CERGE
Center for Economics Research and Graduate Education
Charles University Prague

Essays on Monetary Policy

Ruslan Aliyev

Dissertation

Prague, June 2015

Dissertation Committee

Byengju Jeong (CERGE-EI, Charles University; chair)

Michal Kejak (CERGE-EI, Charles University)

Jan Kmenta (University of Michigan)

Sergey Slobodyan (CERGE-EI, Charles University)

Evangelia Vourvachaki (CERGE-EI, Charles University)

Referees

Luca Bossi (University of Pennsylvania)

Agnieszka Markiewicz (Erasmus University Rotterdam)

Dedicated to my parents.

Table of Contents

Acknowledgments

First of all, I would like to express my very great appreciation to Byeongju Jeong for his guidance and constant support. Without him this thesis may not have been written. I am particularly grateful to Michal Kejak, Jan Kmenta, Sergey Slobodyan, and Evangelia Vourvachaki for valuable comments and helpful suggestions. I am thankful to Downing Andrea and Deborah Novakova for English editing.

I would like to thank my parents and my sister for being my inspiration. My special thanks are extended to all the CERGE-EI community for being so friendly and supportive. Last, but definitely not least, I would like to thank all the people who encouraged and helped me while I was writing this thesis.

All errors remaining in this text are the responsibility of the author.

Czech Republic, Prague — Ruslan Aliyev

June 2015

Abstract

This thesis deals with topics related to monetary policy in general. The dissertation consists of three chapters. The first chapter focuses on the role of monetary policy in resource-rich developing countries from a theoretical perspective. The second chapter empirically analyses the determinants of the choice of exchange rate regime in resource-rich countries. The third chapter studies the monetary transmission channels in the Czech Republic by using micro-level data.

In the first chapter we construct a DSGE model for a small, open economy to show that if fiscal indiscipline, in the form of immediate responses to foreign resource revenue changes is inevitable, then monetary policy can help improve the allocation problem. The simulation results indicate that targeting the exchange rate or price level, through foreign exchange interventions by the central bank, can soften the negative effects of Dutch Disease and stabilize the economy in the face of volatile natural resource revenues in the short run. We also find that a fixed exchange rate regime outperforms price level targeting by delivering higher isolation and hence less vulnerability to shocks in natural resource revenues. In contrast, if the central bank chooses to pursue a laissez faire policy, i.e., not to intervene, then the economy becomes vulnerable to shocks in foreign resource revenues and the resource curse becomes more severe.

The second chapter studies the specific determinants of the choice of exchange rate regime in resource-rich countries. We run multinomial logit regressions for an unbalanced

panel data set of 145 countries over the 1975-2004 period. We find that resource-rich countries are more likely to adopt a fixed exchange rate regime compared to resource-poor countries. Furthermore, we provide evidence that output volatility contributes to the likelihood of choosing a fixed exchange rate regime, positively in resource-rich countries and negatively in resource-poor countries. In resource-rich countries the fluctuations in natural resource extraction and exports are the main sources of output volatility. We claim that in resource-rich countries a fixed exchange rate regime is mainly preferred due to its stabilization function in the face of turbulent foreign exchange inflows. Moreover, our results reveal that the role of democracy and independent central banks in choosing more flexible exchange rate regimes is stronger in resource-rich countries. In resource-rich countries with non-democratic institutions and non-independent central banks, the government is less accountable for spending natural resource revenues and fiscal dominance prevails. In this situation, fluctuations in natural resource revenues are more easily transmitted into the domestic economy and therefore a fixed exchange rate becomes the more favorable option.

In the third chapter, coauthored with Dana Hájková and Ivana Kubicová, we use firm-level financial data for Czech firms in the period from 2003 to 2011 and test for the role of companies' financial structure in the transmission of monetary policy. Our results indicate that higher short-term interest rates coincide with lower shares of total debt and long-term debt, and with higher shares of short-term bank loans and trade credit. We find that firm-specific characteristics, such as size, age, collateral, and profit affect the way monetary policy influences the external financing decisions of firms. These findings indicate the presence of informational frictions in credit markets and hence provide some empirical evidence on the existence of a broad credit channel in the Czech Republic.

Abstrakt

Tato práce se zabývá tématy všeobecně spojenými s měnovou politikou. Disertace se skládá ze tří kapitol. První kapitola je zaměřena na roli měnové politiky v rozvojových zemích bohatých na zdroje z teoretického hlediska. Druhá kapitola empiricky analyzuje determinanty volby kurzového režimu v zemích bohatých na zdroje. Třetí kapitola studuje monetární transmisní kanály v České republice s využitím dat na mikroúrovni.

V první kapitole je vybudován DSGE model pro malou otevřenou ekonomiku ukazující, že když je fiskální nekázeň ve formě okamžitých reakcí na změny zahraničních příjmů z přírodních zdrojů nevyhnutelná, pak měnová politika může pomoci zlepšit alokační problém. Výsledky simulace ukazují, že cílování směnného kurzu nebo cenové úrovně prostřednictvím devizových intervencí centrální banky může zmírnit negativní dopady holandské nemoci a stabilizovat hospodářství tváří v tvář nestálým příjmům z přírodních zdrojů v krátkém období. Také zjišťujeme, že režim fixního směnného kurzu překonává cílování cenové hladiny tím, že poskytuje vyšší izolaci a tím i menší zranitelnost vůči šokům v příjmech z přírodních zdrojů. Oproti tomu, když se centrální banka rozhodne provádět politiku laissez faire, tj. nezasahování, pak se ekonomika stává zranitelnější vůči šokům v příjmech ze zahraničních zdrojů a prokletí zdrojů se stává ještě závažnějším.

Druhá kapitola zkoumá specifické příčiny volby kurzového režimu v zemích bohatých na zdroje. Využíváme multinomické logitové regrese pro nevyvážená panelová data ze 145 zemí mezi lety 1975 a 2004. Zjišťujeme, že země bohaté na zdroje s větší pravděpodob-

ností přijímají pevný kurzový režim v porovnání se zeměmi chudými na zdroje. Dále přinášíme důkazy, že volatilita výstupů přispívá pozitivně k pravděpodobnosti výběru režimu pevného kurzu v zemích bohatých na zdroje a negativně v zemích chudých na zdroje. V zemích bohatých na zdroje jsou fluktuace v těžbě a exportu nerostných surovin hlavním zdrojem nestálosti produkce. Tvrdíme, že v zemích bohatých na zdroje je fixní kurzový režim preferovaný zejména kvůli své stabilizační funkci v prostředí turbulentních devizových příjmů. Navíc naše výsledky odhalují, že role demokracie a nezávislosti centrální banky při výběru pružnějšího kurzového režimu je silnější v zemích bohatých na zdroje. V zemích bohatých na zdroje s nedemokratickými institucemi a závislou centrální bankou je vláda méně zodpovědná při utrácení příjmů z přírodních zdrojů a převládá fiskální dominance. V této situaci jsou výkyvy v příjmech z přírodních zdrojů snadněji přeneseny do domácí ekonomiky, čímž se pevný kurz stává výhodnější možností.

Ve třetí kapitole spolu se spoluautorkami Danou Hájkovou a Ivanou Kubicovou používáme finanční data na úrovni podniků pro české firmy v období 2003-2011 a testujeme roli finanční struktury společností v transmisi měnové politiky. Naše výsledky ukazují, že vyšší krátkodobé úrokové sazby se shodují s nižším podílem celkového a dlouhodobého dluhu a s vyššími podíly krátkodobých bankovních úvěrů a obchodních úvěrů. Zjišťujeme, že firemní charakteristiky, jako je velikost, stáří, výše zastavitelného majetku a zisk, ovlivňují způsob, jakým měnová politika ovlivňuje rozhodnutí o externím financování firem. Tato zjištění naznačují existenci informačních frikcí na úvěrových trzích, a tím poskytují empirickou podporu pro existenci širšího úvěrového kanálu v České republice.

Chapter 1

Monetary Policy in Resource-Rich Developing Economies

Abstract

The economic literature acknowledges that to avoid the resource curse, resource-rich countries should restrict fiscal expansion and save a significant part of resource revenues outside the domestic economy. However, in these countries governments tend to ineffectively spend a considerable part of windfall revenues in the short run. In this study we construct a DSGE model for a small, open economy to show that if fiscal indiscipline, in the form of immediate responses to foreign resource revenue changes is inevitable, then monetary policy can help improve the allocation problem. The simulation results indicate that targeting the exchange rate or price level, through foreign exchange interventions by the central bank, can soften the negative effects of Dutch Disease and stabilize the economy in the face of volatile natural resource revenues in the short run. We also find that a fixed exchange rate regime outperforms price level targeting, by delivering higher isolation and hence less vulnerability to shocks in natural resource revenues. In contrast, if a central bank chooses to pursue a laissez faire policy, i.e., not to intervene, then the economy becomes vulnerable to shocks in foreign resource revenues and the resource curse becomes more severe.

An earlier version of this paper has been published in Aliyev, R., 2012, Monetary Policy in Resource-Rich Developing Economies, CERGE-EI Working Paper Series, No. 466. This research was supported by a grant from the CERGE-EI Foundation under a program of the Global Development Network.

1.1 Introduction

A large stream of research finds evidence that sustainable economic development of resource-rich countries is challenged by their ability to efficiently absorb revenues from resource exports. For instance, it has been documented that there is a negative relationship between natural resource abundance and economic growth (Sachs and Warner, 1995, 2001; Auty, 1993, 2001a). In face of this challenge, the future development of a resource-rich economy heavily depends on the successful formulation of policy with regards to the revenues from natural resource exports. The key to this success is the restriction of fiscal expansion and saving a significant part of natural resource revenues abroad (Barnett and Ossowski, 2003; Davis et al., 2003; Segura, 2006). However, the experience of resource-rich developing countries shows that in these countries political pressure is often directed toward spending the revenues from resource exports (Aliyev, 2012; Hermann, 2006). The government's increased fiscal spending of these revenues creates appreciation pressure on the domestic currency. This increases the imports of tradable goods, and decreases the competitiveness of the domestic manufacturing sector. In the economic literature this is called Dutch Disease, and is observed in most resource-rich economies (Corden and Neary, 1982; Corden, 1984; Wijnbergen, 1984). In addition to Dutch Disease, such government policy often creates vulnerability to the volatility in the world prices of exported commodities and the exhaustibility of natural resources in resource-rich countries.

Under these circumstances the question arises whether monetary policy plays a significant role in the reallocation of natural resource revenues, and if so, which monetary regimes deliver better outcomes? Natural resource exporting countries vary in their exchange rate arrangements from fully fixed to independently floating monetary regimes, and there are endless discussions over the appropriateness of these regimes. This paper aims to contribute to this debate by evaluating three monetary regimes in a small, developing economy facing volatile and uncertain revenues from natural resource exports: (i) fixed exchange rate, (ii) price level targeting, and (iii) laissez-faire. The main finding is that if fiscal indiscipline, in the form of immediate responses to foreign resource revenue changes is inevitable, then certain monetary actions can help improve the allocation problem. In particular, targeting the exchange rate or price level through foreign exchange interventions by the central bank allows for consumption smoothing and avoidance of the negative effects of Dutch Disease. Also due to higher intensity in using foreign exchange interventions, the fixed exchange rate regime outperforms price level targeting by delivering higher isolation and hence smaller vulnerability to shocks in foreign revenues. In contrast, if the central bank chooses a laissez faire policy, more revenues are spent and the domestic economy becomes more vulnerable to shocks in foreign revenues.

		Fiscal authority: Undisciplined	Fiscal authority: Disciplined
Monetary authority	Fixed Exchange Rate	Little vulnerability Volatile price level Stable exchange rate	Minimum vulnerability Stable price level Stable exchange rate
Monetary authority	Fixed Price Level	Moderate vulnerability Stable price level Volatile exchange rate	Minimum vulnerability Stable price level Stable exchange rate
Monetary authority	Laissez Faire	High vulnerability Volatile price level Volatile exchange rate	Minimum vulnerability Stable price level Stable exchange rate

Figure 1.1: Normal form representation of the game between the fiscal and monetary authorities

Such an interaction between fiscal and monetary policies can be described by a game consisting of two players: fiscal and monetary authorities (Figure 1.1). In this game the fiscal authority can choose between two possible policies: it can behave either in a disciplined or in an undisciplined way. An undisciplined fiscal authority does not save and spends windfall revenues in the short run. With disciplined behavior, which is the opposite of undisciplined behavior, the fiscal authority does not respond immediately to changes in natural resource revenues and keeps spending stable in the long run. The monetary authority sets one of the three possible monetary regimes described above. In this game the first best solution is achieved when the fiscal authority behaves in a disciplined way regardless of the implemented monetary policy. We also seek to determine the optimal monetary regime under the assumption that the fiscal authority always chooses an undisciplined strategy, which is very common among developing countries. The interesting finding is that the second and third best solutions are achieved when the monetary authority chooses a fixed exchange rate and a fixed price level regime respectively, taking into account the advantages of these regimes in consumption smoothing. The worst outcome is achieved with a laissez faire policy.

The assumption of a purely undisciplined fiscal authority is made to model a stylized version of the situation observed in some oil exporting countries. We also hypothetically assume a government which never deviates its fiscal spending from the long run equilibrium level. However, in real life, optimal spending lies somewhere in between these two extremes. Here one can also think of a disciplined policy where the government moderately increases spending during a period of high natural resource revenues and moderately decreases it during a period of low or zero natural resource revenues (see Barnett and Ossowski, 2003). However a sharp increase/cut in spending during high/low natural resource revenues is commonplace among developing economies, which we treat as undisciplined.

In this paper we construct a general equilibrium model reflecting the main properties of a resource-exporting, developing, small economy to evaluate the effectiveness of different monetary regimes during shocks in revenues from natural resource exports. The model replicates the main macroeconomic developments in Azerbaijan, a post-Soviet transition economy which has been experiencing huge, volatile oil and gas revenues during the last decade. In line with Dutch Disease threats, the limitedness of oil reserves and volatile world oil prices make Azerbaijan vulnerable to revenues from oil exports. To mitigate exchange rate appreciation, the Central Bank of Azerbaijan intervenes in the foreign exchange market. The simulation of the model reveals that such a policy response is effective in dealing with volatile and short-lived natural resource revenues. A similar situation has been observed in a number of natural resource exporting emerging countries, making the findings of this research applicable also for these countries. Moreover, the results from this paper can be applied to countries receiving aid, due to the similarities between aid and natural resource revenue inflows.

The remainder of the paper is organized as follows: The next section reviews the existing related literature on the topic. Section 3 describes the macroeconomic situation and monetary policy in Azerbaijan to support the relevance of the model presented in section 4. The simulation and findings of the model are presented in section 5 and section 6 concludes.

1.2 Literature Review

Resource-rich economies have been widely studied. The empirical literature on the one hand finds a negative relationship between natural resource abundance and economic growth, and on the other hand tries to answer the question why resource-rich economies tend to grow more slowly (Sachs and Warner, 1995, 2001; Auty, 2001a; Gylfason et al., 1997; Cerny and Filer, 2007). The slower growth rate observed in natural resource exporting countries, also known as the resource curse, is mainly explained through the Dutch Disease concept. The Dutch Disease term was used for the first time to describe the decline of the tradable sector in the Netherlands driven by the discovery of large natural gas fields in 1960s. In general the Dutch Disease defines an economic situation in which all other traded sectors are crowded out by the one dominant tradable sector. Furthermore, the increased exports of the dominant sector create appreciation pressure on the domestic currency, which in turn harms the exports of other tradable goods.

The consolidated analysis of Dutch Disease was pioneered by Corden (1982, 1984, 1997). His archetypal economy includes three sectors: one non-tradable and two tradable. In the benchmark case, a boom in one of the tradable sectors (termed as the booming sector) leads to exchange rate appreciation and the contraction of the other tradable sector (termed as the lagging sector). The resource-movement and the spending effects are identified as two driving forces of Dutch Disease (Neary and Van Wijnbergen, 1986; Corden, 1982; Acosta et al., 2009).

Corden (1982) examines different protective policies, such as trade protection through tariffs and quotas, tax and subsidization and exchange rate protection. According to him, exchange rate protection through devaluation, or preventing the appreciation of the exchange rate, may seem attractive but this policy is not the first best response because it induces price increases and protects not only the lagging sector but also the booming sector, which is unnecessary. Such a policy is disruptive if it leads to non-optimal saving and accumulation of international reserves. Alternatively, a country can subsidize the lagging sector by taxes collected from the booming sector, or apply tariffs or quantitative restrictions on imports. However, tough international rules against tax-subsidization and difficulties in the legislation of tariffs make exchange rate protection more favorable. Moreover, if a boom is due to the opening up of oil or gas reserves or a positive shock to world oil prices, then exchange rate protection can help moderate the effects of the shock. Corden claims that during investment and export booms a fixed exchange rate regime through foreign reserves accumulation and the sterilization of its monetary consequences can prevent real appreciation and insulate an economy from Dutch Disease.

Lartey (2008) studies the role of monetary policy in a small open economy facing a huge inflow of capital due to a negative shock to the price of imported investment. He finds that Dutch Disease in the form of a contracting manufacturing sector, rising prices of nontradables and real exchange rate appreciation, occurs only under a fixed exchange rate regime and inactive monetary policy. However under a generalized Taylor rule where the interest rate is used to mitigate the deviations of GDP, inflation in nontradables, and the exchange rate from the steady state, Dutch Disease never occurs. The paper mainly focuses on effective investment and on the reduction in the price of exported investment, which is different from the story of natural resource abundant developing countries.

Larsen (2004) points out a range of policy directives implemented by Norway, through which Dutch Disease has successfully been avoided and revenues from oil extraction have been used to accelerate economic growth. The most important lesson learned from Norway is that investing a significant part of revenues outside the economy and eliminating a possible wage differential between resource and other manufacturing sectors is the main cure for the resource curse. Stevens (2003) claims that the resource "curse" can be turned into a "blessing" only through prudent fiscal and monetary policies, with the dominant role of the former policy. It is commonly accepted that the first best solution is the restriction of fiscal expansion and investing a significant part of the oil revenues outside the domestic economy, though there is no one rule for all cases, i.e., each country needs a specific approach (Barnett and Ossowski, 2003; Davis et al., 2003; Segura, 2006).

The formulation of the optimal spending strategy becomes difficult because resource abundance creates fertile ground for a rent seeking and predatory government (Auty, 2001b). Therefore, resource exporting economies tend to have poor spending strategies (Hermann, 2006). Implicit proof of this is that in oil exporting countries the economic cycle and fiscal spending move in the same direction as world oil prices (Husain et al., 2008; Aliyev, 2012). The behavior of a resource-rich economy becomes tricky if the government spends huge revenues from resource exports in the short run. In this case monetary policy faces a dilemma in choosing between the stabilization of inflation or the exchange rate. If the central bank chooses to target inflation, the exchange rate becomes unsteady; conversely if it chooses to target the exchange rate, inflation becomes uncontrollable. Because in most oil exporting emerging countries monetary authorities use the exchange rate as a nominal anchor (Calvo and Reinhart, 2000; Da Costa and Olivo, 2008; Setser, 2007), the central bank faces difficulties in controlling inflation. To maintain exchange rate stability the central bank increases the money supply, which leads to an increase in foreign exchange reserves. Under such a combination of policies, the central bank's behavior may seem tempting (Corden, 1982) as it protects the domestic tradable sector through exchange rate protection and saves some part of natural resource revenues as its foreign reserves.

Uncertainty and easiness of foreign currency inflows makes the stories of aid receiving and natural resource abundant countries very similar. Therefore in studying natural resource-rich countries, one can benefit from the literature on countries experiencing a huge inflow of aid surges. Macroeconomic policies carry high importance in dealing with the negative effects of huge and volatile foreign aid inflows (Adam et al., 2009; Prati and Tressel, 2006). For instance Prati and Tressel (2006) show that the adverse effects of foreign aid, Dutch Disease and volatility can be mitigated through the accumulation or spending of international reserves.

In the most relevant study Sosunov and Zamulin (2007) investigate an economy where all tradable sectors are completely compressed by the oil and gas sector. Their main finding is that the way the central bank of Russia responds to inflation and the real exchange rate through foreign exchange interventions is optimal. With such a policy the central bank of Russia accumulates international reserves and plays the role of a stabilization fund. There are some shortcomings in Sosunov and Zasulin's analysis that can be improved. First, they do not consider a tradable sector other than the oil and gas production sector, which is very important in countries facing Dutch Disease. Second, in their study money is modeled on an ad hoc basis, i.e., money demand is simply determined by a consumption-based quantity equation. Therefore in this cashless economy money serves as a numeraire and there is no explicit justification for agents to hold money (for a detailed discussion see Gali [2008] and Woodford [2003]).

Lama and Medina (2010) evaluate the role of nominal exchange rate stabilization in a small open economy affected by Dutch Disease. They find that preventing exchange rate appreciation mitigates contraction of tradable output. Lama and Medina also show that such a policy, through exchange rate interventions is highly distortionary as it leads to the misallocation of resources and reduces welfare. In a very recent study Benkhodja (2011) analyses monetary policy and the Dutch Disease in a DSGE framework. He finds that a flexible exchange rate regime improves the social welfare and helps to avoid the Dutch Disease.

This review of the existing literature shows that there is no research that focuses on the unique role of exchange rate pegging through foreign exchange interventions and international reserve management in a natural resource abundant developing economy. Given the underdeveloped financial markets and poor spending experiences of developing countries, such a policy may have exceptional benefits in response to volatile and limited windfall revenues. My research is intended to shed a light on this aspect of monetary policy in a small, open economy in a DSGE framework.

1.3 Background: Azerbaijan

To support the main idea of the paper we consider the example of Azerbaijan, an oil and gas rich, developing, small, open economy. This country possesses the macroeconomic setting described in this research, though there are dozens of other countries with a similar situation.

After the collapse of the Soviet Union, Azerbaijan regained independence in 1991, which brought new challenges arising from broken economic relations and a fragile economic and political system. The contract signed with western oil companies in 1994 started a new era of huge oil revenues.[1] During the 2000s, economic growth has accelerated, mainly driven by oil and gas production. The domestic economy is heavily affected by massive windfall revenues, hence the share of oil in GDP (Figure 1.2) and in total exports (around 95% during 2007-2011) is extremely high.

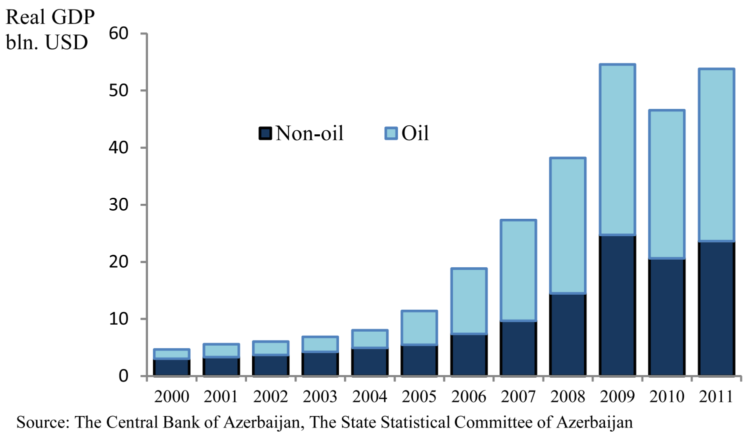

Figure 1.2: Structure of real GDP

The government dramatically increases its spending in response to increases in oil and gas revenues (Figure 1.3). In the meantime, oil financed fiscal expansion creates appreciation pressure on the domestic currency. To prevent exchange rate appreciation the Central Bank of Azerbaijan increases the money supply, which in turn raises its international reserves (Figure 1.4). The recent world financial crisis gives an interesting insight into the mechanism of stabilization. The decline in oil and gas revenues was

[1]The earliest era started in the 19th century when Azerbaijan was on the frontier in the world's oil industry and by the beginning of the 20th century more than half of the world's oil was produced here.

accompanied by a fall in international reserves of the central bank and a constant money supply. This means that during a low oil revenue period the Central of Azerbaijan was using its international reserves as a buffer. Because of this policy we observe a relatively constant exchange rate and accelerated inflation before the crisis, and low inflation during the crisis (Figure 1.5). We also observe a steady increase in aggregate consumption, though this increase is smaller during the global financial crisis (Figure 1.4).

