrowing. Thus, one would expect to observe increased deposits from domestic units, with lower borrowing from the rest of the world. Hence the higher current account surplus. Then, for a country with current account deficit, increasing reserve requirements can be an effective tool to use. However, higher reserve requirement increases current account in two quarters but after about ten quarters, it will go back to its old level.

When banking sector has multiple channels to borrow, we see that it gives banks flexibility to move from one channel to another in different cases. A central bank's primary aim of increasing required reserves is to decrease the credit growth. Therefore, higher reserve requirements generally should increase the interest rates in the economy. However, in this model this is not the exact case because interbank rate is adversely affected by the changes in output level in the country and decreases. This reduces the marginal cost of lending bankers and lending rates decreases despite the positive relationship between reserve requirements and lending rates. This thesis is not alone with respect to this exceptional result. There are also some papers such as Montoro [2010] which displays a negative relationship between interbank rate and reserve requirements.

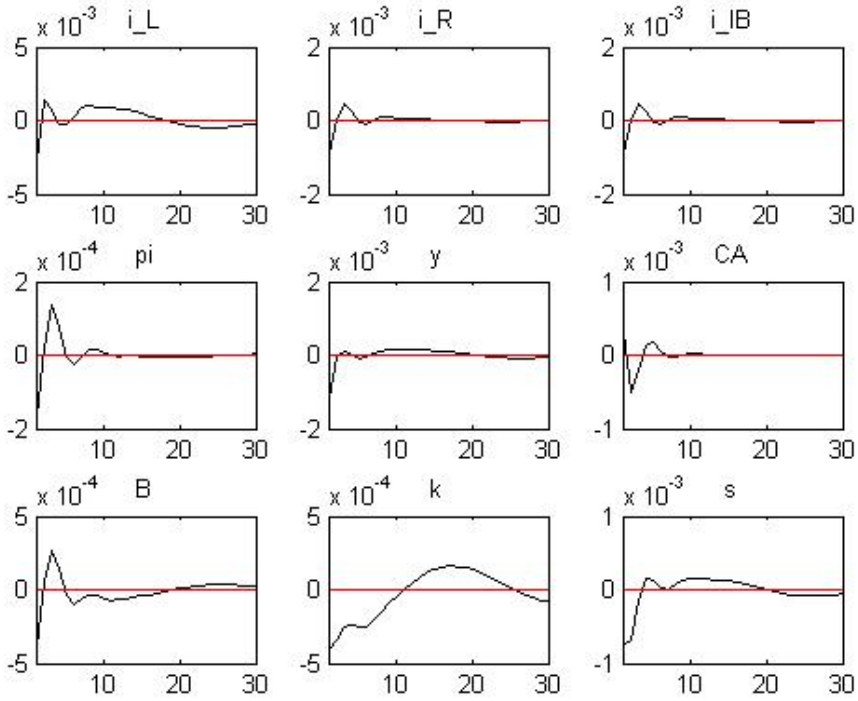

Figure 5.5: Reserve Requirement Shock

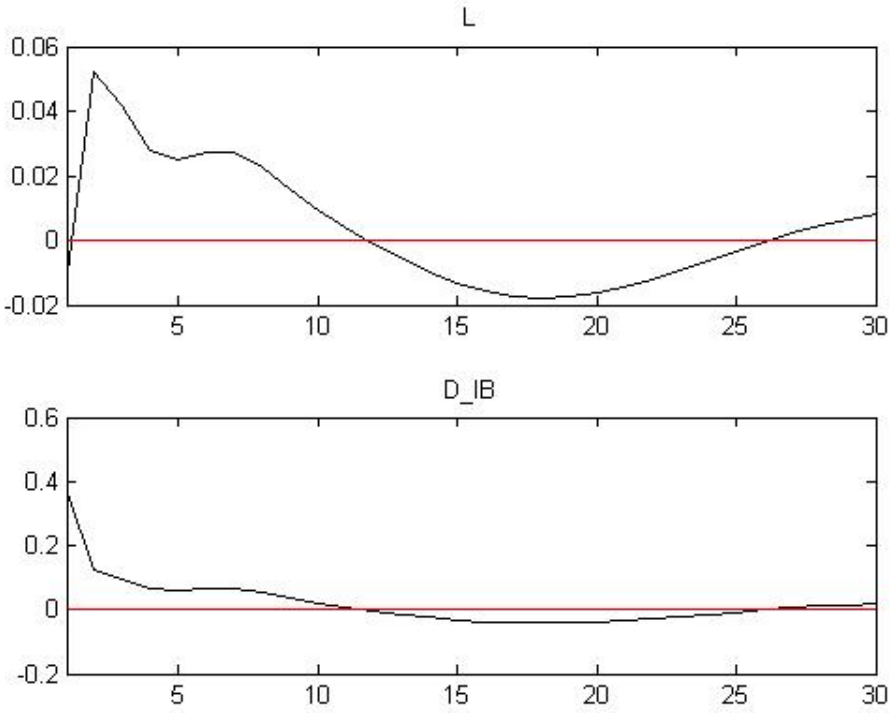

Figure 5.6: Reserve Requirement Shock

CHAPTER 6

CONCLUSIONS

Deepening current account deficit continues to be one of the primary economic concerns of Turkey. Over the past year, in order to rebalance this deficit, Turkish Central Bank has started to implement some macro-prudential policies given the link between the current account the country's financial stability. For this goal they have been using the reserve requirements, an unconventional tool in this aspect as well.

As the governor of the Turkish Central Bank states in the Bank's financial stability report, although it is roughly known how required reserves might affect the current account deficit, there is not formal theoretical framework that allows us to make any formal inferences Başçı and Kara [2011]. In order to fill this gap this thesis builds a DSGE model with the financial accelerator mechanism including a banking sector which engages in international borrowing. In this framework, this thesis allows examination of reserve requirements as a policy tool to correct external (current/capital) account imbalances in developing countries.

Originally, higher reserve requirements tend to decrease credits which eventually implies lower consumption. By this way, countries like Turkey intent to decrease current account deficit. However, when the banking sector have multiple channels to borrow in order to create a loan for entrepreneurs,

how much the credit growth decreases depends mostly on which channel is superior compared to other. In this model, although rising reserve requirements do not brings about a decrease in overall credits, it decreases the amount of loans obtained from abroad. This constitutes the main channel of reserve requirements against external imbalances In Turkey.

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