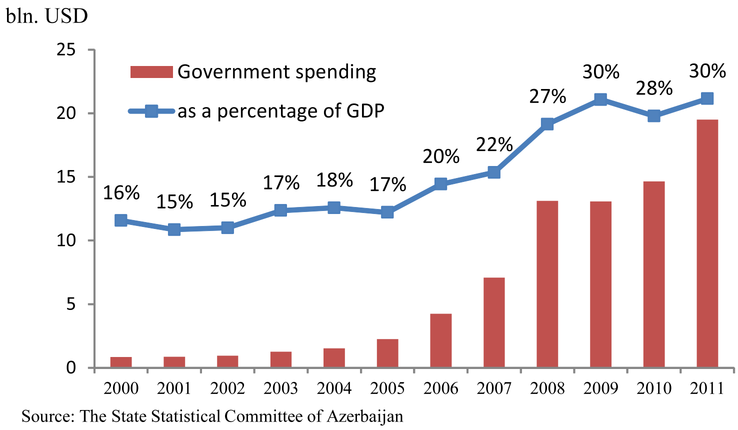

Figure 1.3: Government expenditure

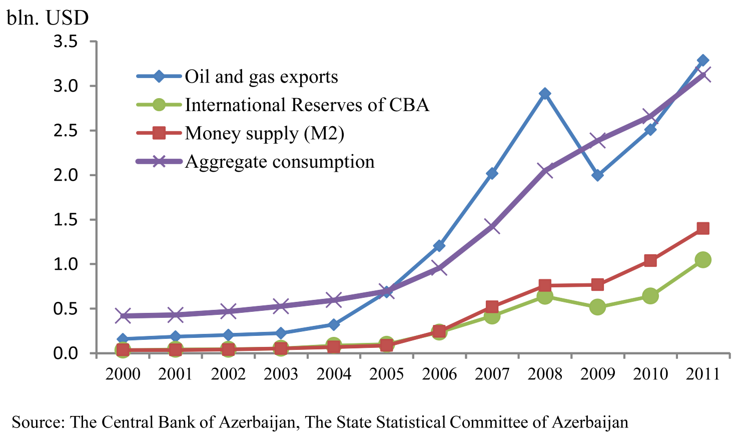

Figure 1.4: Selected macroeconomic variables

Given these numbers one can infer that in Figure 1.1, the case of Azerbaijan is situated at the intersection of "undisciplined" and "fixed exchange rate" strategies, where the government chooses to spend petrodollars and the central bank partially neutralizes the impact of these dollars by foreign exchange interventions. During high oil revenues the outcomes of this combination of policies are a fixed exchange rate and accelerated inflation. If the Central Bank of Azerbaijan were to choose laissez faire or price level

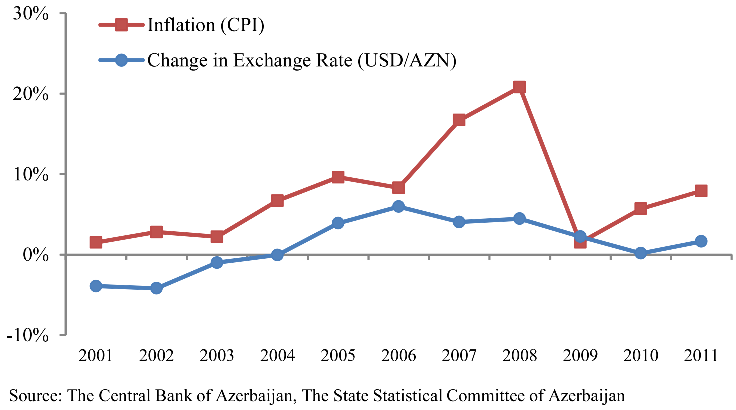

Figure 1.5: Inflation and exchange rate

targeting, then the exchange rate would appreciate, harming the already fragile domestic tradable sector and more oil revenues would be spent in the short run. Therefore the current policy followed by the Central Bank of Azerbaijan is efficient in the sense that besides exchange rate pegging it helps to achieve two important goals. First, such a policy stabilizes the economy in face of volatile oil revenues by using international reserves as a buffer. Second, saving some part of oil revenues abroad implicitly softens the negative effects of Dutch Disease. The results obtained from the theoretical model presented in the next section support this idea.

These findings in some sense coincide with the IMF's policy recommendations for Azerbaijan. After 2003, the IMF withdrew its approval of the appropriateness of an exchange rate anchor, which for a long period served to achieve macroeconomic stability, and insisted on allowing nominal appreciation and maintaining lower inflation later on. However, in 2010 it clearly supported a U.S. dollar peg as an appropriate regime in the short term and more flexible in the medium term (IMF Country Reports).

1.4 The Model

We construct a dynamic general equilibrium model of a resource-rich, small, open, two sector economy. The economy consists of four key agents: households, firms, fiscal and monetary authorities. Besides the fiscal authority the monetary authority also has a peculiar independence in saving some part of these revenues in the form of its international reserves through foreign exchange interventions. The domestic economy produces two types of consumption goods: non-tradables and tradable manufactured goods. There is an international market of tradable goods with unlimited demand and supply with constant world prices. Economic agents cannot invest in interest-bearing assets. This assumption is made to reflect the situation observed in most underdeveloped natural resource rich countries where a huge part of natural resource revenues is spent on non-durable consumption goods and a small fraction is saved as cash holdings.

1.4.1 Households

The economy is populated by infinitely many identical households of measure unity. The representative household is endowed with one unit of time and transfer from the government, $\tau_t F_t$, each period. Here τ_t is a share of natural resource revenues transferred to households by the fiscal authority. F_t represents total natural resource endowment meaning that fluctuations in world prices of an exported natural resource or changes in natural resource exports has a direct impact on it. The time endowment is split between leisure and work. The representative household enters each period with a nominal money balance from the previous period (M_{t-1}), and receives profit from the production sector (Π_t), interest on fixed capital (K), and wages on supplied labor (L).

The household has preferences over consumption goods (C_t), leisure ($1 - L_t$), and real money balances ($\frac{M_t}{P_t}$). The representative household seeks to solve the following maximization problem:

$$\underset{\{C_t^M, C_t^N, M_t, L_t\}}{Max} E_0 \sum_{t=0}^{\infty} \beta^t \left[\zeta Ln(C_t) + \chi Ln(\frac{M_t}{P_t}) + \psi Ln(1 - L_t) \right], \tag{1.1}$$

subject to budget constraint

$M_{t-1} + e_t \tau_t F_t + W_t L_t + R_t K_t + \Pi_t = M_t + P_t^M C_t^M + P_t^N C_t^N$.

Here β is the discount factor, C_t is the aggregate consumption index consisting of the consumption of manufactured goods C_t^M and non-tradable goods C_t^N, defined by $C_t = \frac{(C_t^M)^\theta (C_t^N)^{1-\theta}}{\theta^\theta (1-\theta)^{1-\theta}}$, e_t is the nominal exchange rate in the units of domestic currency per unit of foreign currency, W_t is the nominal wage, R_t is the nominal interest rate, P_t^N is the price of domestic non-tradable goods and $\zeta, \chi, \psi > 0$. The price of foreign tradable goods ($P_t^{M^*}$) is given exogenously, hence we normalize it to one. Therefore the price of tradable goods in the domestic currency (P_t^M) equals the nominal exchange rate: $P_t^M = e_t P_t^{M^*} = e_t$. Given the structure of the consumption aggregate, the consumption based price index is given by $P_t = (P_t^M)^\theta (P_t^N)^{1-\theta}$.[1] The aggregate price index is defined as a minimum expenditure price required to purchase one unit of composite real consumption.

Using the first order conditions of the household's maximization, we get the following equations:[2]

$$\frac{P_t^M C_t^M}{P_t^N C_t^N} = \frac{\theta}{1-\theta}; \tag{1.2}$$

$$\frac{\chi}{M_t} = \frac{\zeta}{P_t C_t} - \beta \frac{\zeta}{P_{t+1} C_{t+1}}; \tag{1.3}$$

$$\frac{\psi}{\zeta} = \frac{W_t(1-L_t)}{P_t C_t}. \tag{1.4}$$

Equation (1.2) shows that the ratio of the value of the two types of consumption goods is constant and depends on the shares of different consumption goods in aggregate consumption. With equal shares the value of the consumption of manufactured and tradable goods should be the same. Equation (1.3) can be written as:

$\frac{\zeta}{P_t C_t} = \chi E_t \sum_{j=0}^{\infty} \beta^j \frac{1}{M_{t+j}}$.

This equation relates the current value of consumption to the expected future growth rate of the money supply. Equation (1.4) expresses the relationship between the household's choice over consumption and leisure. Precisely, it relates the ratio between the nominal value of aggregate consumption and leisure to the ratio of the coefficient of consumption and leisure in the household's utility function.

1.4.2 Firms

There are two production sectors in the domestic economy, tradable and nontradable, and a continuum of identical firms in each sector. We assume Cobb-Douglas technology in both sectors with different capital/labor intensities and total factor productivities. The factors of production are mobile between the sectors, hence wages and interest rates are equal in both sectors. We fix aggregate capital at a constant level $\overline{K}$. Therefore $\overline{K} = K_t^M + K_t^N$. A representative firm solves the profit maximization problem in the tradable sector,

[1] For the derivation see Appendix 1.A.1.

[2] The derivations are given in Appendix 1.A.2.

$$\underset{\{K_t^M, L_t^M\}}{Max} \left\{ P_t^M Y_t^M - R_t K_t^M - W_t L_t^M \right\}, \tag{1.5}$$

and in the non-tradable sector,

$$\underset{\{K_t^N, L_t^N\}}{Max} \left\{ P_t^N Y_t^N - R_t K_t^N - W_t L_t^N \right\}. \tag{1.6}$$

Production functions are given by $Y_t^M = A(K_t^M)^\alpha (L_t^M)^{1-\alpha}$ and $Y_t^N = B(K_t^N)^\gamma (L_t^N)^{1-\gamma}$, where α and γ are capital shares, and A and B are total factor productivities in the tradable and non-tradable sectors, respectively. From the first order conditions of these problems we derive the following equation:[3]

$\left(\frac{\alpha}{\gamma}\right)^\alpha \left(\frac{1-\gamma}{1-\alpha}\right)^{\alpha-1} \left(\frac{K_t^N}{L_t^N}\right)^{\alpha-\gamma} = \frac{P_t^N}{P_t^M}.$

This equation means that if capital intensity in the tradable sector is higher than capital intensity in the non-tradable sector, then any change in the price ratio leads to a proportional change in the capital/labor ratio.

1.4.3 Fiscal Authority

Each period the fiscal authority receives natural resource revenues and decides what share of these revenues to transfer to households. For the sake of simplicity we assume that the fiscal authority faces two possible choices:(i) it is either disciplined ($\tau_t \neq 1$); or (ii) it behaves in an undisciplined way ($\tau_t = 1$). Under fiscal discipline, the fiscal authority chooses values for τ_t such that households' endowment does not deviate from the long run average value of natural resource revenues. This implies that there is no effect of temporary changes in natural resource revenues on the domestic economy, or in other words permanent income level is maintained. In contrast under undisciplined fiscal policy any shock to the natural resource is reflected in the household's natural resource endowment. We assume that the fiscal authority saves natural resource revenues outside the domestic economy, without interest accumulation in a special welfare fund. The accumulation of the resources in this fund is given by:

$\Phi_t = \Phi_{t-1} + (1 - \tau_t)F_t.$

As discussed above, disciplined fiscal policy does not necessarily imply zero transfers to households and accumulation of all revenue from natural resource exports. Therefore in the model, instead of $\tau_t = 0$, (i.e., government saves all the revenue), we assume $\tau_t \neq 1$,

[3]See Appendix 1.A.3 for the derivations.

which implies that the disciplined fiscal authority constantly changes its control variable in order to maintain transfers at the permanent level.

1.4.4 Monetary Authority

The central bank chooses between one of three monetary regimes: (i) exchange rate targeting, (ii) price level targeting, and (iii) laissez faire, where the central bank fixes the money supply. The assumption of the three pure regimes may seem unrealistic, however, pegging the exchange rate and inflation targeting are two alternative policies usually considered by central bankers. Here we also consider a laissez faire policy or fixed money supply to capture the benchmark case where the central bank is inactive. Depending on the implemented policy rule, one of the variables, e_t, P_t, or M_t is fixed.

The central bank uses foreign exchange interventions to control the money supply. It can sell/buy domestic currency (M_t), and buy/sell some share (μ_t) of foreign exchange inflows (F_t) in the foreign exchange market. This policy determines the path of international reserves (S_t) denominated in the foreign currency and held outside the domestic economy:

$S_t = S_{t-1} + \mu_t F_t$.

An increase in the money supply is given by the following equation:

$\Delta M_t = e_t \mu_t F_t$.

The foreign exchange interventions enable the monetary authority to play a crucial role in the allocation of resources in the economy. By increasing/decreasing the money supply, the central bank uses inflation tax and controls how much natural resource revenues are spent and how much are saved as international reserves.

Here we do not make any assumption about the interest income on accumulated reserves, neither of the fiscal authority, nor of the central bank. In the long run the equilibrium value of foreign reserves, and consequently interest accumulation, is zero. Introducing interest income does not have any qualitative impact in the long run, though one can use interest for estimating the optimal spending/saving strategy in the short run, to get more precise quantitative results. Given heterogeneous reserve accumulation under different regimes, extra investment income would strengthen the position of a regime with higher accumulation from the welfare perspective.

1.4.5 Equilibrium

Now the characterization of the environment is completed, so we can define the equilibrium. Given the sequence of natural resource revenues $\{F_t\}_{t=0}^{\infty}$ there is an equilibrium where the sequence of household's choice of $\{C_t^M\}_{t=0}^{\infty}, \{C_t^N\}_{t=0}^{\infty}, \{M_t\}_{t=0}^{\infty}, \{L_t\}_{t=0}^{\infty}$, the firm's choice of $\{K_t^M\}_{t=0}^{\infty}, \{K_t^N\}_{t=0}^{\infty}, \{L_t^M\}_{t=0}^{\infty}, \{L_t^N\}_{t=0}^{\infty}$, the fiscal authority's choice of $\{\tau_t\}_{t=0}^{\infty}$, the central bank's control variable $\{\mu_t\}_{t=0}^{\infty}$, prices $\{P_t^M\}_{t=0}^{\infty}, \{P_t^N\}_{t=0}^{\infty}$, exchange rate $\{e_t\}_{t=0}^{\infty}$, interest rate $\{R_t\}_{t=0}^{\infty}$, and wage rate $\{W_t\}_{t=0}^{\infty}$ such that

(i) the household's utility maximization problem (1.1) is solved,

(ii) the firms' profit maximization problems (1.5) and (1.6) are solved,

(iii) the market clearing holds

- in the labor market: $(L_t)^s = (L_t^M)^d + (L_t^N)^d$
- in the capital market: $\overline{K} = (K_t^M)^d + (K_t^N)^d$
- in the tradable goods market: $C_t^M = Y_t^M + (\tau_t - \mu_t)F_t$
- in the non-tradable goods market: $C_t^N = Y_t^N$
- in the money market: $M_t - M_{t-1} = e_t \mu_t F_t$.

The market clearing condition in the tradable goods market means that households' demand for tradable goods can be either met by the domestic production of tradables or by import in exchange for foreign revenues from resource exports. Here μ_t may result in negative values, meaning that spending on imported goods exceeds foreign revenues. This happens through a decrease in the money supply and correspondingly the depletion of international reserves.

1.5 Calibration

To solve the model numerically we fix the model parameters consistent with the values used in the economic literature. We assume that households assign a lower share (0.4) to manufactured goods in their utility function. The capital share in the manufactured goods production sector is higher than the capital share in the non-tradable goods production sector. This assumption comes from the fact that the non-tradable sector mainly consists of a labor intensive service sector opposed to the more capital intensive tradable sector, which mainly produces manufactured goods. Assuming a considerable low capital share in the non-tradable sector has only a quantitative impact and enables visualization of the differences between monetary regimes. In the initial steady state we normalize the total production (non-resource output denominated in foreign currency Y), prices (P, P^M, and P^N), exchange rate (e) and money supply (M) to unity. This normalization enables the tracking of the changes in model variables as a percentage deviation from the base value. The value of fixed capital stock is taken from Koeda and Kramarenkos' (2008) estimate for Azerbaijan. We assume that the household spends 3/5 of its time on work and 2/5 on leisure. The list of all the simulation parameters used in the simulations is given in Table 1.1. After the simulations we additionally test the robustness of the results to changes in parameters.

β	discount factor	0.99
ζ	coefficient on consumtion in utility	1.15
χ	coefficient on money in utility	0.01
ψ	coefficient on leisure in utility	1
θ	share of manufactured goods in aggregate consumption	0.4
α	capital share in the tradable sector	0.4
γ	capital share in the non-tradable sector	0.1
A	total factor productivity in tradable sector	1.13
B	total factor productivity in non-tradable sector	2.16
K	capital stock	1.6
F	long run average of resource revenues in the AR model	0.5
ρ	parameter of the AR model	0.9
σ	standard deviation of shocks in AR model	0.0001

Table 1.1: Parameters used in calibration

1.5.1 Simulation Results

In this section we describe the simulation of the model and the results computed from this simulation. The structural form of the model is shown in Appendix 1.A.4. We use the MATLAB software package and the Dynare toolbox in all computations.

First we consider the effects of a permanent positive shock on the revenues from natural resource exports. Then we analyze the case where natural resource revenues are assumed to be stochastic. Stochasticity of natural resource revenues can be due to volatility in the world prices of the exported natural resource or the uncertainty of existing resources or future production capacity. The deterministic case with a permanent positive shock is studied because of two reasons. First, it enables us to illustrate the effects of

Dutch Disease in detail. Secondly, it explains the intuition behind the findings from the case where natural resource revenues are stochastic.

In all cases under the disciplined fiscal policy natural resource revenues have no impact because of full isolation of the economy from the shocks. Hence fiscal discipline equates the situation with volatile natural resource revenues to one where natural resource revenues do not fluctuate. Naturally in this framework monetary policy does not play any role. Therefore we consider only the case with an undisciplined fiscal policy and compare the results under different monetary regimes with a benchmark case where the fiscal authority is disciplined.

Consequences of a permanent positive shock on natural resource revenues

For now let's assume that revenues from natural resource exports jump up permanently. Perhaps an increase in foreign revenues that lasts forever is not a realistic assumption, but such a formulation enables us to observe the effects of Dutch Disease and the role of monetary policy in the reallocation process during the transition period to a new steady state. We assume that in the beginning there is no revenue from natural resource exports and the economy is in a steady state. Suddenly in period t=5 foreign resource revenues jump to a level where the domestic economy produces almost only tradable goods and the tradable sector is squeezed out. This assumption is made to reflect a situation where the economy suddenly experiences a huge inflow of windfall revenues due to the discovery of natural resource fields.

The first finding from this analysis is the symptoms of Dutch Disease observed under all monetary regimes. Hence, in general the steady-state values of the real macroeconomic variables do not differ under various monetary regimes except foreign international reserves (Table 1.2). By comparing prior and posterior steady state levels, we can draw several conclusions about the effects of Dutch Disease. The natural resource sector does not use labor and capital in the model, and consequently the resource movement effect is ruled out. Therefore, the wealth effect is the only driving force of the changes.[4] Increased income due to a permanent positive shock on foreign revenues increases aggregate demand and price level, which implies real appreciation. The excess demand for the tradables and non tradables is satisfied through imports and domestic production, respectively. Therefore factors of production move from the tradable sector towards the nontradable sector.

[4]See Corden (1982) for a detailed analysis of wealth and resource movement effects in a three sector economy.

		Prior Steady State	Posterior Steady State		
			Fixed Exchange Rate	Fixed Price Level	Laissez-faire
F	*natural resource revenues (in foreign currency)*	0.0	0.65	0.65	0.65
C	*aggregate consumption*	1.00	1.42	1.42	1.42
Cm	*consumption of tradables*	0.40	0.69	0.69	0.69
Cn	*consumption of non-tradables*	0.60	0.75	0.75	0.75
Y	*output (in foreign currency)*	1.00	1.07	1.07	1.07
Ym	*output in tradable sector (in foreign currency)*	0.40	0.04	0.04	0.04
Yn	*output in non-tradable sector (in foreign currency)*	0.60	1.03	1.03	1.03
e	*nominal exchange rate*	1.00	1.00	0.83	0.58
P	*aggregate price level*	1.00	1.21	1.00	0.70
Pn	*price of non-tradables*	1.00	1.37	1.13	0.80
1-L	*leisure*	0.60	0.68	0.68	0.68
L	*total labor*	0.40	0.32	0.32	0.32
Lm	*labour in tradable sector*	0.12	0.01	0.01	0.01
Ln	*labour in non-tradable sector*	0.28	0.31	0.31	0.31
Km	*capital in tradable sector*	1.207	0.208	0.208	0.208
Kn	*capital in non-tradable sector*	0.453	1.452	1.452	1.452
W	*nominal wage rate*	1.95	2.96	2.45	1.72
R	*nominal interest rate*	0.13	0.07	0.06	0.04
M	*money supply*	1.00	1.72	1.42	1.00
IR	*international reserves (in foreign currency)*	0.00	0.69	0.50	0.00
τ	*policy parameter of the fiscal authority*	1.00	1.00	1.00	1.00
μ	*policy parameter of the monetary authority*	0.0	0.0	0.0	0.0

Table 1.2: Prior and posterior steady-state results

The nominal wage rate rises and the nominal interest rate declines. Hence Dutch Disease is observed in the form of real appreciation, contraction of the domestic tradable sector's production and an increase of nontradable sector output no matter which monetary regime is implemented.

These predictions of the model coincide with the movements in the actual data for Azerbaijan and therefore proves the empirical validity of the proposed model. For instance, as can be seen in Figures 1.2-1.5, an increase in natural resource revenues is accompanied by a sharp increase in government spending (undisciplined fiscal policy) and aggregate consumption (the wealth effect). Observed growth in international reserves of the central bank and money supply and relatively constant nominal exchange rate and elevated inflation during the oil boom indicates that the Central Bank of Azerbaijan adopted a fixed exchange rate regime and actively used foreign exchange interventions to achieve its goal. Based on this inspection we can conclude that calibration of the model produces transition paths comparable to those observed in the data.

The second interesting observation is heterogeneous accumulation of international reserves and the growth in the money supply across different monetary regimes during

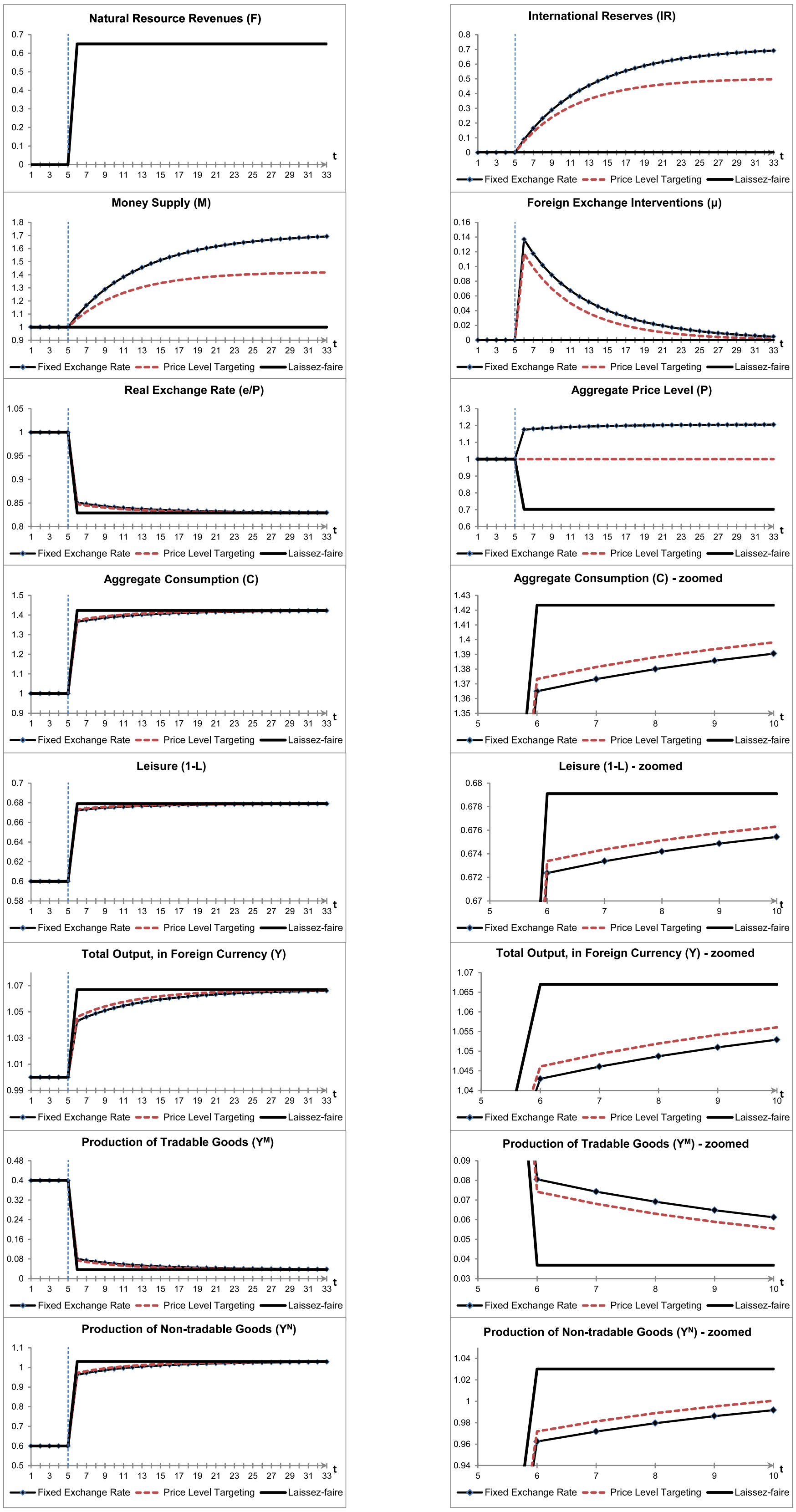

Figure 1.6: Transition to the new steady state

the transition to a new steady-state (Figure 1.6). As we see under a fixed exchange rate and price level targeting regimes, there is an accumulation of international reserves contrary to the laissez-faire policy, where accumulation does not occur. We also observe higher accumulation of international reserves under exchange rate targeting compared to price level targeting. These differences are due to the fact that the highest intensity of foreign exchange interventions happens under a fixed exchange rate regime. Under price level targeting, such actions are less intensive and under laissez faire there is no intervention. Because of these differences in the accumulation of international reserves the consumption of tradables is highest under laissez faire, medium under price level targeting and smallest under a fixed exchange regime. Therefore a fixed exchange rate regime brings about lower exchange rate appreciation and higher production of tradable goods during the transition period. To generalize all these observations, we can conclude that during high natural resource revenues a fixed exchange rate regime outperforms other regimes by saving some part of windfall revenues for future generations and by weakening the symptoms of Dutch Disease in the short run. My further analysis with stochastic natural resource revenues is mainly based on these findings.

Stochastic revenues from natural resource exports

Now we can turn to a more realistic assumption where foreign revenue from natural resource exports is stochastic. Following the literature we assume that revenue from natural resource exports is determined by an AR(1) process defined as

$$F_{t+1} = \rho F_t + (1-\rho)\overline{F} + \epsilon_t.$$

Here $0 < \rho < 1$ and $\epsilon \sim N(0, \sigma)$. The long run average of foreign resource revenues $(\overline{F})$ is taken such that the economy produces mostly non-tradable goods and imports the main part of tradable goods from abroad. This assumption reflects the macroeconomic situation in developing economies heavily affected by the abundance of natural resources.

The results from the simulation of the model under different monetary regimes are summarized in Table 1.3. As we see, a fixed exchange rate regime outperforms other regimes by delivering the smallest volatility in aggregate consumption and leisure. We observe higher volatility of money under a fixed exchange rate regime compared to other regimes. This happens because in order to fix the exchange rate, the central bank uses foreign exchange interventions more intensively to absorb the effects of shocks on foreign revenues. In particular, during high natural resource revenues the central bank increases

	Disciplined Fiscal Policy	Undisciplined Fiscal Policy		
		Fixed Exchange Rate	Fixed Price Level	Laissez Faire
Variation				
aggregate consumption	0.0000	0.0094	0.0100	0.0120
leisure	0.0000	0.0029	0.0031	0.0037
exchange rate	0.0000	0.0000	0.0056	0.0188
price level	0.0000	0.0053	0.0000	0.0120
money supply	0.0000	0.0798	0.0594	0.0000
Welfare cost of fluctuations	0.000%	0.011%	0.013%	0.016%
Total welfare	-4.4682	-4.4806	-4.4830	-4.4866
Aggregate loss				
λ=0	0.0000	0.0001	0.0000	0.0014
λ=1	0.0000	0.0010	0.0010	0.0028
λ=2	0.0000	0.0019	0.0020	0.0043

Table 1.3: Simulation results

the money supply and accumulates its international reserves, and during low or zero foreign revenues it decreases the money supply by foreign exchange purchases that decrease its international reserves. A laissez-fare regime loses to other regimes by yielding considerably higher volatility in consumption, as there is no use of foreign exchange interventions and international reserves. All these differences in volatilities can be visually seen in Figure 1.7.

Different volatilities under different monetary regimes can be compared through the welfare cost of the business cycle. We use Lucas' (1987) approach to estimate the welfare cost of the business cycle:

$$E_0 \sum_{t=0}^{\infty} \beta^t U \left[\overline{C}, \frac{\overline{M}}{\overline{P}}, 1 - \overline{L} \right] - E_0 \sum_{t=0}^{\infty} \beta^t U \left[C_t(1+\eta), \frac{M_t}{P_t}, 1 - L_t \right] = 0$$

where η is the cost of fluctuations. The welfare cost of the business cycle denotes the percentage of increase in consumption needed each period to make the representative household indifferent between volatility and stability. The estimated values of η (Table 1.3)[5] show that the representative household living in the economy with a fixed exchange rate, price level targeting, and laissez faire will require a 0.011, 0.013, and a 0.016 increase in consumption, respectively, to be indifferent between a current regime economy and an

[5]For the derivation of the η, see Appendix 1.A.5.

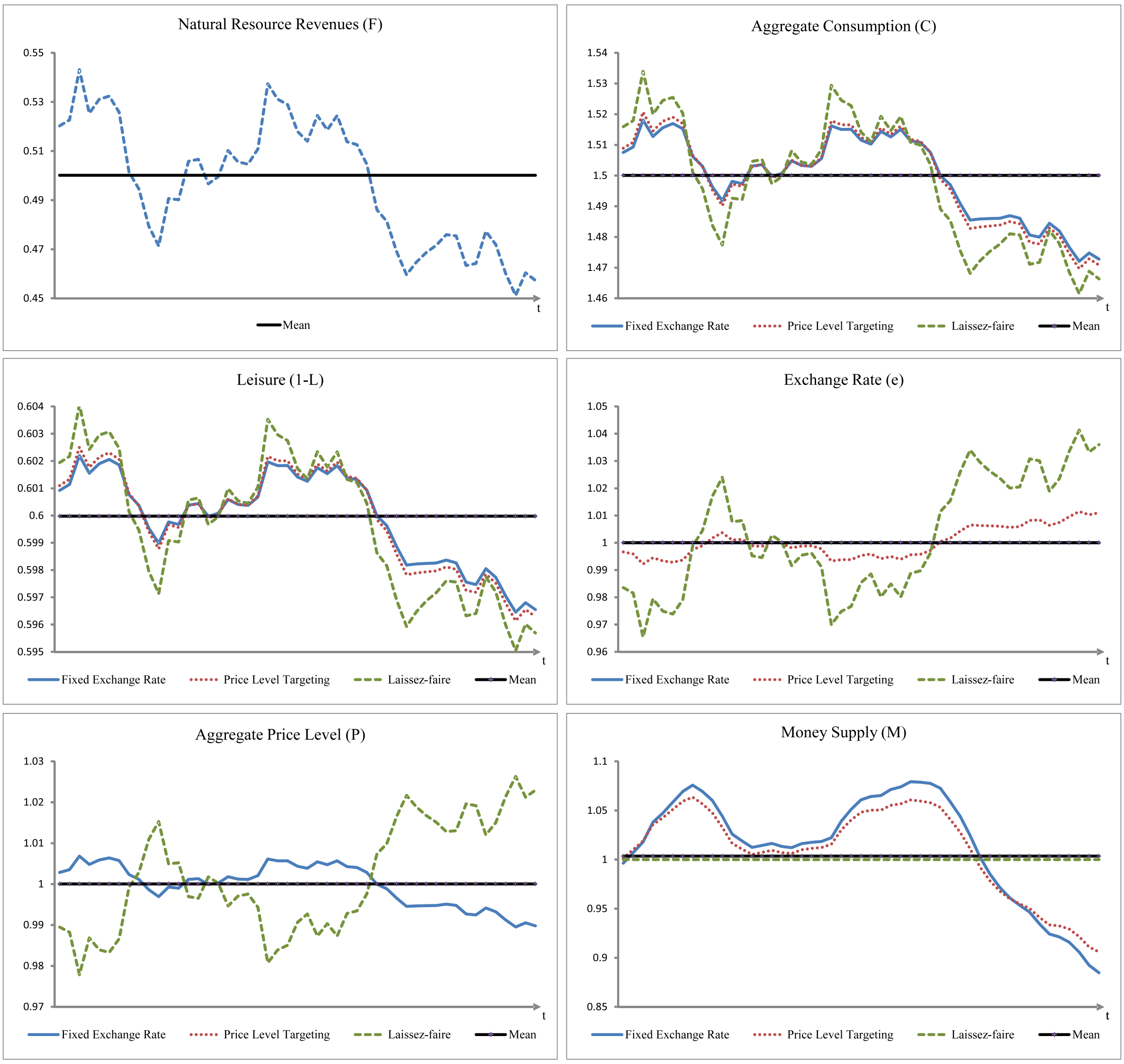

Figure 1.7: Fluctuations in some variables under different monetary regimes

economy with no volatility, i.e., an economy with disciplined fiscal authority. These numbers tell us that if fiscal indiscipline is inevitable, then it is less costly to live in an economy with a fixed exchange rate regime compared to other monetary regimes.

As expected in terms of total welfare ($E_0[\sum_{t=0}^{\infty}\beta^t U(C_t, \frac{M_t}{P_t}, 1-L_t)]$), the first best outcome is achieved when the fiscal authority is disciplined. If the fiscal authority is undisciplined, then a fixed exchange rate regime holds its second best position by delivering the highest total welfare (Table 1.3).

Alternatively, we can evaluate the role of monetary policy by specifying the preferences of the central bank. Following the standard specification we assume that the central bank's objective is to minimize the expected value of the following quadratic loss function

(See Walsh, 2003):

$V_t = \frac{1}{2}\left[\lambda(Y_t - Y_n)^2 + (\pi_t - \pi^*)^2\right].$

Here Y_t is the total output at period t denominated in foreign currency, Y_n is its natural rate, π_t is the inflation rate at period t, π^* is the long run inflation target, and λ is the weight that the central bank assigns on output deviations relative to inflation stabilization. We assume that the central bank desires to stabilize output around Y_n, and inflation around zero ($\pi^* = 0$).

A minimum value of the expected aggregate loss ($E_0[\sum_{t=0}^{\infty}\beta^t V_t]$) is achieved when fiscal authority is disciplined regardless of the implemented monetary regime (Table 1.3). Under undisciplined fiscal policy the parameter λ plays a key role. Zero weight on output gap stabilization ($\lambda = 0$) implies strict inflation targeting (Svensson 1997), and the fixed price level obviously wins over all other regimes by delivering the same outcome as disciplined fiscal policy. If the central bank assigns equal shares to the output gap and inflation stabilization ($\lambda = 1$), then fixed exchange rate and fixed price level regimes bring about the same loss while a laissez-faire regime still falls behind. With higher weight on output gap stabilization ($\lambda = 2$), a fixed exchange rate regime outperforms other regimes. The varying outcomes under the different central bank's preferences are the result of the diversity in natures: a fixed price level regime implicitly targets inflation, while a fixed exchange rate regime stabilizes the real sector as well, and a laissez faire regime has no stabilization power.

All these comparisons provide the rationale as to why and how a fixed exchange rate regime may be an effective tool in the allocation of huge and volatile natural resource revenues in developing economies.

1.5.2 Robustness Tests

In this section we test the robustness of the previous results to changes in the parameters used in calibration. In the basic specification to normalize the variables of interest, we assigned peculiar but not very different from conventional values for the parameters in the utility block. A priori we can identify that all the parameters affect only the steady-state levels of consumption, money, and leisure, but not the qualitative outcomes for different policies. To test this expectation we simulate the model by assigning diverse values to parameters. The results are given in Table 1.4. As we see the results are robust to changes in parameters, i.e., total welfare is maximized under disciplined fiscal policy and the ordering of policies under undisciplined fiscal policy does not change.

	Disciplined Fiscal Authority	Undisciplined Fiscal Authority		
		Fixed Exchange Rate	Fixed Price Level	Laissez Faire
Benchmark case				
welfare cost of fluctuations	0.0000	0.0001	0.0001	0.0002
total welfare	-4.4682	-4.4806	-4.4830	-4.4866
$\zeta' = 0.6$ ($\zeta = 1.15$)				
welfare cost of fluctuations	0.0000	0.0001	0.0001	0.0001
total welfare	-20.4640	-20.4714	-20.4734	-20.4761
$\chi' = 1$ ($\chi = 0.001$)				
welfare cost of fluctuations	0.0000	0.0005	0.0006	0.0002
total welfare	482.6677	482.6082	482.6020	482.6500
$\theta' = 0.6$ ($\theta = 0.4$)				
welfare cost of fluctuations	0.0000	0.0001	0.0001	0.0002
total welfare	0.9127	0.8984	0.8974	0.8940
$K' = 3$ ($K = 1.66$)				
welfare cost of fluctuations	0.0000	0.0001	0.0001	0.0002
total welfare	-4.4682	-4.4806	-4.4830	-4.4866
$A' = B = 2.16$; $B' = A = 1.13$				
welfare cost of fluctuations	0.0000	0.0000	0.0000	0.0000
total welfare	-39.9431	-39.9497	-39.9503	-39.9513
$\alpha' = \gamma = 0.1$; $\gamma' = \alpha = 0.4$				
welfare cost of fluctuations	0.0000	0.0001	0.0001	0.0001
total welfare	13.2846	13.2774	13.2770	13.2743

Table 1.4: Robustness tests

Parameters affect only the distribution of resources in the economy but not the relative performance of fiscal and monetary regimes. The effects of parameter changes on levels are reasonable. For example, if the representative agent puts more weight on money holdings ($\chi' > \chi$), the nominal value of money holdings and the total welfare increases while all other endogenous variables remain constant[6]. Or if the share of tradable goods in the aggregate consumption (θ) is higher than the share of non-tradables (as opposed to the benchmark calibration where the representative household puts slightly more weight on non-tradable goods), the total welfare increases. This happens because the factors of production move towards the tradable sector in order to meet increased demand for manufactured goods. Or in the benchmark case we assumed that productivity is higher in the non-tradable sector ($A < B$). If we assume the opposite ($A' > B'$), the economy uses more factors of production to produce the tradable goods and the total welfare declines.

[6] This is the only case when a laissez-faire regime delivers a higher total welfare compared to other monetary regimes. The reason is straightforward: the regime that stabilizes money supply has an advantage when money has unusually high weight in the utility function.

1.6 Conclusion

This paper evaluates the effectiveness of different monetary regimes in a small, resource-rich, developing economy in a DSGE framework. The welfare analysis provided in this paper aims to shed new light on the specified role of certain monetary actions under certain conditions. In the model presented we mainly focus on the case where government spends revenues from natural resource exports without any discipline. In contrast, the monetary policy is set freely and the central bank independently chooses between one of three given regimes: (i) fixed exchange rate, (ii) price level targeting, and (iii) laissez-faire. Such a combination of fiscal and monetary policies is observed in most developing countries with abundant natural resources.

The calibration and simulation of the model show that the exchange rate and price level targeting regimes outperform the laissez-faire regimes. In particular, we find that under these regimes consumption is smoothed and the domestic economy partially isolated from the fluctuations in revenues from natural resource exports. This is achieved through the intensive use of foreign exchange interventions by the central bank. Therefore the accumulation/decumulation of natural resource revenues in the form of central banks' international assets allows the softening of the negative effects of Dutch Disease during high natural resource revenues and stabilizes the economy in the face of volatile natural resource revenues. Another important finding of the paper is that the economy is less vulnerable to shocks in foreign revenues under a fixed exchange rate regime than price level targeting. Hence a fixed exchange rate regime delivers the highest total welfare and the lowest welfare cost of a business cycle. The evaluation of the loss function is highly dependent upon the central bank's preferences related to output gap stabilization and inflation stabilization. These results confirm the effectiveness of particular monetary policies in the allocation problem when there are large, uncertain natural resource revenues and undisciplined fiscal policy in the short run.

The findings of this paper provide support for the central bank to target exchange rate stability when the government pursues fiscal expansion. The model depicts the situation observed in Azerbaijan, an oil and gas rich developing post-Soviet economy during the last decade. However, the results of the paper can be applied to other natural resource rich developing economies and also to aid receiving countries due to similarities between aid and natural resource revenue inflows.

There are several perspectives for future research on this topic and the model can be enriched by introducing additional assumptions. For example, it might be of some interest to include prudential investment and hybrid monetary rules in the model. This would enable estimation of an optimal spending-saving strategy from the fiscal policy perspective and a precise exchange rate regime from the monetary policy perspective. Such an assumption will improve the results because in reality not all natural resource revenues are inefficiently spent, and the central banks never pursue a single pure target at one time.

1.7 References

Acosta, P.A., Lartey, E.K.K., and Mandelman, F.S., 2009. Remittances and the Dutch Disease, Journal of International Economics, 79, 102-116.

Adam, C., O'Connell, S., Buffie, E., and Pattillo, C., 2009. Monetary Policy Rules for Managing Aid Surges in Africa, Review of Development Economics.

Aliyev, I., 2012. Is Fiscal Policy Procyclical in Resource-Rich Countries?, CERGE-EI Working Paper, No 464.

Auty, R., 2001a. Resource Abundance and Economic Development, Oxford University Press.

Auty, R., 2001b. The Political Economy of Resource-driven Growth, European Economic Review, 45 839-846.

Auty, R., 1993. Sustaining Development in Mineral Economies: The Resource Curse Thesis, London, Routledge.

Barnett, S., and Ossowski, R., 2003. Operational Aspects of Fiscal Policy in Oil-producing Countries in Davis, J., Ossowski, R., and Fedelino, A. (eds.), Fiscal Policy Formulation and Implementation in Oil-Producing Countries, IMF, Washington, D.C.

Benkhodja, M. T., 2011. Monetary Policy and the Dutch Disease in a Small Open Oil Exporting Economy, Gate Working Paper, No. 1134.

Cerny, A., and Filer, R., 2007. Natural Resources: Are They Really a Curse?, CERGE-EI Working Paper, No 321.

Cooley, T. F., and Hansen, G. D., 1989. The Inflation Tax in a Real Business Cycle Model, American Economic Review, 79:733-48.

Corden, W. M., 1981. Exchange Rate Protection, Cooper et al.: The international Monetary System under Flexible Exchange rates: Global, Regional and national, Essays in Honour of Robert Tiffin, Cambridge.

Corden, M., and Neary, P., 1982. Booming Sector and De-industrialization in a Small Open Economy, Economic Journal, 92, 825-848.

Corden, W. M., 1982. Exchange Rate Policy and Resource Boom, Economic Record, 58 (March), 19-31.

Corden, W. M., 1984. Booming Sector and Dutch Disease Economics: Survey and Consolidation, Oxford Economic Papers, 36, 359-380.

Corden, W.M., 1994. Economic Policy, Exchange Rates, and the International System, Oxford University Press, and University of Chicago Press.

Corden, W. M., 1997. Trade Policy and Economic Welfare, second edition, Oxford University Press.

Davis, J. M., Ossowski, R., and Fedelino, A., 2003. Fiscal Policy Formulation and Implementation in Oil-Producing Countries, IMF, Publication Services.

Da Costa, M., and Olivo, V., 2008. Constraints on the Design and Implementation of Monetary Policy in Oil Economies, IMF Working Paper, WP/08/142.

Gali, J., 2008. Monetary Policy, Inflation and Business Cycle, Princeton University Press.

Gylfason, T., Herbertsson, T.T., and Zoega, G., 1997. A Mixed Blessing: Natural Resources and Economic Growth, CEPR Discussion Paper, No 1668.

Hermann, E. F., 2006. Spending Natural Resource Revenues in an Altruistic Growth Model, EPRU Working Paper Series, 06.09.

Husain, A. M., Tazhibayeva, K., and Ter-Martirosyan, A., 2008. Fiscal Policy and Economic Cycles in Oil-Exporting Countries, IMF Working Paper, WP/08/253.

Koeda, J., and Kramarenko, V., 2008. Impact of Government Expenditure on Growth: The Case of Azerbaijan, IMF Working Paper, WP/08/115.

Lama, R., and Medina, P., 2010. Is Exchange Rate Stabilization an Appropriate Cure for the Dutch Disease?, IMF Working Paper, WP/10/182.

Larsen, E. R., 2004. Escaping the Resource Curse and the Dutch Disease? When and Why Norway Caught up with and Forged ahead of Its Neighbors, Statistics Norway, Research Department Discussion Papers, No. 377.

Lartey, E. K. K., 2008. Capital Inflows, Dutch Disease Effects, and Monetary Policy in a Small Open Economy, Review of International Economics, 16(5), 971–989.

Lucas, Robert, E. Jr., 1987. Models of Business Cycles, New York: Basic Blackwell.

Neary, J. P. and Van Wijnbergen S., 1986. Natural Resources and the Macroeconomy: A Theoretical Framework, Natural Resources and the Macroeconomy, The MIT Press: Cambridge, MA, pp. 13-45.

Prati, A., and Tressel, T., 2006. Aid Volatility and Dutch Disease: Is There a Role for Macroeconomic Policies?, IMF Working Paper, WP/06/145.

Sachs, J. D., and Warner, A. M., 1995. Natural Resource Abundance and Economic Growth, Development discussion paper, no. 517a.

Sachs, J. D., and Warner, A. M., 2001. Natural Resources and Economic Development: The curse of natural resources, European Economic Review, 45:827-838.

Segura, A., 2006. Management of Oil Wealth Under the Permanent Income Hypothesis: The Case of Sao Tome and Principe, Working Paper No. 06/183, International Monetary Fund, Washington, D.C.

Setser, B., 2007. The Case for Exchange Rate Flexibility in Oil-Exporting Economies, Peterson Institute, No PB07-8, 2007.

Sidrauski, M., 1967. Rational Choice and Patterns of Growth in a Monetary Economy, The American Economic Review, Vol. 57, No. 2, pp. 534-544.

Sosunov, K., and Zamulin, O., 2007. Monetary Policy in Economy Sick with Dutch Disease, CEFIR/NES Working Paper Series, No 101.

Stevens, P., 2003. Resource Impact: Curse or Blessing?, A Literature Survey, Journal of Energy Literature, 9 (1), pp. 3-42.

Svensson, L., 1997. Inflation Targeting, Some Extensions, NBER working paper, No. 6545.

Walsh, Carl, E., 2003. Monetary Theory and Policy, MIT.

Wijnbergen, V. S., 1984. Inflation, Employment, and the Dutch Disease in Oil-Exporting Countries: A Short-Run Disequilibrium Analysis, The Quarterly Journal of Economics, Vol. 99, No. 2, pp. 233-250.

Woodford, M., 2003. Interest and Prices, Princeton University Press.

1.A Appendix

1.A.1 Derivation of the Price Index

The consumption-based price index solves following minimization problem:

$P_tC_t = Min(P_t^MC_t^M + P_t^NC_t^N);$

$s.t. \frac{(C_t^M)^\theta (C_t^N)^{1-\theta}}{\theta^\theta (1-\theta)^{1-\theta}} = 1.$

The first order conditions yield

$\frac{(1-\theta)}{\theta}\frac{P_t^M}{P_t^N} = \frac{C_t^N}{C_t^M}.$

In the optimal solution we can write

$P_t\frac{(C_t^M)^\theta (C_t^N)^{1-\theta}}{\theta^\theta (1-\theta)^{1-\theta}} = P_t^MC_t^M + P_t^NC_t^N.$

Dividing both sides by C_t^M gives us

$P_t\frac{(C_t^M)^{\theta-1} (C_t^N)^{1-\theta}}{\theta^\theta (1-\theta)^{1-\theta}} = P_t^M + P_t^N\frac{C_t^N}{C_t^M}.$

Using FOC we get

$P_t\frac{(\frac{(1-\theta)}{\theta}\frac{P_t^M}{P_t^N})^{1-\theta}}{\theta^\theta (1-\theta)^{1-\theta}} = P_t^M + P_t^N\frac{(1-\theta)}{\theta}\frac{P_t^M}{P_t^N}.$

After some simplification we end up with the equation for aggregate price index:

$P_t = (P_t^M)^\theta (P_t^N)^{1-\theta}.$

1.A.2 Solution of the Households' Problem

The representative household solves the following maximization problem:

$$\underset{\{C_t^M, C_t^N, M_t, L_t\}}{Max} E_t\sum_{t=0}^{\infty}\beta^t\left[\zeta Ln(C_t) + \chi Ln(\frac{M_t}{P_t}) + \psi Ln(1-L_t)\right],$$

subject to budget constraint

$M_{t-1} + e_t\tau_tF_t + W_tL_t + R_tK_t + \Pi_t = M_t + e_tC_t^M + P_t^NC_t^N.$

Langrangean can be written as

$$\begin{aligned} L \;=\; & \sum_{t=0}^{\infty}\beta^t\{\left[\zeta Ln(\frac{(C_t^M)^\theta (C_t^N)^{1-\theta}}{\theta^\theta(1-\theta)^{1-\theta}}) + \chi Ln(\frac{M_t}{P_t}) + \psi Ln(1-L_t)\right] \\ & + \vartheta_t\left[M_{t-1} + e_t\tau_tF_t + W_tL_t + R_tK + \Pi_t - M_t - e_tC_t^M - P_t^NC_t^N\right]\}. \qquad (1.7) \end{aligned}$$

Now we can derive the first order conditions:

$$[C_t^M] : \beta^t \zeta \theta \frac{1}{C_t^M} - \beta^t \vartheta_t e_t = 0; \tag{1.8}$$

$$[C_t^N] : \beta^t \zeta (1-\theta) \frac{1}{C_t^N} - \beta^t \vartheta_t P_t^N = 0; \tag{1.9}$$

$$[M_t] : \beta^t \chi \frac{1}{M_t} + \beta^{t+1} \vartheta_{t+1} - \beta^t \vartheta_t = 0; \tag{1.10}$$

$$[L_t] : -\beta^t \psi \frac{1}{1-L_t} + \beta^t \vartheta_t W_t = 0; \tag{1.11}$$

$$[\vartheta_t] : M_{t-1} + e_t \tau_t F_t + W_t L_t + R_t K + \Pi_t - M_t - e_t C_t^M - P_t^N C_t^N = 0. \tag{1.12}$$

Further simplification gives us the following equations:

$$\frac{\zeta \theta}{e_t C_t^M} = \vartheta_t; \tag{1.13}$$

$$\frac{1-\theta}{P_t^N C_t^N} = \frac{\theta}{e_t C_t^M}; \tag{1.14}$$

$$\frac{\chi}{M_t} = \frac{\zeta \theta}{e_t C_t^M} - \beta \frac{\zeta \theta}{e_{t+1} C_{t+1}^M}; \tag{1.15}$$

$$\frac{\psi}{1-L_t} = \frac{\zeta \theta}{e_t C_t^M} W_t. \tag{1.16}$$

We can write these conditions as

$\frac{\chi}{M_t} + \beta \frac{\zeta \theta}{e_{t+1} C_{t+1}^M} - \frac{\zeta \theta}{e_t C_t^M} = 0,$

$C_t^M = \theta (\frac{P_t^N}{e_t})^{1-\theta} C_t,$

$\frac{\chi}{M_t} + \beta \frac{\zeta \theta}{e_{t+1} \theta (\frac{P_{t+1}^N}{e_{t+1}})^{1-\theta} C_{t+1}} - \frac{\zeta \theta}{e_t \theta (\frac{P_t^N}{e_t})^{1-\theta} C_t} = 0.$

We can use the aggregate price index (derived in Appendix 1.A.2) to get

$\frac{\chi}{M_t} + \beta \frac{\zeta}{P_{t+1} C_{t+1}} - \frac{\zeta}{P_t C_t} = 0$

or

$\frac{\zeta}{P_t C_t} = \beta \frac{\zeta}{P_{t+1} C_{t+1}} + \frac{\chi}{M_t}.$

Iterating this equation to one period forward yields

$\frac{\zeta}{P_{t+1}C_{t+1}} = \beta\frac{\zeta}{P_{t+2}C_{t+2}} + \frac{\chi}{M_{t+1}};$

$\frac{\zeta}{P_tC_t} = \beta(\beta\frac{\zeta}{P_{t+2}C_{t+2}} + \frac{\chi}{M_{t+1}}) + \frac{\chi}{M_t} = \beta^2\frac{\zeta}{P_{t+2}C_{t+2}} + \beta\frac{\chi}{M_{t+1}} + \frac{\chi}{M_t},$

and

$\frac{\zeta}{P_{t+2}C_{t+2}} = \beta\frac{\zeta}{P_{t+3}C_{t+3}} + \frac{\chi}{M_{t+2}};$

$\frac{\zeta}{P_tC_t} = \beta\frac{\zeta}{P_{t+1}C_{t+1}} + \frac{\chi}{M_t} = \beta(\beta\frac{\zeta}{P_{t+2}C_{t+2}} + \frac{\chi}{M_{t+1}}) + \frac{\chi}{M_t}$

$= \beta(\beta(\beta\frac{\zeta}{P_{t+3}C_{t+3}} + \frac{\chi}{M_{t+2}}) + \frac{\chi}{M_{t+1}}) + \frac{\chi}{M_t} = \beta^3\frac{\zeta}{P_{t+3}C_{t+3}} + \beta^2\frac{\chi}{M_{t+2}} + \beta\frac{\chi}{M_{t+1}} + \frac{\chi}{M_t}.$

If we continue these steps for infinite periods we get

$\frac{\zeta}{P_tC_t} = \chi E_t\sum_{j=0}^{\infty}\beta^j\frac{1}{M_{t+j}}.$

From (1.14) we get $C_t^N = \frac{(1-\theta)e_tC_t^M}{\theta P_t^N}$, and we replace it in the formula for aggregate consumption to get

$C_t^M = \theta(\frac{P_t^N}{e_t})^{1-\theta}C_t.$

We substitute it in (1.16) and after some simple algebra we get

$\frac{\psi}{\zeta} = \frac{W_t(1-L_t)}{P_tC_t}.$

1.A.3 Solution of the Firms' Problem

Maximization of the firms' problem yields

$$\underset{\{K_t^M,L_t^M\}}{Max}\left\{P_t^MA(K_t^M)^\alpha(L_t^M)^{1-\alpha} - R_tK_t^M - W_tL_t^M\right\}; \tag{1.17}$$

$$[K_t^M] \;:\; \alpha P_t^MA(K_t^M)^{\alpha-1}(L_t^M)^{1-\alpha} = R_t; \tag{1.18}$$

$$[L_t^M] \;:\; (1-\alpha)P_t^MA(K_t^M)^\alpha(L_t^M)^{-\alpha} = W_t; \tag{1.19}$$

$$\underset{\{K_t^NL_t^N\}}{Max}\{P_t^NB(K_t^N)^\gamma(L_t^N)^{1-\gamma} - R_tK_t^N - W_tL_t^N\}; \tag{1.20}$$

$$[K_t^N] \;:\; \gamma P_t^NB(K_t^N)^{\gamma-1}(L_t^N)^{1-\gamma} = R_t; \tag{1.21}$$

$$[L_t^N] \;:\; (1-\gamma)P_t^NB(K_t^N)^\gamma(L_t^N)^{-\gamma} = W_t. \tag{1.22}$$

Equating (1.18) with (1.21) and (1.19) with (1.22) we get

$$\alpha P_t^M A(K_t^M)^{\alpha-1}(L_t^M)^{1-\alpha} = \gamma P_t^N B(K_t^N)^{\gamma-1}(L_t^N)^{1-\gamma}, \tag{1.23}$$

$$(1-\alpha)P_t^M A(K_t^M)^{\alpha}(L_t^M)^{-\alpha} = (1-\gamma)P_t^N B(K_t^N)^{\gamma}(L_t^N)^{-\gamma} \tag{1.24}$$

$\frac{\alpha L_t^M}{(1-\alpha)K_t^M} = \frac{\gamma L_t^N}{(1-\gamma)K_t^N}$,

or

$$\frac{K_t^M}{L_t^M} = \frac{\alpha(1-\gamma)K_t^N}{\gamma(1-\alpha)L_t^N}. \tag{1.25}$$

We replace $\frac{K_t^M}{L_t^M}$ in (23) using (25) to get

$(\frac{\alpha}{\gamma})^{\alpha}(\frac{(1-\gamma)}{(1-\alpha)})^{\alpha-1}\frac{A}{B}(\frac{K_t^N}{L_t^N})^{\alpha-\gamma} = \frac{P_t^N}{P_t^M}$,

or

$(\frac{\alpha}{\gamma})^{\alpha}(\frac{(1-\gamma)}{(1-\alpha)})^{\alpha-1}\frac{A}{B}(\frac{K_t^N}{L_t^N})^{\alpha-\gamma} = (\frac{P_t}{e_t})^{\frac{1}{1-\theta}}$.

As we see α and γ determine how the price ratio is related to the capital-labor ratio. To understand how it works, assume that there is an increase in the capital-labor ratio in the non-tradable sector driven by a rise in the natural resource revenues. Under a fixed exchange regime if $\alpha > \gamma$, P_t increases, and if $\alpha < \gamma$, P_t decreases.

1.A.4 Structural Form of the Model

- endogenous variables: $C_t, C_t^M, C_t^N, e_t, P_t, P_t^M, P_t^N, M_t, L_t, L_t^M, L_t^N, K_t^M, K_t^N, W_t,$ $R_t, \Phi_t, S_t, Y, Y^M, Y^N$
- exogenous variables: F_t, τ_t, μ_t
- parameters: $\alpha, \gamma, \beta, \zeta, \theta, \chi, \psi, K, A, B$

1. $C_t = \frac{(C_t^M)^\theta (C_t^N)^{1-\theta}}{\theta^\theta (1-\theta)^{1-\theta}}$
2. $\frac{1-\theta}{P_t^N C_t^N} = \frac{\theta}{e_t C_t^M}$
3. $\frac{\chi}{M_t} + \beta \frac{\zeta}{P_{t+1} C_{t+1}} - \frac{\zeta}{P_t C_t} = 0$
4. $\frac{\psi}{\zeta} = \frac{W_t(1-L_t)}{P_t C_t}$
5. $P_t^M = e_t$
6. $P_t = (P_t^M)^\theta (P_t^N)^{1-\theta}$
7. $C_t^M = A(K_t^M)^\alpha (L_t^M)^{1-\alpha} + (\tau_t - \mu_t) F_t$
8. $C_t^N = B(K_t^N)^\gamma (L_t^N)^{1-\gamma}$
9. $\alpha P_t^M A (K_t^M)^{\alpha-1} (L_t^M)^{1-\alpha} = R_t$
10. $\gamma P_t^N B (K_t^N)^{\gamma-1} (L_t^N)^{1-\gamma} = R_t$
11. $(1-\alpha) P_t^M A (K_t^M)^\alpha (L_t^M)^{-\alpha} = W_t$
12. $(1-\gamma) P_t^N B (K_t^N)^\gamma (L_t^N)^{-\gamma} = W_t$
13. $\Phi_t = \Phi_{t-1} + (1-\tau_t) F_t$
14. $M_t = M_{t-1} + e_t \mu_t F_t$
15. $S_t = S_{t-1} + \mu_t F_t$
16. $\overline{K} = K_t^M + K_t^N$
17. $L_t = L_t^M + L_t^N$
18. $Y_t = Y_t^M + Y_t^N$

19. $Y_t^M = A(K_t^M)^\alpha (L_t^M)^{1-\alpha}$

20. $Y_t^N = \frac{P_t^N}{e} B(K_t^N)^\gamma (L_t^N)^{1-\gamma}$.

In the steady state F is fixed, the fiscal authority and the central bank do not take any action, and consequently τ_t equals one and μ_t equals zero and all endogenous variables are constant. Therefore in the steady-state we have the following equations:

1. $\overline{C} = \frac{(\overline{C}^M)^\theta (\overline{C}^N)^{1-\theta}}{\theta^\theta (1-\theta)^{1-\theta}}$

2. $\frac{1-\theta}{\overline{P}^N \overline{C}^N} = \frac{\theta}{\overline{e}\overline{C}^M}$

3. $\frac{\chi}{\overline{M}} - (1-\beta)\frac{\zeta}{\overline{PC}} = 0$

4. $\frac{\psi}{\zeta} = \frac{\overline{W}(1-\overline{L})}{\overline{PC}}$

5. $\overline{P}^M = \overline{e}$

6. $\overline{P} = (\overline{P}^M)^\theta (\overline{P}^N)^{1-\theta}$

7. $\overline{C}^M = A(\overline{K}^M)^\alpha (\overline{L}^M)^{1-\alpha} + \overline{F}$

8. $\overline{C}^N = B(\overline{K}^N)^\gamma (\overline{L}^N)^{1-\gamma}$

9. $\alpha \overline{P}^M A(\overline{K}^M)^{\alpha-1} (\overline{L}^M)^{1-\alpha} = \overline{R}$

10. $\gamma \overline{P}^N B(\overline{K}^N)^{\gamma-1} (\overline{L}^N)^{1-\gamma} = \overline{R}$

11. $(1-\alpha)\overline{P}^M A(\overline{K}^M)^\alpha (\overline{L}^M)^{-\alpha} = \overline{W}$

12. $(1-\gamma)\overline{P}^N B(\overline{K}^N)^\gamma (\overline{L}^N)^{-\gamma} = \overline{W}$

13. $\overline{Y} = \overline{Y}^M + \overline{Y}^N$

14. $\overline{Y}^M = A(\overline{K}^M)^\alpha (\overline{L}^M)^{1-\alpha}$

15. $\overline{Y}^N = \frac{\overline{P}^N}{\overline{P}^M} B(\overline{K}^N)^\gamma (\overline{L}^N)^{1-\gamma}$

16. $\overline{\mu} = 0$

17. $\overline{\tau} = 1$

18. $\overline{K} = \overline{K}^M + \overline{K}^N$

19. $\overline{L} = \overline{L}^M + \overline{L}^N$.

1.A.5 Derivation of the Formula for the Welfare Cost of the Business Cycle

$$E_0\sum_{t=0}^{\infty}\beta^t\left[\zeta Ln(\overline{C})+\chi Ln(\tfrac{\overline{M}}{\overline{P}})+\psi Ln(1-\overline{L})\right]-$$
$$E_0\sum_{t=0}^{\infty}\beta^t\left[\zeta Ln(C_t(1+\eta))+\chi Ln(\tfrac{M_t}{P_t})+\psi Ln(1-L_t)\right]=0;$$

$$\sum_{t=0}^{\infty}\beta^t\zeta Ln(1+\eta)=$$
$$E_0\sum_{t=0}^{\infty}\beta^t\left[\zeta Ln(\overline{C})+\chi Ln(\tfrac{\overline{M}}{\overline{P}})+\psi Ln(1-\overline{L})\right]-E_0\sum_{t=0}^{\infty}\beta^t\left[\zeta Ln(C_t)+\chi Ln(\tfrac{M_t}{P_t})+\psi Ln(1-L_t)\right];$$
$$\eta=\exp\left\{\frac{E_0\sum_{t=0}^{\infty}\beta^t\left[\zeta Ln(\overline{C})+\chi Ln(\frac{\overline{M}}{\overline{P}})+\psi Ln(1-\overline{L})\right]-E_0\sum_{t=0}^{\infty}\beta^t\left[\zeta Ln(C_t)+\chi Ln(\frac{M_t}{P_t})+\psi Ln(1-L_t)\right]}{\zeta\sum_{t=0}^{\infty}\beta^t}\right\}-1.$$

Chapter 2

Determinants of the Choice of Exchange Rate Regime in Resource-Rich Countries

Abstract

This chapter studies the specific determinants of the choice of exchange rate regime in resource-rich countries. We run multinomial logit regressions for an unbalanced panel data set of 145 countries over 1975-2004. We find that resource-rich countries are more likely to adopt a fixed exchange rate regime compared to resource-poor countries. Furthermore, we provide evidence that output volatility contributes to the likelihood of choosing a fixed exchange rate regime, positively in resource-rich countries and negatively in resource-poor countries. We believe that in resource-rich countries a fixed exchange rate regime is mainly preferred due to its stabilization function in the face of turbulent foreign exchange inflows. Moreover, our results reveal that the role of democracy and independent central banks in choosing more flexible exchange rate regimes is stronger in resource-rich countries. In resource-rich countries that possess non-democratic institutions and non-independent central banks, the government is less accountable for its spending of natural resource revenues and fiscal dominance prevails. In this situation, fluctuations in natural resource revenues are more easily transmitted into the domestic economy and therefore a fixed exchange rate becomes a more favorable option.

An earlier version of this paper has been published in Aliyev, R., 2014, Determinants of the Choice of Exchange Rate Regime in Resource-Rich Countries, CERGE-EI Working Paper Series, No. 527.

2.1 Introduction

In the economic literature much attention has been devoted to the choice of exchange rate regime. Often policymakers are challenged to choose between a fixed exchange rate regime, which may provide trade gains and a "policy crutch", and a floating exchange rate regime, which does not undermine the independence of monetary policy and accommodates the terms of trade shocks. The problem of choosing an appropriate exchange rate strategy is even sharper in resource-rich countries (RRCs) that are exposed to large and volatile foreign exchange inflows. There is empirical evidence that fuel exporters are more likely to have a pegged exchange rate regime (Klein and Shambaugh, 2009). Such behavior may have a rationale, as a natural resource exporting economy facing volatile and huge foreign exchange inflows may benefit from pegging its currency to the dollar (Aliyev, 2012[1]) or to the oil price (Frankel, 2003). Questions then arise as to whether RRCs benefit from any extra stabilization advantages of pegging and what determines the choice of exchange rate regime in these countries. To our knowledge there is no empirical study that focuses on these questions.

The main objective of this work is to address these questions by focusing on the specific determinants of the choice of exchange rate regime in RRCs. Given the nature of the dependent variable, which is a categorical variable that defines different exchange rate regimes, we run multinomial logit regressions for an unbalanced panel data set of 145 countries over the 1975-2004 period. We incorporate different theories that aim to explain the determinants of the exchange rate regime. Besides various variables from the literature, our study also includes additional variables that could be interesting from the point of view of RRCs. We expect that a specific set of variables, such as democracy, output volatility, central bank independence, and fiscal discipline may affect the choice of exchange rate regime differently in RRCs. To check this expectation we analyze the multiplicative effect of these variables with a resource-richness variable on the choice of exchange rate regime.

We have to note that the results of this chapter cannot be interpreted as supportive of the first chapter, since the first paper is more normative than predictive. However, the specific role of exchange rate stabilization in RRCs through foreign reserve management by the central bank, explained in the first chapter, inspired us to empirically study the

[1] Aliyev (2012) in a theoretical framework predicts that, under certain conditions, pegging the exchange rate allows the softening of the negative effects of Dutch Disease and partially stabilizes the economy in the face of volatile natural resource revenues.

determinants of the choice of exchange rate regime in RRCs.

The remainder of the paper is organized as follows: The next section reviews the theories of the determinants and classification of exchange rate regimes and discusses some important issues related to exchange rate regimes in RRCs. Section 3 describes our methodology and data. The results and findings are presented in section 4 and section 5 concludes.

2.2 Literature Review

2.2.1 Theoretical Determinants of Exchange Rate Regime Choice

Until recently the economic literature extensively studied the growth effects of exchange rate regimes (Gosh et al., 2002; Levy-Yeyati and Struzenegger, 2003; Husain et al., 2004). More recent literature draws the possible endogeneity of the choice of exchange rate regime to the front line and rather focuses on the determinants of this choice than its effects on macroeconomic variables (Berdiev et al., 2012; Levy-Yeyati et al., 2010; Markiewicz, 2006; Von Hagen and Zhou, 2007). In the economic literature three major approaches that explain the choice of exchange rate regimes are (i) Optimal Currency Area (OCA) theory, (ii) financial view, and (iii) political view. Levy-Yeyati and Struzenegger (2010) provide an extensive review on how these three theories emerged. All these theories have been empirically tested by many scholars who analyze the determination process of exchange rate regimes.

According to the **OCA theory** (originally formulated by Mundell, 1961) geographical location, trade links, size, openness, and intrinsic shocks are the main determinants of the exchange rate regime. From this perspective the trade and welfare gains from a stable exchange rate are compared with the benefits of exchange rate flexibility as a shock absorber. For instance, more open countries are more likely to have a pegged regime. Or, given the fact that smaller countries trade more, one can expect that these countries also tend to have less flexible regimes.

The **Financial view** is based on the impossible trinity hypothesis, according to which only two out of three goals can be attained: exchange rate stabilization, free capital mobility, and independent monetary policy. Recent global financial deepening and innovation diminished the effectiveness of capital controls. In the presence of free capital mobility the impossible trinity dilemma is reduced to the bipolar view of exchange rate regimes, which defines a fixed exchange rate regime and independent monetary policy tradeoff. According to this view, low financial development should increase the probability of adopting pegs.

The **Political view** highlights political factors as a determinant of an exchange rate regime. Less developed countries experiencing low institutional credibility may adopt a peg as a policy crutch. These countries are more corrupted and have a higher level of bureaucracy. Therefore, they need to have a stable currency to attract international investors and possibly to provide illegal opportunities for influential members of society. In contrast, in more democratic countries governments are more interested in influencing the economy and hence are more likely to use flexible regimes.

2.2.2 Classification of Exchange Rate Regimes

The classification of exchange rate regimes deserves some explanation. Until recently most of the research relied on a de jure exchange rate regime classification which is based on countries' official announcements to the IMF (IMF's Annual Report on Exchange Rate Arrangements and Exchange Restrictions). However, in practice, countries usually demonstrate fear of floating and do not allow their exchange rate to float against their official reports (Calvo and Reinhart, 2002; Levy-Yeyati and Struzenegger, 2005). Therefore, using de facto regime classifications which describe the exchange rate strategies better than de jure regime classifications is growing in popularity.

Levy-Yeyati and Struzeneggers' (2003, 2005) de facto exchange rate regime classification is based on the volatility of the bilateral nominal exchange rate, the volatility of exchange rate changes and the volatility of foreign reserves. Reinhart and Rogoffs' (2004) approach is more sophisticated and accounts for country chronologies, which includes information on the official exchange rate regime, the anchor currency and other important economic events and differences between the official and parallel exchange rates.

The codings of all three directions (de jure classification by IMF, de facto classifications by Levy-Yeyati and Struzenegger, 2003-2005, and by Reinhart and Rogoff, 2004) have been widely used by many scholars and the studies based on de facto classifications significantly differ from the ones that are based on de jure classification.[2] For example, Ghosh et al. (2003) use de jure exchange rate regime classification and find that a fixed exchange rate regime has a positive effect on economic growth. Levy-Yeyati and

[2]See Harms and Kretschmann (2009) for an extensive survey.

Struzenegger (2010) by using their own de facto classification find empirical support for three approaches about the exchange rate regime choice discussed above. Berdiev et al. (2010) use the same classification and emphasize the role of political factors such as wings of governments (left/right), democratic institutions, central bank independence and financial development, among other factors determining the choice of exchange rate regime. Estimations based on the alternative de facto classification of Reinhart and Rogoff (2004) indicate that only rich and financially developed countries can benefit from the flexibility of exchange rate regimes (Reinhart and Rogoff, 2004; Husain et al., 2005; Aghion et al., 2009).

The general conclusion is that countries usually deviate from their official announcements and hence research that is based on de facto classifications delivers more reasonable results. Therefore, in our study we use three-way and five-way classifications proposed by Levy-Yeyati and Struzenegger (2003).

2.2.3 Exchange Rate Regimes in RRCs

The literature agrees that there is no single right exchange rate regime for all countries (Frankel, 1999) and often focuses on a special set of determinants and group of countries with similar characteristics. RRCs differ from other countries by experiencing a huge and volatile inflow of foreign exchange. In the face of these windfalls RRCs are challenged to achieve stabilization in the short run, and economic growth in the long run. Klein and Shambaugh (2009) find that fuel exporters are more likely to peg compared to non-fuel exporting countries. Moreover, it has been documented that the price of oil has a significant effect on real exchange rates in oil rich countries, more precisely, a higher oil price leads to appreciation of the real exchange rate in these countries (Korhonen and Juurikkala, 2009). The effects of oil price changes on the domestic economy are mainly transmitted through fiscal policy (Husain et al., 2008).

The intuition behind these phenomena is straightforward: soaring oil prices or the discovery of natural resource reserves increase a government's income denominated in foreign exchange and fiscal expansion financed through these resources creates appreciation pressure on the domestic currency. In this situation, a monetary authority can choose only one out of the two sides of the stick: it can either stabilize the nominal exchange rate at the cost of high inflation or it can control inflation by allowing the nominal exchange rate to adjust.

The evidence supports the contention that monetary authorities in RRCs mainly choose the first option. Aliyev (2012) shows that besides arguments of existing theories of exchange rate determination there may be an additional rationale to peg the exchange rate in resource-rich developing countries. More precisely, under undisciplined fiscal policy[3] by fixing the exchange rate monetary authorities in RRCs may contribute to achieving consumption smoothing across generations and softening the negative effects of Dutch Disease during a boom. Therefore, it could be interesting to study the role of certain factors in the determination of exchange rate regimes in RRCs. To our best knowledge there is no empirical study that concentrates on this issue, and we are trying to fill this gap by focusing on a specific set of determinants such as macroeconomic volatility, democracy, central bank independence, and fiscal discipline.

2.3 Methodology and Data

2.3.1 Econometric Model

Given the nature of the dependent variable - which is a categorical variable that takes three values[4] - we run multinomial ordered logit regressions for an unbalanced panel data set. This technique is the most relevant in a discrete choice analysis since the choice set includes more than two ordered alternatives.[5]

The econometric literature suggests using a country fixed-effects model on panel data. However, a country-specific fixed-effects model may produce inconsistent results if maximum likelihood estimator (MLE) is used. In the panel data with T observations within each group of N, MLE is consistent if T tends to infinity. A fixed effect model can give inconsistent estimators if T is small and N tends to infinity (see Chamberlain, 1980). Given the small number of years in our database we abandon the idea of using country fixed-effects model in our estimations.

The discrete variable y_{it} denotes the choice of exchange rate regime by country i at period t and is defined as:

[3] In this context, undisciplined fiscal policy defines a situation when windfall revenues are spent in the short run, while under disciplined fiscal policy fiscal spending is maintained relatively constant in the long run.

[4] To check the robustness of our results, besides 3-way classification we also use the 5-way classification in section 2.4.1.

[5] The information criteria of Akaike, Schwarz and Hannan-Quinn do not clearly favor any model, so we employ a logit model in our estimations.

$$y_{i,t} = j \begin{cases} j = 1, & \text{if country i at period t implements a flexible regime,} \\ j = 2, & \text{if country i at period t implements an intermediate regime,} \\ j = 3, & \text{if country i at period t implements a fixed regime.} \end{cases} \tag{2.1}$$

The probability of choosing regime j is denoted by p_j, such that $\sum_{j=1}^{3} p_j = 1$. The choice of exchange rate regime is described by a latent variable $y^*_{i,t}$ which denotes the unobserved utility that government i derives in year t from a fixed regime. $y^*_{i,t}$ is determined as a linear function of different explanatory variables $X_{i,t}$, natural resource-richness dummy $D^{nr}_{i,t}$ and its interaction term with the specific set of variables $Z_{i,t}$ ($Z_{i,t} \subset X_{i,t}$):

$$y^*_{i,t} = X_{i,t} + D^{nr}_{i,t} + D^{nr}_{i,t} \times Z_{i,t} + u_{i,t}, \text{ for } i = 1, 2, ..., N; \; t = 1, 2, ..., T_i. \tag{2.2}$$

Where N denotes the number of countries and T_i is the number of observations for country i. We assume that the error term $u_{i,t}$ is i.i.d. with standard logistic distribution. The probabilities of country i choosing regime j at period t are defined in the following way:

$$\begin{aligned} &y_{i,t} = 1 \text{ if } y^*_{i,t} < c_1 \text{ and } Pr(y_{i,t} = 1) = Pr(y^*_{i,t} < c_1), \\ &y_{i,t} = 2 \text{ if } c_1 < y^*_{i,t} < c_2 \text{ and } Pr(y_{i,t} = 2) = Pr(c_1 < y^*_{i,t} < c_2), \\ &y_{i,t} = 3 \text{ if } y^*_{i,t} > c_2 \text{ and } Pr(y_{i,t} = 3) = Pr(y^*_{i,t} > c_2), \end{aligned} \tag{2.3}$$

where c_1 and c_2 ($c_1 < c_2$) are thresholds defining the edges between different regimes. The estimates of all the coefficients and thresholds c_1 and c_2 are obtained by using the maximum likelihood technique.

In order to reduce the potential endogeneity we use lagged values for some explanatory variables. This correction for endogeneity bias may not be a sufficient solution. Some authors try to resolve the endogeneity problem by replacing the variables with their initial values or by using the instrumental variables. However, due to certain limitations these techniques are ineffective in dealing with the endogeneity problem.

The list of control variables $X_{i,t}$ and their classification according to different approaches are given in Table 2.1. Most of these explanatory variables are taken from the standard literature and the reasoning behind them is described in the literature review section. The predictions of the **OCA theory** are tested by including the country's openness and its size. A-priori, we expect that larger and more open countries are more likely to adopt more flexible exchange rate regimes. To test the **Financial view** we include the ratio of private credit to GDP as a measure of the financial development and the Chinn-Ito index which measures a country's degree of capital account openness.[6] To capture the effects of **Political factors** on the choice of exchange rate regime we use central bank independence index, democracy dummy and inflation rate. According to the Political view, countries with more independent central banks and democratic societies would prefer a floating exchange rate. Central bank independence indicates how political conflicts around choices over exchange rate regimes are solved. In other words, this measure points out to what extent monetary authorities can oppose pressures by the ruling party. For example, prior to elections a flexible exchange rate regime may look a more attractive option for policymakers since such a policy may achieve employment growth and facilitate their likelihood of reelection. In this situation, a credible independent central bank will not forego its own interests to defend the political interests of the ruling party. Therefore, central bank independence is included among other determinants of the exchange rate regime. Inflation can be the focus of a government that tries to build up a reputation by attaining monetary stability. For instance, a government favoring low inflation may choose a fixed exchange rate regime.

Besides these variables, we also control for three additional variables and their interaction terms with a resource-richness dummy: volatility of GDP, the cyclicality of fiscal policy, and fiscal elasticity (the elasticity of government consumption expenditure to income). The independent effects of these additional variables need to be explained. The effect of GDP volatility on the choice of exchange rate regime is pretty straightforward since the later has a direct impact on economic activity in the short run. The exchange rate is used extensively among other policy tools in dealing with macroeconomic stabilization. The cyclicality and elasticity of fiscal expenditure have similar effects on the choice of exchange rate regime. Both variables can be an important determinant of the choice of exchange rate regime, especially in natural-resource exporting countries. For instance, in an undisciplined fiscal environment where fiscal policy is procyclical or fiscal elasticity is high, an oil exporting economy is challenged by volatility in the money market. In this situation a pegged regime may serve as a shock absorber.[7]

[6]Because of a large number of missing data in our estimations we do not include liability dollarization, a variable commonly used in the literature for testing the Financial view. Surprisingly, in the robustness test the dollarization variable appears to be insignificant.

[7]A mechanism of how exchange rate regime affects macroeconomic stabilization and how fiscal disci-

Variable	Description	Source
Dependent variables		
lys_3	3 way de facto classification (1 = float; 2 = intermediate; 3 = fix)	Levy-Yeyati and Struzenegger (2003, 2005)
lys_5	5 way de facto classification (1 = inconclusive; 2 = float; 3 = dirty; 4 = dirty/crawling peg; 5 = fix)	Levy-Yeyati and Struzenegger (2003, 2005)
Independent variables		
OCA theory		
size	Natural logarithm of real GDP (constant 2005 US$)	WDI
open	Trade openness (the average of exports plus imports, % of GDP)	WDI
Financial view		
fin_dev	Financial development (domestic credit to private sector, % of GDP)	WDI
ka_open	De jure capital account openness (the Chinn-Ito index). The index is based on the binary dummy variables that codify the tabulation of restrictions on cross-border financial transactions reported in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions.	Chinn and Ito (2008)
Political view		
inf	Inflation, consumer prices (% change)	WDI
dem	Democracy dummy variable (coded 1 if the regime qualifies as democratic and 0 otherwise)	Cheibub (2010)
cbi	Central Bank Independence index	Arnone and Romelli 2013
Additional interest variables		
nr	Natural resource exporter dummy (coded 1 if ores, metals, and fuel exports exports' share of merchandise exports > 50%, 0 otherwise)	WDI
fuel	Fuel exporter dummy (coded 1 if fuel exports' share of merchandise exports > 50%, 0 otherwise)	WDI
rgdp_vol	Standard deviation of the growth rate of real GDP (constant 2005 US$) over a rolling five-year period	WDI
fis_cyc	Fiscal cyclicality (coefficients estimated based on the linear regression of natural log of change in government consumption (constant 2005 US$) on log of change in real GDP)	WDI
fis_el	Elasticity of government consumption expenditure (the ratio of % change in government consumption to % change in real GDP)	WDI

Table 2.1: Variable definitions and sources

In line with these three variables we also focus on the interaction of democracy and central bank independence with the resource-richness dummy. These two variables are related with the accountability of government and may carry extra importance in RRCs where fiscal dominance is a major issue.

pline shapes the overall macroeconomic situation is extensively explained in Aliyev (2012).

2.3.2 Data Analysis

The full sample contains annual observations for 120 developing and 25 developed countries over the 1975-2004 period. The list of all variables and their sources is given in Table 2.1. Table 2.5 in Appendix 2.A.1 lists all the countries in our sample. Most of the macroeconomic data are obtained from the International Financial Statistics (IFS) and World Economic Outlook (WEO) by the IMF, World Development Indicators (WDI) by the World Bank, and from the United Nations Statistics Division. A detailed summary statistics about different variables is provided in Table 2.6 in Appendix 2.A.1.

We borrow the de facto exchange rate regime classification from Levy-Yeyati and Struzenegger (2003, 2005). Specifically we use two ways of classification, named lys_3 for three-way classification and lys_5 for five-way classification.

As a measure of size we use a natural logarithm of real GDP. To control openness we employ two measures: de facto capital account openness (open), estimated as the GDP share of the average of exports plus imports, and de jure capital account openness (ka_open) measured by the Chinn-Ito index (Chinn and Ito, 2008). We also control for CPI as a measure of inflation. Financial development is captured by the ratio of domestic credit to the private sector as a percentage of GDP. The democracy variable (dem) comes from Cheibub (2010). The distribution of number of observations according to democracy and resource-richness is given in Table 2.7 in Appendix 2.A.1. Based on visual inspection we can see that the majority of RRCs are non-democratic.

We use the central bank independence index from Arnone et al. (2007) and Klomp and De Haan (2009).[8] Central bank independence is built based on two indicators of central bank autonomy: (i) political autonomy, the ability of the central bank to choose the objectives of monetary policy, and (ii) economic autonomy, the ability of the central bank to choose its instruments (the methodology is proposed by Grilli et al., 1991).

In our specification a country is considered natural resource exporting if its natural resource (ores, metals, and fuel) exports' share is larger than one half of total merchandize exports. Although the threshold may seem large, countries exposed to a windfall of huge natural resource revenues lie in our interest area. GDP volatility is measured as a standard deviation of the growth rate of GDP over a rolling centered five-year period.

We use two alternative measures of fiscal discipline: (i) the fiscal cyclicality (fis_cyc) and (ii) the elasticity of government consumption (fis_el). To estimate the cyclicality

[8]We are grateful to Jeroen Klomp, Jakob de Haan and Davide Romelli for providing us with the data.

measure we run the following regression of the growth of real government expenditures on real GDP growth (similar to Woo, 2009).

$$lnG_{i,t} - lnG_{i,t-1} = \delta_i + \beta_i[lnY_{i,t} - lnY_{i,t-1}] + \epsilon_{i,t} \tag{2.4}$$

Fiscal elasticity is estimated as the ratio of the percentage change in government consumption to the percentage change in GDP. This variable reflects how much government expenditure responds to changes in income. For example, high values of the $fis\_el_{i,t}$ would mean that government i at period t simultaneously increases/decreases fiscal expenditures in response to increase/decrease in GDP.

To test for multicollinearity among the variables we estimate the variance inflation factor (VIF) and the condition index. The test results do not indicate the presence of strong multicollinearity. The correlation among independent variables is also weak (Table 2.8 in Appendix 2.A.1).

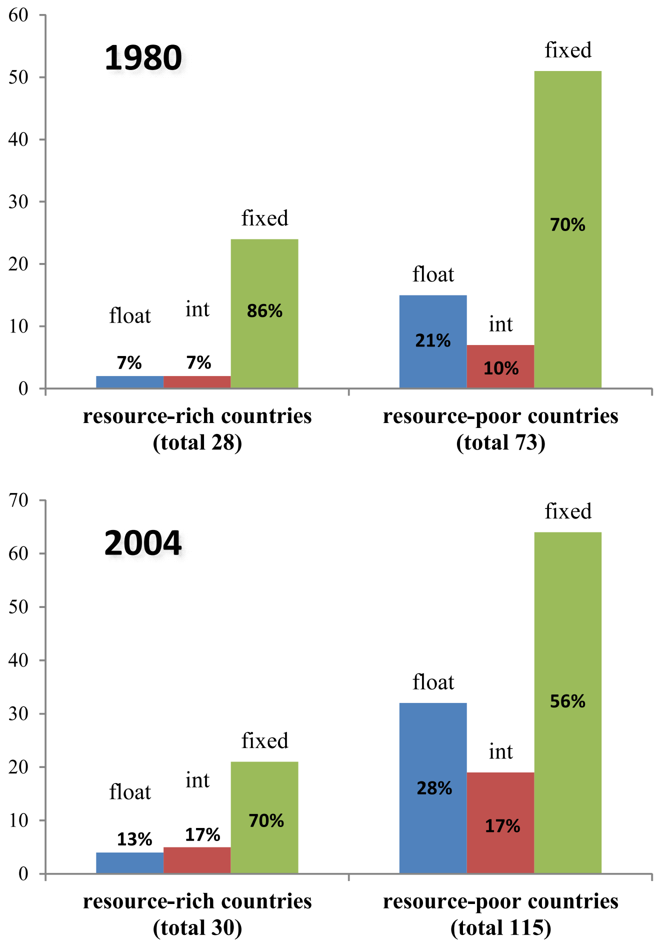

Figure 2.1: Distribution of countries according to exchange rate regimes

From the first-pass over the data it is interesting to explore the distribution of exchange rate regimes across countries (Figure 2.1). As can easily be seen from the figure, RRCs adopt a fixed exchange rate regime more frequently as compared to resource-poor countries. In 1980, 86% of RRCs adopted a fixed exchange rate regime, though this number was 70% among resource-poor countries. In 2004 the relative disparity between resource-rich and resource-poor countries remained (a fixed exchange rate regime is adopted by 70% of resource-rich and by 56% of resource-poor countries), though the overall popularity of a fixed exchange rate regime dropped in both groups.

2.4 Results

Our main results are summarized in Tables 2.2 - 2.4: Table 2.2 illustrates our estimation results for the full set of countries, Tables 2.3 and 2.4 display the results for developing and developed countries respectively[9]. First, we estimate the parameters of the model with only the main effects (column 1) and then include interaction terms (columns 2 - 6).

The effects of control variables on the choice of exchange rate regime are consistent with those found in the literature. Size has negative coefficients in all specifications, meaning that larger countries are less likely to adopt a fixed exchange rate regime. Positive coefficients on openness indicate that more open countries are more likely to use a fixed exchange rate regime. These two findings are consistent with the principles of the OCA theory.[10]

We also confirm that higher central bank independence is associated with more flexible exchange rate regimes. A fixed exchange rate regime constraints the central bank to conducting independent monetary policy and a flexible exchange rate regime enables the central bank to have full control over the monetary policy decisions (Siklos, 2008). Therefore, a more flexible exchange rate regime is more likely to be used by an independent central bank. Our results indicate that democratic countries are more likely to adopt flexible exchange rate regimes. Such a regime allows the government to conduct monetary policy toward domestic stabilization purposes. Democratic countries are more transparent and possess politically accountable institutions. These findings about central

[9]The reason for us splitting the sample into developing and developed countries is that there are only a few developed countries that export natural resources in large quantities and it would be more proper to focus on developing countries that share many similarities.

[10]Berdiev et al. (2012), Levy-Yeyati et al. (2010), Von Hagen and Zhou (2007) among many others find similar results.

bank independence and democracy are intuitive and in line with the Political view.

	lys_3 [a]					
	(1)	(2)	(3)	(4)	(5)	(6)
size	-0.390 *** 0.027	-0.405 *** 0.027	-0.385 *** 0.028	-0.211 *** 0.035	-0.348 *** 0.033	-0.306 *** 0.032
open	1.546 *** 0.331	1.523 *** 0.324	1.539 *** 0.330	1.771 *** 0.447	1.356 *** 0.372	1.553 *** 0.377
ka_open	0.564 *** 0.144	0.574 *** 0.145	0.493 ** 0.148	0.769 *** 0.178	0.691 *** 0.157	0.622 *** 0.157
fin_dev	0.007 *** 0.001	0.007 *** 0.001	0.007 *** 0.002	0.005 *** 0.002	0.004 ** 0.001	0.004 *** 0.002
inf_l [b]	-0.0002 *** 0.000	-0.0001 *** 0.000	-0.0002 *** 0.000	-0.0001 ** 0.000	0.0000 0.000	-0.0001 ** 0.000
nr	1.002 *** 0.126	1.292 *** 0.146	0.695 *** 0.223	2.396 *** 0.457	1.573 *** 0.255	0.894 *** 0.141
dem	-0.286 *** 0.098	-0.156 * 0.104	-0.242 * 0.100	0.014 0.123	-0.444 *** 0.107	-0.425 *** 0.109
dem x nr		-0.840 *** 0.256				
rgdp_vol_l			-4.646 ** 2.386			
rgdp_vol_l x nr			9.420 *** 4.160			
cbi				-0.499 * 0.276		
cbi x nr				-3.092 *** 0.932		
fis_cyc					-0.3592 *** 0.095	
fis_cyc x nr					-1.307 *** 0.315	
fis_el_l						0.0001 ** 0.000
fis_el_l x nr						0.007 0.017
Pseudo R2 [c]	0.12	0.12	0.12	0.07	0.11	0.10
Log likelihood	-2356.19	-2350.77	-2223.20	-1516.54	-1923.95	-1900.31
Wald chi2 (32)	539.04	565.79	505.57	198.38	345.01	353.36
Number of observations	2712	2712	2537	1532	2096	2040

Estimations from an ordered multinomial logit. All regressions include year dummies. Robust standard errors below coefficients. Significantly different from zero at the 10% (*), 5% (**), and 1% (***) confidence level.

[a] The dependent variable lys_3 is a categorical variable that takes the value 1 if a country is classified as a floating exchange rate regime, 2 if intermediate and 3 if fixed.

[b] A variable X with lagged values is denoted as X_1.

[c] For ordered logit models, the R2 statistic is meaningless. Hence, we report McFadden's pseudo R-squared.

Table 2.2: Multinomial ordered logistic regression estimates: full sample

	lys_3 [a]					
	(1)	(2)	(3)	(4)	(5)	(6)
size	-0.563 *** 0.034	-0.596 *** 0.035	-0.566 *** 0.035	-0.395 *** 0.049	-0.537 *** 0.045	-0.509 *** 0.044
open	1.011 *** 0.270	0.986 *** 0.261	1.011 *** 0.270	0.844 *** 0.316	0.743 ** 0.290	0.936 *** 0.278
ka_open	-0.002 0.163	0.000 0.165	-0.063 0.167	0.173 0.213	0.040 0.188	-0.070 0.187
fin_dev	0.010 *** 0.002	0.011 *** 0.002	0.010 *** 0.002	0.012 *** 0.003	0.007 *** 0.002	0.007 *** 0.002
inf_l [b]	-0.0001 *** 0.000	-0.0001 ** 0.000	-0.0001 *** 0.000	-0.0001 * 0.000	0.0000 0.000	-0.0001 0.000
nr	1.226 *** 0.141	1.707 *** 0.171	0.909 *** 0.253	2.593 *** 0.543	1.446 *** 0.275	0.958 *** 0.157
dem	-0.540 *** 0.106	-0.313 *** 0.112	-0.541 *** 0.109	-0.362 *** 0.138	-0.734 *** 0.120	-0.751 *** 0.119
dem x nr		-1.391 *** 0.274				
rgdp_vol_l			-0.902 2.743			
rgdp_vol_l x nr			8.938 ** 1.810			
cbi				-0.622 * 0.360		
cbi x nr				-2.798 *** 1.074		
fis_cyc					-0.3588 *** 0.115	
fis_cyc x nr					-0.950 *** 0.331	
fis_el_l						0.0001 ** 0.000
fis_el_l x nr						0.004 0.019
Pseudo R2 [c]	0.15	0.16	0.15	0.10	0.16	0.15
Log likelihood	-1718.65	-1705.85	-1634.67	-984.42	-1295.21	-1280.04
Wald chi2 (32)	494.36	490.82	467.49	198.31	334.74	353.09
Number of observations	2091	2091	1964	1007	1488	1447

Estimations from an ordered multinomial logit. All regressions include year dummies. Robust standard errors below coefficients. Significantly different from zero at the 10% (*), 5% (**), and 1% (***) confidence level.

[a] The dependent variable lys_3 is a categorical variable that takes the value 1 if a country is classified as a floating exchange rate regime, 2 if intermediate and 3 if fixed.

[b] A variable X with lagged values is denoted as X_1.

[c] For ordered logit models, the R2 statistic is meaningless. Hence, we report McFadden's pseudo R-squared.

Table 2.3: Multinomial ordered logistic regression estimates: developing countries

	lys_3 [a]					
	(1)	(2)	(3)	(4)	(5)	(6)
size	-0.548 ***	-0.544 ***	-0.556 ***	-0.505 ***	-0.483 ***	-0.538 ***
	0.105	0.104	0.112	0.121	0.102	0.107
open	6.893 ***	6.795 ***	7.431 ***	7.860 ***	7.503 ***	7.164 ***
	1.101	1.073	1.276	1.347	1.144	1.136
ka_open	-0.037	0.000	-0.531	0.096	0.243	-0.159
	0.457	0.457	0.473	0.648	0.466	0.467
fin_dev	-0.013 ***	-0.013 ***	-0.014 ***	-0.013 ***	-0.012 ***	-0.013 ***
	0.004	0.004	0.004	0.004	0.004	0.004
inf_1 [b]	-0.052 ***	-0.051 ***	-0.042 ***	-0.042 ***	-0.053 ***	-0.050 ***
	0.016	0.016	0.016	0.016	0.016	0.016
nr	2.160 ***	1.580 *	4.272 ***	3.630	23.049 ***	2.144 ***
	0.564	0.809	1.090	1.082	0.732	0.621
dem	-0.925 *	-1.020 **	-0.883 *	-0.338	-0.800 *	-0.734
	0.484	0.515	0.479	0.515	0.495	0.513
dem x nr		13.492 ***				
		0.903				
rgdp_vol_l			-35.043 ***			
			10.434			
rgdp_vol_l x nr			-34.827 *			
			20.371			
cbi				-0.200		
				0.723		
cbi x nr				-3.440		
				2.604		
fis_cyc					1.5516 ***	
					0.538	
fis_cyc x nr					-35.956 ***	
					2.437	
fis_el_l						-0.002
						0.009
fis_el_l x nr						0.068
						0.120
Pseudo R2 [c]	0.28	0.28	0.29	0.27	0.29	0.28
Log likelihood	-449.62	-448.69	-403.86	-375.17	-435.13	-424.28
Wald chi2 (32)	251.44	3866.30	270.68	184.24	3852.56	242.62
Number of observations	621	621	573	525	608	593

Estimations from an ordered multinomial logit. All regressions include year dummies. Robust standard errors below coefficients. Significantly different from zero at the 10% (*), 5% (**), and 1% (***) confidence level.

[a] The dependent variable lys_3 is a categorical variable that takes the value 1 if a country is classified as a floating exchange rate regime, 2 if intermediate and 3 if fixed.

[b] A variable X with lagged values is denoted as X_1.

[c] For ordered logit models, the R2 statistic is meaningless. Hence, we report McFadden's pseudo R-squared.

Table 2.4: Multinomial ordered logistic regression estimates: developed countries

The negative sign on the coefficient of inflation indicates that higher rates of inflation lower the likelihood of a fixed regime. This result is similar to the findings of Berdiev et al. (2012) and Markiewicz (2006). One explanation for this finding could be that it is difficult to maintain a stable exchange rate in countries with high levels of consumer prices. Hence high inflation rates may undermine the credibility of a fixed regime, and force a country to move towards a flexible regime. Another explanation for this relationship could be that a fixed exchange rate regime may cause low rates of inflation.

Positive coefficients on the financial development measure in developing countries imply that greater financial development increases the probability of a fixed exchange rate regime in these countries. This finding can be explained through a high correlation of financial deepness with denominated debt and greater currency mismatches in developing countries (Berdiev, 2012; Eichengreen and Hausmann, 2005; Levy-Yeyati et al., 2010). However, in developed countries the Financial view holds, since higher financial development is associated with more flexible exchange rate regimes. Capital account openness has a significant and positive coefficient for the full sample, but it is insignificant if developed and developing countries are analyzed separately.

Our notable finding is that the probability of implementing a pegged exchange rate regime is higher in RRCs compared to resource-poor countries. This result is depicted in Figure 2.2, where we obtain different probabilities by holding all other explanatory variables at their mean. A similar conclusion has been documented by Klein and Shambaugh (2009) for fuel exporting countries. Our study extends their results to all natural resource exporting countries. The incentives of RRCs to choose pegging are explained through the stabilization function of the exchange rate and are extensively described above. We believe that on the background of large and volatile foreign exchange inflows, pegging the exchange rate might have a rationale: in a natural resource exporting economy a fixed exchange rate regime may seem the best option to achieve short-term stabilization.

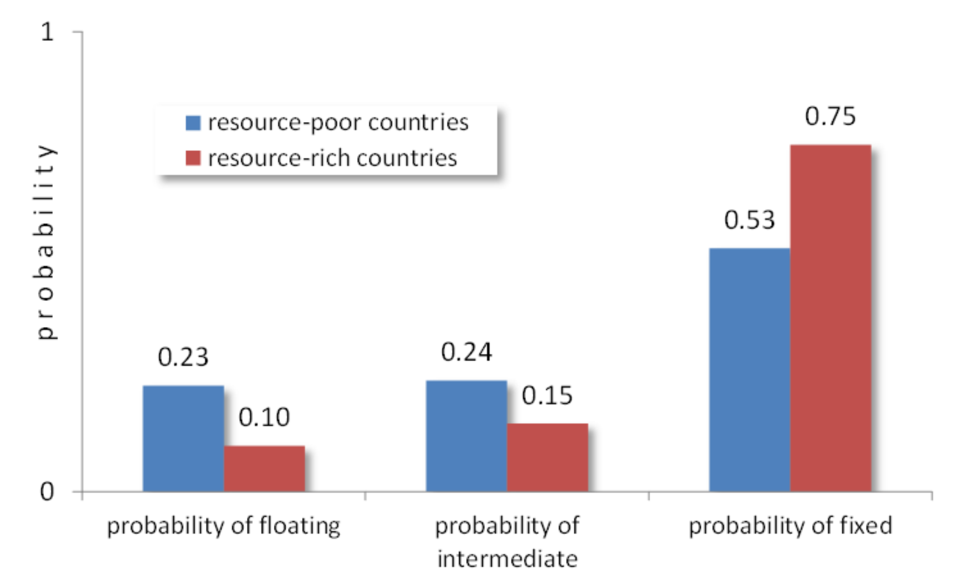

Figure 2.2: Probabilities of the choices of exchange rate regimes

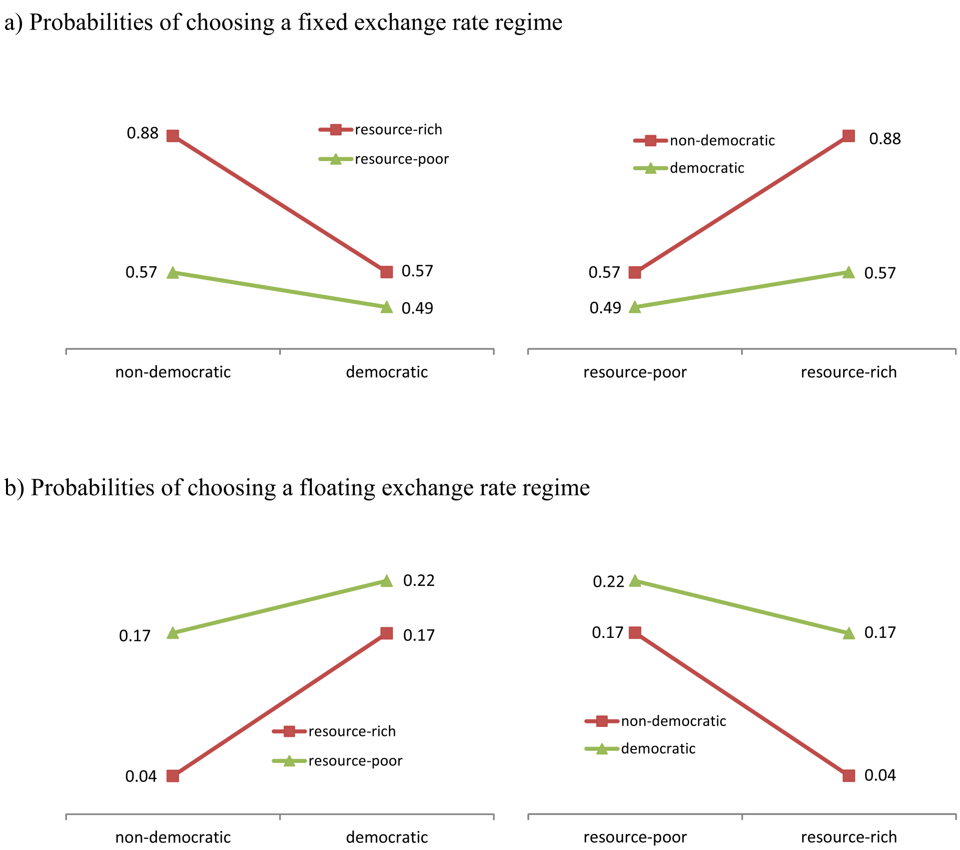

Figure 2.3: Probabilities of choosing fixed and floating exchange rate regimes in developing countries: democracy

Now we can analyze the interaction terms of the natural resource-richness dummy with some other variables. The coefficient on the interaction term of democracy and the resource-richness dummy (*dem* x *nr*) is negative for the full sample and for developing countries.[11] The way democracy influences the effect of resource-richness on the choice of exchange rate regime can be better seen in Figure 2.3. As we can see, democratic countries are less likely to adopt a fixed exchange rate regime both in resource-rich and resource-poor countries. However, the effect of democracy is stronger in resource-rich countries since we observe a steeper slope for resource-rich countries and a flatter slope for resource-poor countries. If we look at the interaction coefficient from a different perspective, we can observe that resource-richness increases the probability of a fixed exchange rate regime in all countries, though this effect is weaker in democratic countries. Therefore, we can conclude that in RRCs democratic institutions play a stronger role in supporting more flexible exchange rate regimes.

[11] The interaction terms for developed countries do not primarily lie in our focus, since among these countries only Norway is classified as a resource-rich country.

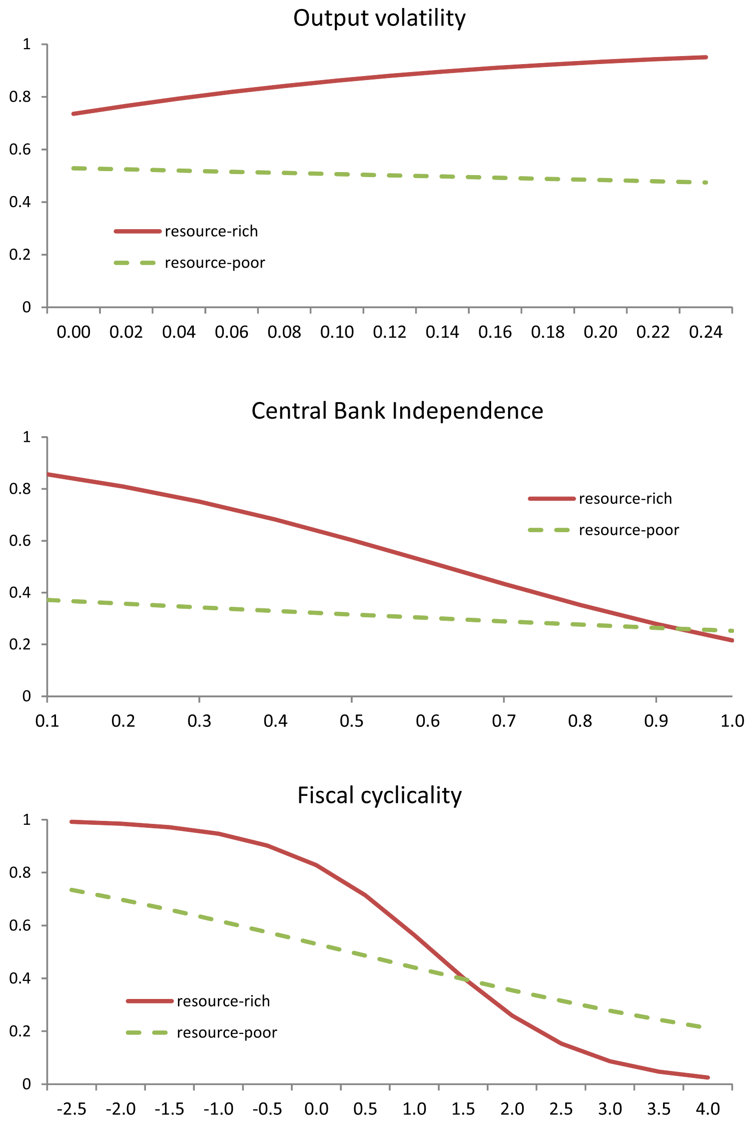

Figure 2.4: Probabilities of choosing a fixed exchange rate regime in developing countries: output volatility, central bank independence, and fiscal cyclicality

The multiplicative effects of output volatility, central bank independence, and fiscal cyclicality with a resource-richness dummy in developing countries are depicted in Figure 2.4. The interaction effect of GDP volatility and resource-richness is significant at the 1% and 10% levels in the full sample and in the developing countries respectively. This multiplicative effect unveils another interesting relation: the probability of adoption of a fixed exchange rate regime decreases in resource-poor countries and increases in resource-rich countries with higher values of output volatility. In RRCs the output mainly consists of natural resources and hence, the fluctuations in natural resource extraction and exports are the main sources of output volatility in these countries. Therefore, we can conclude that in RRCs a fixed exchange rate regime is mainly preferred because of high volatility of natural resource revenues.

Previous studies have shown that central bank independence decreases the probability of a fixed exchange rate regime. In line with this phenomenon our results indicate that the effect of central bank autonomy is more pronounced in resource-rich countries as compared to resource-poor ones. In other words RRCs are more likely to abandon a fixed exchange rate regime if they possess more independent central banks.

We obtain significant effects of fiscal cyclicality and its interaction with the resource-richness dummy on the choice of exchange rate regime. According to our results, countries with procyclical fiscal policies are less likely to adopt a fixed exchange rate regime, meaning that if we move from countries with countercyclical policies towards countries with procyclical fiscal policies, the probability of adopting a fixed exchange rate regime diminishes. This can be due to difficulties in maintaining exchange rate stability in countries where governments pursue a procyclical fiscal policy. We observe that if fiscal policy is countercyclical, then RRCs are more likely to peg their exchange rate. However, when fiscal policy becomes procyclical, the probability of pegging in RRCs drops below the probability of pegging in resource-poor countries. A procyclical fiscal policy in RRCs – a situation when the government changes fiscal expenditure in response to changes in income from natural resource exports – might make it even more difficult to achieve a pegged exchange rate regime.

Fiscal elasticity increases the overall probability of a fixed exchange rate regime, meaning that adoption of a fixed exchange rate regime is more likely in countries where the response of fiscal expenditure to changes in income is high. Its multiplication effect with resource-richness is insignificant.

2.4.1 Robustness Checks

All our robustness checks are given in Appendix 2.A.2. To test the robustness of our results, first, we estimate the model with a 5-way exchange rate regime classification, instead of the 3-way classification used in our benchmark specification[12]. Some economists believe that distinguishing among floaters, fixers and intermediate regimes is enough. Others argue that there is a need for more detailed classification and split intermediate

[12]Basically it is rather a 4-way classification, since there are only 9 observations (0.33% of total) that belong to the inconclusive category. Observations with these categories are dropped in order to keep the consistency of ordered logit estimations.

regimes into crawling peg and dirty floats. To make sure that our results are robust to this modification we use 5-way classification. The results for developing countries with 5-way classification are described in Table 2.10[13]. One can easily check that the signs and significance of the coefficients are similar in both classifications. The main differences are in the relative values of the coefficients.

We also focus solely on fuel exporting countries instead of all natural resource exporting countries. The results with fuel exporting developing countries are summarized in Table 2.11. As we can see, new coefficients do not significantly differ from the ones in the benchmark specification.

As the final test, we estimate our model with additional control variables: interest rate, "years office", and dollarization. To measure the interest rate we use the lending interest rate from WDI. "Years office" is obtained from the Database of Political institutions 2012, and indicates how many years the chief executive has been in office. And for dollarization, we use the deposit dollarization ratio (foreign currency deposits over total deposits) assembled by Levy and Yeyati (2006).

The estimation results with these additional variables are summarized in Table 2.12. We can see that, with the additional variables, the number of observations is reduced more than threefold. Therefore, direct comparison of the new results with the benchmark specification is inappropriate. With the additional variables the effect of capital account openness becomes insignificant and financial development obtains significant coefficients. Interest rate and years the chief executive has been in office are both insignificant.

A-priori we could expect that to deal with high dollarization a fixed exchange rate regime may be preferred, since stability of the exchange rate may increase the confidence of residents in the domestic currency. However, our estimation results indicate that higher levels of dollarization are associated with a lower probability of a fixed regime in all specifications. We believe that in this relationship the effect works in a reverse direction. A pegged exchange rate regime increases the faith of residents in the domestic currency as they switch from foreign currency to domestic and dollarization falls. Therefore, we observe negative coefficients on the dollarization variable.

[13] The results for the full set of countries and for developing countries are also similar to the benchmark results, so we do not report them.

2.5 Conclusion

This chapter analyzes the determinants of the choice of exchange rate regime in 145 countries over the period 1975-2004 by primarily focusing on RRCs. As other studies have found, we confirm that size, openness, financial development, central bank independence, and democracy are important determinants of the choice of exchange rate regime.

Moreover, our results reveal that RRCs are more likely to adopt a fixed exchange rate regime compared to resource-poor countries. We think that on the background of large and volatile foreign exchange inflows, there may be a rationale for pegging the exchange rate. In a natural resource exporting economy a fixed exchange rate regime may seem the best option to achieve short-term stabilization. The data provides support for this position: the probability of adoption of a fixed exchange rate regime decreases in resource-poor countries and increases in resource-rich countries with higher values of output volatility. In RRCs the output mainly consists of natural resources, and therefore the fluctuations in natural resource extraction and exports are the main sources of output volatility. Therefore, we can conclude that in RRCs a fixed exchange rate regime is mainly preferred due to its stabilization function in the face of turbulent foreign exchange inflows.

Our study finds that democracy and central bank independence affect the choice of exchange rate regime differently in RRCs. Estimations show that democratic countries are less likely to adopt a fixed exchange rate regime regardless of whether they are resource rich or poor. However, we find that the effect of democracy is stronger in resource-rich countries. In other words, in RRCs, democratic institutions play a stronger role in supporting more flexible exchange rate regimes. Previous studies have shown that central bank independence decreases the probability of a fixed exchange rate regime. In line with this phenomenon, our results indicate that the effect of central bank autonomy is more pronounced in resource-rich countries as compared to resource-poor ones. This implies that in RRCs, more independent central banks are more inclined to choose a flexible exchange rate regime.

In resource-rich countries with non-democratic institutions and non-independent central banks, the government is less accountable for its spending of natural resource revenues and fiscal dominance is more likely. In this situation, fluctuations in natural resource revenues are more easily transmitted into the domestic economy and therefore a fixed exchange rate becomes a more favorable option.

According to our results, countries with procyclical fiscal policies are less likely to adopt a fixed exchange rate regime, meaning that if we move from countries with countercyclical policies towards those with procyclical fiscal policies, the probability of adopting a fixed exchange rate regime diminishes. This can be due to difficulties in maintaining exchange rate stability in countries where governments pursue a procyclical fiscal policy. We observe that if fiscal policy is countercyclical, then RRCs are more likely to peg their exchange rate. However, when fiscal policy becomes procyclical, the probability of pegging in RRCs drops below the probability of pegging in resource-poor countries. A procyclical fiscal policy in RRCs – a situation when the government changes fiscal expenditure in response to changes in income from natural resource exports – might make it even more difficult to achieve a pegged exchange rate regime.

2.6 References

Aghion, P., Bacchetta, P., Ranciere, R., Rogoff, K., 2009. Exchange Rate Volatility and Productivity Growth: the Role of Financial Development. Journal of Monetary Economics, Volume 56, Issue 4, P. 494-513.

Akaike, H., 1974. A New Look at the Statistical Model Identification. I.E.E.E. Transactions on Automatic Control, AC 19, 716-723.

Akaike, H., 1976. Canonical Correlation Analysis of Time Series and the Use of an Information Criterion. in R. K. Mehra and D. G. Lainotis (eds.), System Identification: Advances and Case Studies, Academic Press, New York, 52-107.

Aliyev, R., 2012. Monetary Policy in Resource-Rich Developing Economies. CERGE-EI Working Paper No: 466.

Arnone, M., Laurens, B., J., Segalotto, J., F., 2006. The measurement of central bank autonomy: survey of models, indicators, and empirical evidence. IMF Working Paper No: 06/227.

Berdiev, A., N., Kim, Y., Chang, C., P., 2012. The Political Economy of Exchange Rate Regimes in Developed and Developing Countries. European Journal of Political Economy, Volume 28, p. 38-53.

Calvo, A., G., Reinhart, C., M., 2002. Fear of Floating. The Quarterly Journal of Economics, Volume 117, issue 2, p. 379-408.

Chamberlain, G., 1980. Analysis of covariance with qualitative data. Review of Economic Studies, Volume 47, p. 225-238.

Cheibub, J., A., Gandhi, J., Vreeland, J., R., 2010. Democracy and Dictatorship Revisited. Public Choice, Volume 143, no. 2-1, p. 67-101.

Chinn, M., D., Ito, H., 2008. A New Measure of Financial Openness. Journal of Comparative Policy Analysis, Volume 10, Issue 3, p. 309-322.

Frankel, J., 1999. No Single Currency Regime is Right for All Countries or at All Times. National Bureau of Economic Research (Cambridge, MA) Working Paper No. 7338.

Frankel, J., 2003. A Proposed Monetary Regime for Small Commodity-Exporters: Peg the Export Price. International Finance, Wiley Blackwell, Volume 6(1), p. 61-88.

Ghosh, A., R., Anne, G., Wolf, H., 2003. Exchange Rate Regimes - Choices and Consequences. Cambridge, MA. MIT Press.

Grilli, V., Masciandaro, D., Tabellini, G., 1991. Political and Monetary Institutions and Public Financial Policies in the Industrial Countries. Economic Policy 13, 341-392.

Hannan, E., J., Quinn, B. G., 1979. The Determination of the Order of an Autoregression. Journal of the Royal Statistical Society, B, Volume 41, 190-195.

Harms, P., Kretschmann, M., 2009. Words, Deeds and Outcomes: A Survey on The Growth Effects of Exchange Rate Regimes. Journal of Economic Surveys, Volume 23, No. p. 139-164.

Husain, A., M., Tazhibayeva, K., Ter-Martirosyan, A., 2008. Fiscal Policy and Economic Cycles in Oil-Exporting Countries. IMF Working Paper WP/08/253.

Husain, A., M., Ahoka, M., Rogoff, K., 2004. Exchange Rate Regime Durability and Performance in Developing Versus Advanced Economies. Journal of Monetary Economics, Volume 52, p. 35-64.

Klein, M., W., Shambaugh, J., C., 2009. Exchange Rate Regimes in the Modern Era. The MIT Press.

Klomp, J., Haan, J., 2009. Central bank independence and financial instability. Journal of Financial Stability, Volume 5, p. 321-338.

Korhonen, I., Juurikkala, T., 2009. Equilibrium exchange rates in oil-exporting countries. Journal of Economics and Finance, Volume 33, No. 1, p. 71-79.

Levy-Yeyati, E., Sturzenegger, F., 2003. To Float or to Fix: Evidence on the Impact of Exchange Rate Regimes on Growth. American Economic Review, Volume 93, p. 1173-1193.

Levy-Yeyati, E., Sturzenegger, F., 2005. Classifying Exchange Rate Regimes: Deeds vs. Words. European Economic Review, Volume 49, p. 1603-1635.

Levy-Yeyati, E., Sturzenegger, F., Reggio, I., 2010. On The Endogeneity of Exchange Rate Regimes. European Economic Review, Volume 54, p. 659-677.

Markiewicz, A., 2006. Choice of exchange rate regime in transition economies: An empirical analysis. Journal of Comparative Economics, Volume 34, p. 484-498.

Mundell, R., 1961. A Theory of Optimal Currency Areas. American Economic Review, Volume 51(4), p. 657-65.

Reinhart, C., M., Rogoff, K., S., 2004. The Modern History of Exchange Rate Arrangements. Quarterly Journal of Economics, Volume CXIX, February issue 1.

Sachs, J., D., Warner, A., M., 2001. Natural Resources and Economic Development: The Curse of Natural Resources. European Economic Review, Volume 45, p. 827-838.

Schwarz, G., 1978. Estimating the Dimension of a Model. Annals of Statistics, 6, 461-464.

Siklos, P., 2008. No single definition of central bank independence is right for all countries. European Journal of Political Economy, Volume 24, p. 802-816.

Von Hagen, J., Zhou, J., 2007. The choice of exchange rate regimes in developing countries: a multinomial panel analysis. Journal of International Money and Finance, Volume 26 (7), p. 1071-1094.

Woo, J., 2009. Why Do More Polarized Countries Run More Procyclical Fiscal Policy? The Review of Economics and Statistics, Volume 91, No. 4, p. 850-870.

International Monetary Fund (2010, various years). Annual Report on Exchange Arrangements and Exchange Restrictions. (AREAER), Washington, D.C.: International Monetary Fund.

2.A Appendix

2.A.1 Data Description

Developed Countries	**Developing Countries**			
Australia	Albania	Cote D'Ivoire	Kuwait	Romania
Austria	Algeria	Croatia	Kyrgyz Rep	Russia
Belgium	Angola	Cyprus	Latvia	Samoa
Canada	Antigua Barb	Czech Rep	Lesotho	Saudi Arabia
Denmark	Armenia	Djibouti	Libya	Senegal
Finland	Azerbaijan	Dominica	Lithuania	Seychelles
France	Bahamas	Dominican Rep	Macedonia	Singapore
Germany	Bahrain	Ecuador	Madagascar	Slovak Rep
Greece	Bangladesh	Egypt	Malawi	Slovenia
Iceland	Barbados	El Salvador	Malaysia	South Africa
Ireland	Belarus	Estonia	Mali	Sri Lanka
Italy	Belize	Ethiopia	Mauritius	St Kitts N
Japan	Benin	Fiji	Moldova	St Lucia
Korea	Bhutan	Gabon	Mongolia	St Vincent Gr
Mexico	Bolivia	Gambia	Morocco	Sudan
Netherlands	Botswana	Georgia	Mozambique	Suriname
New Zealand	Brazil	Ghana	Namibia	Swaziland
Norway	Bulgaria	Grenada	Nepal	Syria
Portugal	Burkina Faso	Guatemala	Nicaragua	Tajikistan
Spain	Burundi	Guyana	Niger	Tanzania
Sweden	CAR	Haiti	Nigeria	Thailand
Switzerland	Cambodia	Honduras	Oman	Togo
Turkey	Cape Verde	Hungary	Pakistan	Trinidad Tob
UK	Chad	India	Panama	Tunisia
US	China	Indonesia	Papua New G.	Uganda
	Colombia	Iran	Paraguay	Ukraine
	Comoros	Israel	Peru	Uruguay
	Congo, Dem.	Jordan	Philippines	Yemen
	Congo, Rep.	Kazakhstan	Poland	Zambia
	Costa Rica	Kenya	Qatar	Zimbabwe

Table 2.5: List of countries (145)

	1976					1986					1996					2004				
Variable	Obs.	Mean	St. De.	Min	Max	Obs.	Mean	St. De.	Min	Max	Obs.	Mean	St. De.	Min	Max	Obs.	Mean	St. De.	Min	Max
lys_3	57	2.39	0.84	1	3	73	2.32	0.80	1	3	116	2.26	0.85	1	3	130	2.32	0.86	1	3
ln_rgdp (size)	57	2.98	2.20	-1.44	8.56	73	2.81	2.31	-1.41	8.89	116	3.15	2.28	-1.10	9.18	130	3.34	2.27	-1.01	9.45
open	57	0.31	0.16	0.08	0.78	73	0.33	0.19	0.06	0.92	116	0.40	0.22	0.07	1.70	130	0.44	0.23	0.12	2.06
fin_dev	57	29.1	23.2	3.85	129	73	35.8	26.5	2.90	154	116	40.3	38.6	1.17	202	130	49.0	46.8	2.9	208
ka_open	57	0.35	0.30	0	1	73	0.34	0.32	0	1	116	0.45	0.35	0	1	130	0.56	0.37	0	1
inf	57	14.3	13.8	1.08	80.4	73	19.2	39.7	-13.1	276	116	49.8	384	-8.48	4145	130	7.29	25.2	-5.36	282
dem	57	0.40	0.49	0	1	73	0.52	0.50	0	1	116	0.64	0.48	0	1	130	0.65	0.48	0	1
cbi	0	-	-	-	-	41	0.37	0.17	0.09	0.82	84	0.51	0.20	0.09	0.94	105	0.61	0.20	0.19	1.00
nr	57	24.0	30.1	0	100	73	22.7	29.7	0	99	116	21.2	28.9	0	100	130	22.4	29.4	0	100
fuel	57	14.1	27.5	0	100	73	14.6	26.0	0	99	116	14.2	27.0	0	99	130	15.3	27.3	0	97
rgdp_vol	0	-	-	-	-	73	0.04	0.03	0	0.11	116	0.03	0.03	0	0.13	130	0.02	0.02	0	0.12
fis_cyc	44	0.37	0.42	-0.45	1.45	54	0.38	0.40	-0.45	1.45	94	0.45	0.54	-0.45	3.19	106	0.50	0.76	-2.51	3.94
fis_el	44	0.84	1.65	-6.01	3.35	54	4.47	18	-10.4	127	94	0.67	3.95	-29.8	11.2	106	0.61	1.63	-8.54	6.63

Table 2.6: Summary statistics

	Resource-poor	Resource-rich	Total
Non-democratic	779	360	1,139
Democratic	1,446	127	1,573
Total	2,225	487	2,712

Table 2.7: Distribution of number of observations according to democracy and resource-richness

	size	open	ka_open	fin_dev	inf	nr	dem	cbi	fis_cyc	fis_dis
size	1.00									
open	-0.24	1.00								
ka_open	0.31	0.20	1.00							
fin_dev	0.60	0.11	0.49	1.00						
inf	-0.03	-0.06	-0.11	-0.05	1.00					
nr	-0.10	-0.08	-0.09	-0.23	0.13	1.00				
dem	0.27	-0.14	0.21	0.23	0.00	-0.22	1.00			
cbi	0.09	0.05	0.30	0.05	-0.05	-0.07	0.23	1.00		
fis_cyc	-0.39	-0.14	-0.25	-0.34	0.09	0.02	-0.24	-0.07	1.00	
fis_dis	0.01	-0.03	0.01	0.03	0.00	-0.01	-0.02	0.01	0.02	1.00

Table 2.8: Correlation coefficients

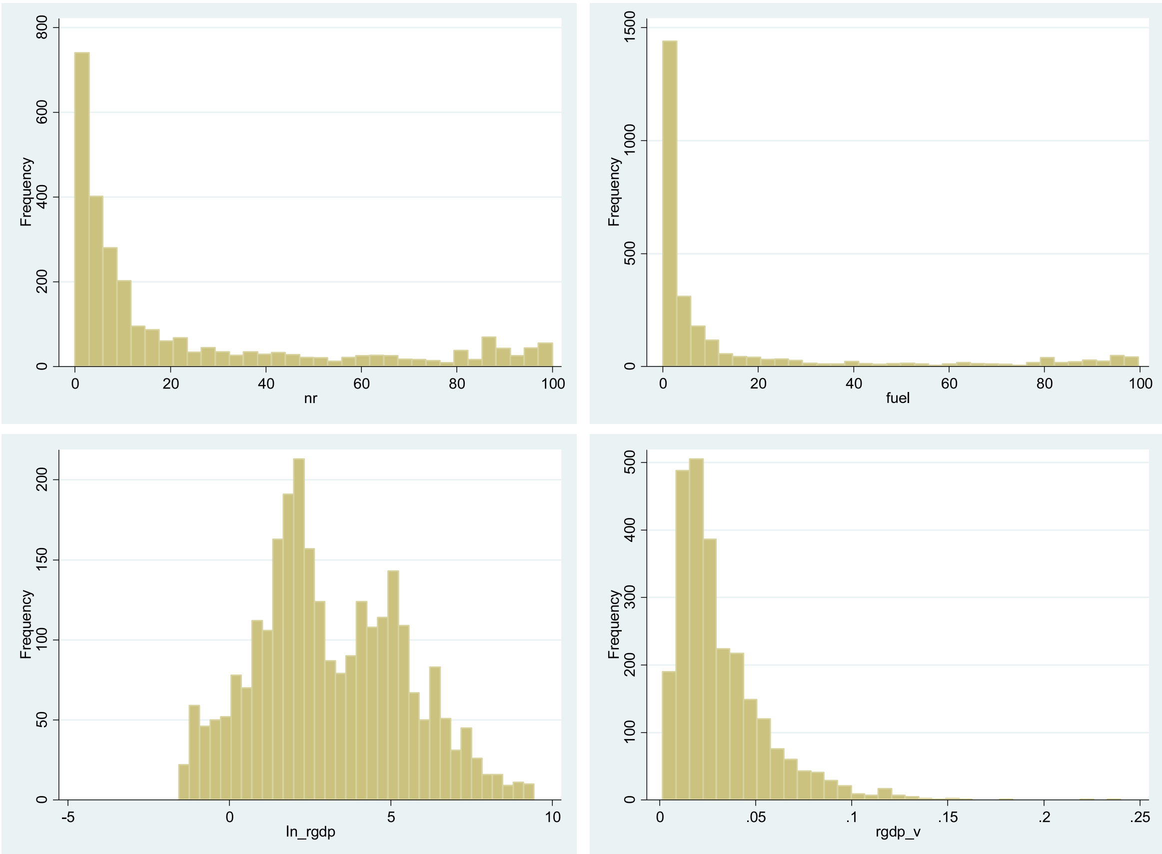

Figure 2.5: Distributions of number of observations for selected variables

country	year	lys_3	ln_rgdp	rgdp_v	open	ka_open	interest	inf	fin_dev	dollar	dem	yrsoffc	nr	fuel	cbi	fis_cyc	fis_dis
Albania	2003	1	2.01	0.02	0.33	0.41	14.27	0.48	7.67	0.31	1	1.0	0	0	0.75	1.07	1.80
Algeria	2003	1	4.54	0.01	0.31	0.16	8.13	4.27	11.39	0.16	0	4.0	1	1	0.81	0.68	0.59
Angola	2003	2	3.07	0.06	0.66	0.16	96.12	98.22	5.01	0.74	0	24.0	1	1	0.31	-	-
Antigua Barb	2003	3	-0.11	0.04	0.58	0.75	12.82	1.99	65.05	0.06	1	-	0	0	-	-	-
Armenia	2003	2	1.36	0.02	0.41	1.00	20.83	4.72	5.68	0.71	1	5.0	0	0	0.81	0.29	1.00
Australia	2003	1	6.47	0.01	0.20	0.69	8.41	2.77	99.36	-	1	7.0	0	0	0.63	0.07	0.99
Austria	2003	3	5.67	0.01	0.46	1.00	-	1.36	104.81	0.01	1	4.0	0	0	0.94	0.27	1.44
Azerbaijan	2003	3	2.25	0.07	0.54	0.41	15.46	2.23	7.01	0.82	0	10.0	1	1	-	0.54	2.73
Bahamas	2003	3	2.00	0.02	0.41	0.00	6.00	3.03	58.92	0.03	1	1.0	0	0	0.31	0.54	8.55
Bahrain	2003	3	2.64	0.02	0.73	1.00	8.30	1.59	42.13	0.3	0	4.0	1	1	0.44	-	-
Barbados	2003	3	1.31	0.02	0.54	0.16	8.50	1.62	61.23	0.15	1	9.0	0	0	0.38	-	-
Belarus	2003	2	3.21	0.03	0.67	0.16	23.98	28.40	11.75	0.55	0	9.0	0	0	0.44	0.60	0.03
Belgium	2003	3	5.88	0.01	0.71	1.00	6.89	1.59	73.81	-	1	4.0	0	0	0.94	-0.01	1.74
Belize	2003	3	0.03	0.02	0.60	0.00	14.35	2.61	51.03	0.12	1	5.0	0	0	0.38	0.03	0.58
Benin	2003	3	1.41	0.01	0.20	0.16	-	1.49	14.21	-	1	7.0	0	0	-	0.84	1.79
Bolivia	2003	3	2.17	0.01	0.26	0.75	17.66	3.34	47.88	0.93	1	1.0	0	0	0.75	1.25	1.31
Botswana	2003	3	2.22	0.02	0.40	0.84	16.40	9.19	19.98	0.33	0	5.0	0	0	0.44	0.78	0.27
Brazil	2003	1	6.70	0.02	0.14	0.41	67.08	14.72	28.65	-	1	1.0	0	0	0.63	1.14	1.01
Bulgaria	2003	3	3.24	0.01	0.54	0.22	8.54	2.16	26.49	0.5	1	2.0	0	0	-	1.16	1.57
Burkina Faso	2003	3	1.57	0.02	0.15	0.16	-	2.03	13.91	-	0	12.0	0	0	-	0.65	0.41
Burundi	2003	2	0.05	0.03	0.14	0.16	18.23	10.76	22.20	-	0	7.0	0	0	0.38	3.94	-17.88
CAR	2003	3	0.23	0.04	0.16	0.16	18.00	4.13	6.18	-	0	10.0	0	0	-	3.00	6.21
Cambodia	2003	2	1.62	0.03	0.62	0.43	-	1.21	7.21	0.95	0	10.0	0	0	0.56	2.04	0.57
Canada	2003	1	7.00	0.01	0.36	1.00	4.69	2.76	162.92	-	1	1.0	0	0	0.63	-0.10	1.48
Chad	2003	3	1.44	0.10	0.42	0.16	18.00	-1.75	4.19	-	0	13.0	1	0	-	-0.38	0.89
China	2003	3	7.52	0.01	0.28	0.16	5.31	1.16	127.15	0.06	0	-	0	0	0.56	-0.08	0.48
Colombia	2003	1	4.89	0.02	0.19	0.16	15.19	7.13	24.89	0	1	1.0	0	0	0.5	0.80	0.46
Comoros	2003	3	-0.99	0.02	0.24	0.16	11.83	3.80	9.55	0.01	0	4.0	0	0	0.44	-	-
Congo, Rep.	2003	3	1.70	0.02	0.78	0.16	18.00	-0.63	3.64	-	0	6.0	1	1	-	0.81	-13.34
Costa Rica	2003	3	2.90	0.02	0.48	0.71	25.58	9.45	31.32	0.45	1	1.0	0	0	0.69	0.47	-0.05
Cote D'Ivoire	2003	3	2.76	0.02	0.40	0.16	-	3.35	13.62	-	0	3.0	0	0	-	1.45	-0.58
Croatia	2003	1	3.72	0.01	0.47	0.69	11.58	1.75	45.76	0.65	1	3.0	0	0	0.88	-0.07	0.36
Cyprus	2003	2	2.75	0.01	0.48	0.41	6.95	4.14	206.23	0.05	1	10.0	0	0	0.56	0.48	3.06
Czech Rep	2003	2	4.76	0.02	0.60	0.94	5.95	0.11	30.48	0.09	1	5.0	0	0	0.88	0.63	1.58
Denmark	2003	3	5.50	0.01	0.42	1.00	-	2.09	151.62	-	1	2.0	0	0	0.75	0.21	1.85
Djibouti	2003	3	-0.41	0.01	0.44	1.00	11.30	1.98	22.58	0.5	0	4.0	0	0	-	2.80	2.38
Dominica	2003	3	-1.04	0.04	0.40	0.16	11.50	1.45	45.71	0.02	1	-	0	0	-	-	-
Dominican Rep	2003	2	3.42	0.04	0.43	0.45	31.39	27.45	37.51	0.27	1	3.0	0	0	0.56	0.18	52.90
Ecuador	2003	3	3.60	0.02	0.27	0.47	13.64	7.93	16.72	-	1	1.0	0	0	0.94	0.46	0.43
Egypt	2003	1	4.41	0.01	0.23	0.71	13.53	4.51	53.90	0.31	0	22.0	0	0	0.38	-0.14	0.86
El Salvador	2003	3	2.79	0.01	0.35	1.00	-	2.12	41.75	-	1	4.0	0	0	0.81	0.26	-0.14
Estonia	2003	3	2.49	0.01	0.73	1.00	5.51	1.34	50.65	0.26	1	2.0	0	0	-	-0.18	0.81
Ethiopia	2003	3	2.26	0.07	0.20	0.16	7.00	17.76	20.53	-	0	8.0	0	0	0.5	1.36	5.61
Finland	2003	3	5.21	0.01	0.35	1.00	4.13	0.88	64.18	-	1	4.0	0	0	0.94	0.20	0.77
France	2003	3	7.62	0.01	0.25	1.00	6.60	2.11	88.66	-	1	1.0	0	0	0.94	-0.10	2.09
Gabon	2003	3	2.12	0.01	0.43	0.16	18.00	2.24	12.36	-	0	36.0	0	0	-	0.87	-1.47
Gambia	2003	3	-0.53	0.05	0.34	1.00	29.33	17.03	11.76	0.26	0	9.0	0	0	-	-0.16	0.19
Georgia	2003	1	1.71	0.03	0.39	0.75	32.27	4.76	8.62	0.74	0	11.0	0	0	0.75	-	-
Germany	2003	3	7.91	0.01	0.34	1.00	-	1.03	116.30	-	1	5.0	0	0	0.88	0.14	-0.93
Ghana	2003	3	2.26	0.01	0.49	0.16	-	26.67	12.49	0.31	1	3.0	0	0	0.5	-	-
Greece	2003	3	5.42	0.01	0.27	1.00	6.79	3.53	64.77	0.15	1	7.0	0	0	0.81	0.48	-0.15
Grenada	2003	3	0.49	0.02	0.41	0.16	12.05	2.23	57.94	0.07	1	8.0	0	0	-	-	-
Guatemala	2003	2	3.24	0.01	0.33	1.00	14.98	5.60	26.24	0.1	1	4.0	0	0	0.63	0.87	-0.59
Guyana	2003	2	-0.21	0.02	0.95	1.00	14.99	5.98	57.64	-	0	4.0	0	0	0.5	-	-
Haiti	2003	1	1.44	0.02	0.32	0.76	44.21	39.28	16.57	-	0	3.0	0	0	0.5	-	-
Honduras	2003	2	2.15	0.01	0.61	0.41	20.80	7.67	37.61	0.35	1	2.0	0	0	0.5	0.69	0.82
Hungary	2003	3	4.62	0.00	0.63	0.88	9.60	4.65	42.71	0.14	1	1.0	0	0	0.94	0.13	1.30
Iceland	2003	3	2.65	0.03	0.36	0.69	11.95	2.06	130.39	0.09	1	6.0	0	0	0.75	0.10	0.75
India	2003	2	6.56	0.02	0.15	0.16	11.46	3.81	31.08	0.03	1	5.0	0	0	0.5	0.14	0.36
Indonesia	2003	1	5.55	0.01	0.27	0.69	16.94	6.59	22.95	0.16	1	2.0	0	0	0.69	0.98	2.05
Iran	2003	2	5.16	0.02	0.26	0.45	-	16.47	26.28	-	0	2.0	1	1	-	0.54	0.09
Ireland	2003	3	5.21	0.01	0.75	1.00	2.85	3.48	113.93	-	1	6.0	0	0	0.81	0.42	0.81
Israel	2003	1	4.80	0.03	0.37	0.82	10.65	0.67	85.66	-	1	3.0	0	0	0.38	-0.06	-1.88
Italy	2003	3	7.46	0.01	0.24	1.00	5.83	2.68	83.21	0.04	1	2.0	0	0	0.81	0.20	-42.65
Japan	2003	1	8.39	0.01	0.11	1.00	1.82	0.17	186.47	-	1	3.0	0	0	0.44	0.26	1.11
Jordan	2003	3	2.37	0.02	0.58	1.00	9.30	1.63	70.82	0.28	0	4.0	0	0	0.38	0.57	0.59

Table 2.9: Raw data sample

country	year	lys_3	ln_rgdp	rgdp_v	open	ka_open	interest	inf	fin_dev	dollar	dem	yrsoffc	nr	fuel	cbi	fis_cyc	fis_dis
Kazakhstan	2003	3	3.86	0.02	0.46	0.16	-	6.44	21.94	0.47	0	12.0	1	1	-	0.79	0.96
Kenya	2003	1	2.82	0.02	0.27	0.69	16.57	9.82	24.60	0.14	1	1.0	0	0	0.44	0.15	2.02
Korea	2003	3	6.71	0.02	0.34	0.41	6.24	3.51	114.74	-	1	-	0	0	0.56	0.04	1.28
Kuwait	2003	3	4.19	0.07	0.43	0.69	5.42	0.96	67.74	0.13	0	26.0	1	1	0.31	-	-
Kyrgyz Rep	2003	1	0.83	0.04	0.42	0.69	19.13	2.97	4.78	0.67	0	13.0	0	0	0.88	1.10	0.18
Latvia	2003	3	2.59	0.02	0.48	1.00	5.38	2.96	40.23	0.38	1	1.0	0	0	1	-0.01	0.27
Lesotho	2003	3	0.26	0.02	0.84	0.16	16.02	6.63	6.39	-	0	5.0	0	0	0.44	-0.12	0.22
Lithuania	2003	1	3.11	0.01	0.54	1.00	5.84	-1.15	22.78	0.26	1	6.0	0	0	0.81	1.04	0.41
Macedonia	2003	3	1.70	0.04	0.46	0.45	16.00	1.10	18.26	0.52	1	1.0	0	0	0.88	-0.07	-3.77
Madagascar	2003	1	1.52	0.09	0.28	0.41	24.25	-1.22	8.78	0.19	1	2.0	0	0	0.63	1.05	2.67
Malawi	2003	1	0.94	0.04	0.34	0.16	48.92	9.58	5.46	0.19	1	9.0	0	0	0.38	-	-
Malaysia	2003	3	4.85	0.02	0.97	0.41	6.30	0.99	118.97	0.03	0	22.0	0	0	0.5	0.51	1.47
Mali	2003	3	1.59	0.04	0.32	0.16	-	-1.35	19.04	-	1	1.0	0	0	-	-	-
Mauritius	2003	1	1.77	0.02	0.56	1.00	21.00	3.92	73.25	0.11	1	3.0	0	0	-	0.13	0.82
Mexico	2003	1	6.69	0.02	0.26	0.45	7.02	4.55	15.71	0.06	1	3.0	0	0	0.69	0.61	-0.39
Moldova	2003	1	0.95	0.01	0.70	0.16	19.29	11.62	20.32	0.5	1	2.0	0	0	0.75	0.68	0.34
Mongolia	2003	2	0.75	0.03	0.60	0.69	31.91	5.13	22.31	0.44	1	6.0	0	0	0.75	-	-
Mozambique	2003	3	1.72	0.02	0.38	0.16	24.69	13.43	11.40	0.46	0	17.0	1	0	0.44	1.11	1.05
Nepal	2003	2	2.02	0.02	0.22	0.16	7.42	5.71	26.14	-	0	1.0	0	0	0.5	-0.03	2.59
Netherlands	2003	3	6.42	0.01	0.60	1.00	3.00	2.11	147.99	-	1	9.0	0	0	0.88	0.04	8.54
New Zealand	2003	3	4.66	0.01	0.29	1.00	7.00	1.12	107.90	0.04	1	4.0	0	0	0.44	0.09	1.13
Nicaragua	2003	2	1.75	0.02	0.38	1.00	15.55	5.30	17.68	0.7	1	2.0	0	0	0.56	0.64	2.20
Niger	2003	3	1.18	0.03	0.21	0.16	-	-1.61	5.23	-	1	4.0	1	0	-	-	-
Nigeria	2003	1	4.40	0.13	0.42	0.31	20.71	14.03	13.82	0.08	1	4.0	1	1	0.44	-	-
Norway	2003	3	5.65	0.01	0.34	1.00	4.73	2.48	77.44	-	1	2.0	1	1	0.75	0.22	1.32
Oman	2003	3	3.36	0.03	0.41	1.00	8.23	0.19	36.94	0.16	0	33.0	1	1	0.31	-	-
Panama	2003	3	2.60	0.03	0.61	1.00	9.93	0.39	87.12	-	1	4.0	0	0	0.38	0.75	0.10
Papua New G.	2003	3	1.53	0.02	0.62	0.16	13.36	14.71	13.59	0.08	1	1.0	1	0	0.63	-	-
Paraguay	2003	1	2.11	0.02	0.49	0.75	49.99	14.24	14.81	0.62	1	4.0	0	0	0.5	0.70	-0.48
Philippines	2003	1	4.52	0.01	0.51	0.45	9.47	2.29	33.14	0.31	1	3.0	0	0	0.63	0.88	0.73
Poland	2003	1	5.63	0.02	0.35	0.45	7.30	0.79	28.07	0.16	1	8.0	0	0	0.88	-0.34	1.25
Portugal	2003	3	5.23	0.01	0.31	1.00	-	3.28	135.38	-	1	1.0	0	0	0.81	0.58	-0.47
Qatar	2003	3	3.55	0.06	0.45	1.00	-	2.26	29.99	0.27	0	8.0	1	1	0.19	-	-
Romania	2003	1	4.47	0.02	0.38	0.51	25.44	15.27	13.74	0.42	1	3.0	0	0	0.27	-0.28	1.90
Russia	2003	2	6.51	0.01	0.30	0.41	12.98	13.68	21.24	0.27	0	3.0	1	1	0.44	0.46	0.34
Saudi Arabia	2003	3	5.64	0.04	0.35	0.69	-	0.59	28.40	0.18	0	21.0	1	1	0.5	-	-
Senegal	2003	3	2.05	0.02	0.33	0.16	-	-0.03	19.68	-	1	4.0	0	0	-	0.17	0.41
Singapore	2003	3	4.68	0.04	1.93	1.00	5.31	0.51	105.48	-	0	13.0	0	0	0.38	-0.25	0.09
Slovak Rep	2003	2	4.00	0.01	0.77	0.45	8.46	8.55	31.85	0.14	1	5.0	0	0	0.63	0.55	0.89
Slovenia	2003	3	3.49	0.01	0.54	0.76	10.75	5.58	41.28	0.32	1	1.0	0	0	0.81	0.28	0.79
South Africa	2003	1	5.41	0.01	0.27	0.16	14.96	5.86	120.71	0.03	0	4.0	0	0	0.25	0.31	2.02
Spain	2003	3	6.96	0.00	0.28	1.00	-	3.04	113.17	-	1	7.0	0	0	0.88	0.42	1.54
Sri Lanka	2003	2	3.08	0.03	0.38	0.45	10.34	6.31	28.92	0.22	1	10.0	0	0	0.56	0.89	0.81
St Kitts N	2003	3	-0.76	0.04	0.48	0.16	12.22	2.24	55.21	0.31	1	-	0	0	-	-	-
St Lucia	2003	3	-0.16	0.05	0.58	0.16	15.00	1.03	71.02	0.02	1	6.0	0	0	-	-	-
St Vincent Gr	2003	3	-0.66	0.02	0.43	0.16	11.83	0.21	48.94	0.02	1	-	0	0	-	-	-
Suriname	2003	2	0.45	0.02	0.33	0.00	21.04	23.00	17.27	0.56	1	3.0	0	0	-	-	-
Swaziland	2003	3	0.90	0.01	1.01	0.16	14.63	7.29	15.11	-	0	17.0	0	0	-	0.74	-2.75
Sweden	2003	2	5.84	0.01	0.40	1.00	4.79	1.93	99.82	-	1	1.0	0	0	0.94	-0.23	0.40
Switzerland	2003	2	5.90	0.01	0.41	1.00	3.27	0.64	152.47	-	1	5.0	0	0	0.75	0.21	132.35
Syria	2003	3	3.24	0.03	0.31	0.00	7.50	5.80	10.10	0.07	0	3.0	1	1	0.44	-0.45	17.27
Tajikistan	2003	3	0.68	0.02	0.68	0.16	16.67	16.30	14.76	0.6	0	11.0	0	0	0.81	1.61	0.12
Tanzania	2003	1	2.50	0.01	0.21	0.16	14.52	5.30	8.08	0.36	0	8.0	0	0	0.38	3.19	3.82
Thailand	2003	1	5.07	0.02	0.62	0.41	5.94	1.80	100.50	0.01	1	3.0	0	0	0.44	0.25	0.35
Togo	2003	3	0.72	0.03	0.51	0.16	-	-0.96	17.17	-	0	10.0	0	0	-	-0.17	3.39
Trinidad Tob	2003	3	2.65	0.04	0.45	1.00	11.17	3.81	36.84	0.2	1	2.0	1	1	0.44	0.54	0.01
Tunisia	2003	1	3.38	0.02	0.41	0.16	-	2.71	60.75	0.03	0	16.0	0	0	-	0.29	1.36
Turkey	2003	1	6.01	0.06	0.24	0.16	-	25.30	14.55	0.49	1	1.0	0	0	0.81	0.49	-0.52
UK	2003	1	7.69	0.01	0.27	1.00	3.69	1.36	142.04	0.17	1	6.0	0	0	0.69	-0.19	1.02
US	2003	1	9.41	0.01	0.12	1.00	4.12	2.27	176.54	-	1	1.0	0	0	0.75	-0.08	0.65
Uganda	2003	3	2.07	0.01	0.18	1.00	18.94	8.68	8.40	0.32	0	18.0	0	0	0.56	0.43	0.79
Ukraine	2003	3	4.32	0.04	0.56	0.16	17.89	5.18	24.58	0.32	1	9.0	0	0	0.81	0.33	0.74
Uruguay	2003	1	2.73	0.06	0.26	1.00	58.94	19.38	43.19	0.89	1	3.0	0	0	0.63	0.54	-6.13
Yemen	2003	2	2.73	0.01	0.37	1.00	18.00	10.83	6.37	0.51	0	25.0	1	1	0.44	-	-
Zambia	2003	3	1.87	0.01	0.35	1.00	40.57	21.40	6.77	0.42	0	2.0	1	0	0.44	-0.17	3.95
Zimbabwe	2003	2	1.87	0.07	0.35	0.00	97.29	431.70	57.03	0.07	0	16.0	0	0	0.44	-	-

Table 2.9 (cont.): Raw data sample

2.A.2 Robustness Tests

	lys_5 [a]					
	(1)	(2)	(3)	(4)	(5)	(6)
size	-0.550 ***	-0.583 ***	-0.552 ***	-0.380 ***	-0.522 ***	-0.495 ***
	0.034	0.035	0.035	0.049	0.045	0.044
open	0.891 ***	0.867 ***	0.891 ***	0.715 **	0.612 **	0.796 ***
	0.272	0.263	0.272	0.323	0.291	0.280
ka_open	0.010	0.011	-0.051	0.186	0.048	-0.066
	0.163	0.165	0.168	0.213	0.189	0.188
fin_dev	0.010 ***	0.011 ***	0.011 ***	0.012 ***	0.007 ***	0.007 ***
	0.002	0.002	0.002	0.003	0.002	0.002
inf_1 [b]	-0.0001 ***	-0.0001 *	-0.0001 **	-0.0001 *	0.0000	-0.0001
	0.000	0.000	0.000	0.000	0.000	0.000
nr	1.197 ***	1.673 ***	0.893 ***	2.464 ***	1.444 ***	0.927 ***
	0.141	0.170	0.253	0.543	0.281	0.157
dem	-0.505 ***	-0.281 **	-0.505 ***	-0.317 **	-0.687 ***	-0.704 ***
	0.106	0.112	0.108	0.137	0.119	0.119
dem x nr		-1.377 ***				
		0.272				
rgdp_vol_1			-0.641			
			2.732			
rgdp_vol_1 x nr			8.515 *			
			4.930			
cbi				-0.680 *		
				0.353		
cbi x nr				-2.613 **		
				1.064		
fis_cyc					-0.3416 ***	
					0.114	
fis_cyc x nr					-0.999 ***	
					0.343	
fis_el_1						0.0001 **
						0.000
fis_el_1 x nr						0.005
						0.0191761
Pseudo R2 [c]	0.13	0.13	0.13	0.08	0.13	0.12
Log likelihood	-2014.49	-2001.75	-1918.77	-1167.58	-1533.19	-1513.25
Wald chi2 (32)	475.52	474.18	451.12	183.26	314.81	333.47
Number of observations	2086	2086	1959	1003	1483	1442

Estimations from an ordered multinomial logit. All regressions include year dummies. Robust standard errors below coefficients. Significantly different from zero at the 10% (*), 5% (**), and 1% (***) confidence level.

[a] The dependent variable lys_5 is a categorical variable that takes the value 1 if a country is classified as an inconclusive, 2 if floating exchange rate regime, 3 if dirty, 4 if dirty/crawling peg and 5 if fixed.

[b] A variable X with lagged values is denoted as X_1.

[c] For ordered logit models, the R2 statistic is meaningless. Hence, we report McFadden's pseudo R-squared.

Table 2.10: Multinomial ordered logistic regression estimates with 5 way exchange rate regime classification: developing countries

	lys_3 [a]					
	(1)	(2)	(3)	(4)	(5)	(6)
size	-0.589 *** 0.036	-0.610 *** 0.036	-0.585 *** 0.036	-0.406 *** 0.050	-0.554 *** 0.046	-0.523 *** 0.045
open	0.891 *** 0.261	0.877 *** 0.258	0.880 *** 0.261	0.797 ** 0.313	0.619 * 0.285	0.843 *** 0.272
ka_open	0.029 0.164	0.030 0.165	-0.021 0.168	0.242 0.213	0.068 0.189	-0.013 0.187
fin_dev	0.009 *** 0.002	0.010 *** 0.002	0.010 *** 0.002	0.011 *** 0.003	0.006 *** 0.002	0.007 *** 0.002
inf_l [b]	-0.0001 0.000	0.0000 0.000	-0.0001 0.000	-0.0001 0.000	0.0000 0.000	0.0000 0.000
fuel	1.417 *** 0.169	1.735 *** 0.189	1.361 *** 0.288	2.453 *** 0.601	1.412 *** 0.304	1.177 *** 0.186
dem	-0.531 *** 0.105	-0.416 *** 0.107	-0.510 *** 0.108	-0.355 ** 0.140	-0.785 *** 0.118	-0.767 *** 0.118
dem x fuel		-1.299 *** 0.369				
rgdp_vol_l			3.093 2.504			
rgdp_vol_l x fuel			2.384 5.761			
cbi				-0.609 * 0.357		
cbi x fuel				-2.325 * 1.269		
fis_cyc					-0.4395 *** 0.106	
fis_cyc x fuel					-0.616 * 0.383	
fis_el_l						0.0001 * 0.000
fis_el_l x fuel						-0.001 0.0222447
Pseudo R2 [c]	0.15	0.16	0.15	0.10	0.16	0.15
Log likelihood	-1719.40	-1712.76	-1636.60	-989.91	-1296.09	-1278.07
Wald chi2 (32)	474.28	473.24	449.49	188.58	341.09	354.43
Number of observations	2091	2091	1964	1007	1488	1447

Estimations from an ordered multinomial logit. All regressions include year dummies. Robust standard errors below coefficients. Significantly different from zero at the 10% (*), 5% (**), and 1% (***) confidence level.

[a] The dependent variable lys_3 is a categorical variable that takes the value 1 if a country is classified as a floating exchange rate regime, 2 if intermediate and 3 if fixed.

[b] A variable X with lagged values is denoted as X_l.

[c] For ordered logit models, the R2 statistic is meaningless. Hence, we report McFadden's pseudo R-squared.

Table 2.11: Multinomial ordered logistic regression estimates with fuel exporters: developing countries

	lys_3 [a]					
	(1)	(2)	(3)	(4)	(5)	(6)
size	-0.572 *** 0.066	-0.600 *** 0.068	-0.597 *** 0.067	-0.581 *** 0.066	-0.690 *** 0.084	-0.561 *** 0.076
open	2.309 *** 0.580	2.224 *** 0.587	2.402 *** 0.577	2.177 *** 0.591	2.114 *** 0.707	2.396 *** 0.681
ka_open	1.159 *** 0.328	1.220 *** 0.335	1.168 *** 0.329	1.124 *** 0.335	1.225 *** 0.398	1.260 *** 0.381
fin_dev	0.003 0.003	0.003 0.003	0.002 0.003	0.003 0.003	0.003 0.003	0.003 0.003
inf_l [b]	-0.0002 * 0.000	-0.0001 * 0.000	-0.0002 * 0.000	-0.0002 * 0.000	-0.0001 0.000	-0.0002 * 0.000
nr	1.266 *** 0.246	1.715 *** 0.325	0.792 * 0.452	2.721 *** 0.784	2.460 *** 0.492	1.694 *** 0.304
cbi	-1.283 *** 0.458	-1.228 *** 0.463	-1.232 ** 0.455	-1.059 ** 0.481	-0.908 * 0.510	-1.034 * 0.539
interest	0.00011 0.000	0.00002 0.000	0.00011 0.000	0.00017 0.000	0.00007 0.000	0.00015 0.000
dollar_l	-2.2909 *** 0.389	-2.3662 *** 0.393	-2.3032 *** 0.385	-2.3615 *** 0.404	-1.8374 *** 0.487	-1.8642 *** 0.450
yrsoffice	0.018 0.013	0.016 0.013	0.015 0.014	0.012 0.014	0.028 0.019	0.029 * 0.016
dem	-0.628 *** 0.214	-0.458 ** 0.233	-0.718 * 0.224	-0.671 *** 0.218	-0.674 ** 0.266	-0.504 ** 0.250
dem x nr		-0.958 * 0.493				
rgdp_vol_l			-10.663 ** 4.790			
rgdp_vol_l x nr			14.541 10.271			
cbi x nr				-3.033 * 1.656		
fis_cyc					-0.941 *** 0.213	
fis_cyc x nr					-1.1080 ** 0.564	
fis_el_l						-0.011 ** 0.005
fis_el_l x nr						0.032 0.035
Pseudo R2 [c]	0.19	0.19	0.19	0.19	0.19	0.16
Log likelihood	-582.91	-580.89	-577.69	-581.05	-	-
Wald chi2 (32)	858.72	1090.44	799.91	917.20	-	-
Number of observations	656	656	655	656	509	504

Estimations from an ordered multinomial logit. All regressions include year dummies. Robust standard errors below coefficients. Significantly different from zero at the 10% (*), 5% (**), and 1% (***) confidence level.

[a] The dependent variable lys_3 is a categorical variable that takes the value 1 if a country is classified as a floating exchange rate regime, 2 if intermediate and 3 if fixed.

[b] A variable X with lagged values is denoted as X_l.

[c] For ordered logit models, the R2 statistic is meaningless. Hence, we report McFadden's pseudo R-squared.

Table 2.12: Multinomial ordered logistic regression estimates with additional variables: developing countries

Chapter 3

The Impact of Monetary Policy on Financing of Czech Firms

(with Dana Hájková and Ivana Kubicová)

Abstract

This paper uses firm-level financial data for Czech firms in the period from 2003 to 2011 and tests for the role of companies' financial structure in the transmission of monetary policy. Our results indicate that higher short-term interest rates coincide with lower shares of total debt and long-term debt, and with higher shares of short-term bank loans and trade credit. We find that firm-specific characteristics, such as size, age, collateral, and profit affect the way monetary policy influences the external financing decisions of firms. These findings indicate the presence of informational frictions in credit markets and hence provide some empirical evidence of the existence of a broad credit channel in the Czech Republic.

This paper is forthcoming in the Czech Journal of Economics and Finance. An earlier version of this paper has been published in Aliyev R., Hájková D., and Kubicová I., 2014, The Impact of Monetary Policy on Financing of Czech Firms, CNB Working Paper Series, 5/2014. This work was supported by Czech National Bank Research Project No. A1/2010. We are grateful for helpful comments and suggestions from Michal Franta, Tomáš Holub, Paul Mizen, Jiří Schwarz, and Cihan Yalcin.

3.1 Introduction

In a perfect-information world, changes in monetary policy rates would (via the interest rate channel) affect the financing decisions of firms directly by changing their borrowing costs. However, in reality, credit market imperfections influence bank lending and firm financing behavior and (via the broad credit channel) alter monetary policy transmission.

The extent to which changes in monetary policy rates transmit to client rates depends on the functioning of financial markets, which set the financing costs for banks, and then on the conditions on retail-lending markets. The first part of the transmission tends to be fast and complete; the second part, however, is slower and often incomplete, while being heterogeneous across agents (Bernanke and Gertler, 1995) and countries (e.g. Sørensen and Werner, 2006). This has also been documented for the Czech Republic (Crespo-Cuaresma, Égert, and Reininger, 2007; Pruteanu-Podpiera, 2007; Horváth and Podpiera, 2012). One of the primary reasons for the delays and unevenness in interest rate transmission is the existence of information asymmetries among banks and clients; a bank's imperfect knowledge about its client's economic situation increases the transaction cost and hence the borrowing costs for the client. The information frictions typically amplify the effects of the interest rate channel. Country-specific reasons for the heterogeneity in transmission include differences in the prevailing structure of financing and in the level of competition on the retail-banking market.

The concept of the broad credit channel addresses those aspects of monetary policy transmission that the interest rate channel does not capture. It concerns the supply of and demand for bank loans in general, or in a client-specific relationship. Several mechanisms of operation of the broad credit channel have been established and analyzed in the literature, most of them distinguishing between the effects of bank-level characteristics and firm-level characteristics.

In this paper, we are interested in how firm-specific characteristics are reflected in the financing structure of Czech firms. In order to control for and assess the effects of monetary policy changes, we mainly follow the lines established in the literature regarding the bank lending, balance sheet, and relationship channels. We look at firm-level data to analyze firms' use of external finance. Our approach is to map the patterns in the financing of entrepreneurial firms in the Czech Republic and their implications for monetary policy transmission. We focus on the response of firms' external financing indicators to monetary policy rate changes. The heterogeneity of the individual responses - depending on the firm's size, age, collateral, and profitability indicates the importance of the broad credit channel for Czech monetary policy.

It is important to point out that Czech firm financing is characterized by significant use of trade credit and non-bank financing. Although bank loans are an important source of finance, too, their share in the financial liabilities of Czech firms is lower than in the euro area (CNB, 2011). The use of market financing by equity and commercial paper is limited to a small number of large firms.

Evidence of the balance sheet channel of monetary transmission in the Czech Republic has been limited. A notable exception is a study of balance sheet data and bankruptcy information by Pospíšil and Schwarz (2014), who find evidence of financial constraints for small Czech firms after 2008.

Our study extends the empirical evidence in two respects: First, we cover 2003-2011 and use firm-level balance sheet data for about 57,000 Czech firms. This allows us to analyze recent developments in firms' balances and describe the recent patterns in firm financing. Second, we directly focus on the role of firm-specific characteristics such as age, size, profitability, and collateral in the relationship between firm-level financing and monetary policy. Thus we are able to estimate the effects of information asymmetries between firms and banks on the transmission of monetary policy, and contribute to the debate about the importance of the broad credit channel with recent empirical evidence.

The paper is organized as follows. In the second section, we explore the existing literature on the topic. In the third and fourth sections, we explain our methodology and describe the data. The fifth section reports our findings and robustness tests, and the sixth section concludes.

3.2 Literature Review

The mechanism for the balance sheet channel is that, after a monetary tightening, external financing becomes scarce for firms and households with certain characteristics. For instance, small firms are more likely to be more vulnerable to information asymmetries arising from credit market frictions (Gertler and Gilchrist, 1994; Oliner and Rudebusch, 1996). Less capitalized firms with weak balance sheets have lower access to bank credit and/or a higher price of external funds as compared to large, well-capitalized firms. Banks do not have perfect information and therefore approximate the creditworthiness of firms by the strength of their balance sheets. In addition, banks tend to make their lending standards stricter in times of uncertainty. After a monetary tightening, individual firms' bank debt may decrease, not only because of the firms' own reaction to the higher interest rates but also because of banks' tightened lending standards, especially in a situation where they cannot easily replace bank credit with other types of financing. Hence, the balance sheet position of a firm determines the accessibility of market funds for borrowing (Bernanke and Gertler, 1995).

The effects of the balance sheet channel have been intensively analyzed on the micro level from the point of view of the conditions faced by firms and households and their financing behavior (Gertler and Gilchrist, 1994; Fidrmuc et al., 2009; Bougheas et al., 2006). In the literature, different firm-specific indicators have been analyzed for their role in the balance sheet channel. For example, De Haan and Sterken (2000) look at the effects of corporate governance and find that private firms are more dependent on bank debt and external funds and thus more sensitive to changes in the monetary policy conditions. Mizen and Yalcin (2002) and Bougheas et al. (2006) show that risky, young, and small firms have decreased access to lending when monetary policy is tight. Also, Prasad and Saibal Ghosh (2005) find that corporations behave differently depending on ownership, size, and period.

However, changes in bank debt in the balance sheets of firms may also result from shifts in the supply of bank debt alone. This channel became relatively important in some countries during the recent economic and financial crisis.[1] Identification of the supply and demand channels has featured in the literature since the debate between Kashyap et. al. (1993 and 1996) and Oliner and Rudebusch (1996a) and requires very detailed data to be addressed correctly. For example, Jiménez et al. (2012) analyze a Spanish micro-dataset with information on old and new loans, credit applications, and loan conditions, along with firm and bank characteristics. Ciccarelli et al. (2010) use comprehensive data from the U.S. and euro area bank lending surveys.

The so-called relationship lending channel assumes that the existence of a long-term relationship between banks and their debtors alleviates information asymmetries (Boot, 2000; Elsas, 2005). This long-term relationship hence creates benefits in terms of intertemporal smoothing, increased credit availability, enhancement of borrower's project payoffs, and more efficient decisions if borrowers face financial distress (Petersen and Rajan, 1994).

[1] The different sources of shocks to the supply of bank debt were discussed, for example, by Acharya and Naqvi (2012) and Dell'Ariccia and Marquez (2006).

As regards the relationship channel, Elsas and Krahnen (1998) and Harhoff and Korting (1998) find that companies who have a relationship with a finance provider have easier access to loans. Alternative evidence is presented by De Haan and Sterken (2006), who find higher sensitivity of firms to monetary policy shocks in market-based systems than in bank-based ones.

For the Czech Republic, the evidence on the balance sheet channel of monetary transmission is limited and only covers the period up to 2003.[2] Horváth (2006 and 2009) and Fidrmuc et al. (2009) analyze financial accelerator effects in firms' balance sheets in the Czech Republic and find that monetary policy has stronger effects on small firms than on big ones and that debt structure and cash-flow have a significant influence on firm-level interest rates.

Geršl and Jakubík (2010) analyze the relationship banking channel in the Czech Republic and underline the high relevance of single relationship banking for small and young firms in technology- and knowledge-intensive industries.

The methodology used in our paper provides an alternative view of the balance sheet channel, by describing various measures of indebtedness of Czech firms, which is complementary to previous analyses of financial accelerator effects. Furthermore, besides the effects of monetary policy on average debt ratios, our study extends the focus to different firm-specific characteristics.

3.3 Methodology

We borrow our methodology mainly from Bougheas et al. (2006) and De Haan and Sterken (2006). Following their approach we consider the impact of monetary policy on different indicators of firms' external financing, drawn from annual balance sheet data. We analyze how these financing indicators react to monetary policy changes depending on firm heterogeneity, and control for firm-specific variables that may influence capital structure choices. To do so, we regress different financing indicators on the monetary policy variable; size, age, profit, collateral, gearing, and their interaction terms with the monetary policy variable, as well as controlling for some other variables. Our basic regression model is given below:

[2] Égert (2009) provides a description of the empirical evidence across the majority of monetary policy transmission channels in the countries of Central and Eastern Europe. The bank lending channel is analyzed by Pruteanu (2007) and Matousek and Sarantis (2009).

$$Y_{i,t} = \alpha_1 + \alpha_2 MP_t + \beta X_{i,t} + \gamma MP_t \times X_{i,t} + \alpha_3 \Delta GDP_{t-1} + \varepsilon_{i,t} \tag{3.1}$$

where $Y_{i,t}$ denotes one of the following four debt ratios of firm i in period t:

TODEBT - the total debt to total assets ratio, i.e., the overall use of external debt SHLOAN - the short-term bank loans to total assets ratio SHTRADE - the trade credit to total assets ratio; this is a component of working capital which can be a substitute for bank debt (Petersen and Rajan, 1997) LDEBT - the long-term debt to total assets ratio.

MP_t is a monetary policy indicator, an increase in which corresponds to monetary tightening. Following the standard literature we focus mainly on the short-term market interest rate, which is typically closely linked to the monetary policy rate. As a measure of the short-term interest rate we use the 3-month PRIBOR (Prague Interbank Offered Rate). In the robustness test we check our results using the 1-year PRIBOR. Since interest rates are yearly averages and balance sheet variables are indicators reported at the end of the year, there is a lag in the effect of market rates on firms' financing decisions.

$X_{i,t}$ denotes firm-specific characteristics. These analyzed firm characteristics are:

SIZE – the natural logarithm of total assets (Kashyap and Stein, 1995).

AGE – the number of years in existence since 1996.[3]

COLLATERAL – the ratio of tangible fixed assets to total assets.

PROFIT – the ratio of earnings before interest and taxes to total assets.

ΔGDP_{t-1} is the one-year-lagged real GDP growth rate. This variable is included to control for the business cycle.

$\varepsilon_{i,t}$ is the error term.

We use a panel model to analyze the above-mentioned relationships.[4] We test for a fixed versus a random effects structure of the model using a Hausman specification test in order to determine the precise structure of the general model. In most cases the null hypothesis of firm-specific effects being uncorrelated with the regressors was rejected and hence the fixed effect model is favored.

[3]We use this approach to quantify the firm's reputation build-up and relationship with financial institutions since the establishment of the free market economy. By picking 1996, we disregard some initial years of transition, when the Czech banking sector failed to operate on prudent principles, which led to bank consolidation and stabilization programs in 1995-1996.

[4]Given the possible endogeneity problem indicated in the literature, and a lack of good instruments, we considered using the panel GMM estimator suggested by Arellano and Bond (1991), as it ensures efficiency and consistency, being robust to heteroscedasticity and autocorrelation, especially on samples with short time dimensions and large firm dimensions. However, the Sargan test of over-identifying restrictions indicated that all the proposed instruments are invalid. Therefore, we do not report results obtained using the Arellano and Bond GMM methodology.

In analysing the relationship between monetary policy and loan supply, the identification is very important and deserves some explanation. Some studies use more detailed data to meet this challenge. For example, Jiménez et al. (2012) use loan-level data to separate loan supply from demand.[5] Given the limitations of our dataset – which does not contain detailed information about loan applications and their results, linked with firm/bank-specific characteristics – we are not able to clearly identify supply and demand effects.

3.4 Data

The data used in the main part of our paper comprise information on firms' yearly balance sheets and financial results from the Bureau van Dijk Amadeus[6] database, and macroeconomic data on interest rates and output from the CNB's ARAD time series database, all for the 2003-2011 period.

Our final sample contains about 312,000 observations for 57,000 firms from the manufacturing, construction, wholesale, retail, car repair, and transport sectors. We include only active firms belonging to all size categories (named very large, large, medium, and small) in our analysis. The original raw data were much larger and included 1.5 billion observations for about 530,000 firms for the 1993-2013 period. The availability of data for 2012 and 2013 was rather limited, so we decided that 2011 would be the last year of the data. In addition, irrespective of year, the financial information for many of the observations was incomplete, and there were occurrences of misleading and wrong numbers, such as negative total assets, inequality between total assets and total liabilities, and components of total liabilities being larger than total liabilities. The raw data also contained bankrupted, dissolved, in liquidation, and inactive firms (defined by health status), which may not react to monetary policy changes properly. To obtain the final dataset, we excluded all the irrelevant observations. We also performed the Grubbs test for outliers, which indicated that the data do not contain any outliers.

[5] Jiménez et al. (2012) use confidential information from the Credit Register of Spain to study the effects of bank specific characteristics on success of loan applications. Specifically, they focus on how banks' capital or liquidity positions influence the probability of loan granting.

[6] Amadeus is a database of comparable financial information for public and private companies across Europe. It contains company financial information in a standardized format created by Bureau van Dijk to ensure cross-country comparability. The companies are included in the database based on the availability of financial data, or firm size if financial data are not available. Financial information is gathered from all available official sources.

The summary statistics of the main variables are given in Table 3.1. All firm-specific variables except AGE and SIZE are scaled by total assets.

		Mean	Standard deviation	Min	Max
TODEBT	total debt to total assets ratio	0.51	0.30	0	1
SHLOAN	short-term bank loans to total assets ratio	0.04	0.11	0	1
SHTRADE	short-term trade credit to total assets ratio	0.12	0.20	0	1
LDEBT	long-term debt to total assets ratio	0.05	0.15	0	1
SIZE	log of total assets	15.8	2.2	7	25
AGE	age of firm	8.3	4.1	0	15
COLLATERAL	tangible fixed assets to total assets ratio	0.2	0.3	0.0	1.0
PROFIT	EBIT to total assets ratio	0.1	0.4	-19.8	19.2
PRIBOR 3M	3-month PRIBOR	2.6%	1.0%	1.2%	4.1%
ΔGDP	real GDP growth rate	3.4%	3.5%	-4.5%	7.0%

Table 3.1: Summary statistics

Figure 3.3 in Appendix 3.A.1 describes the structure of liabilities averaged across firms for different time periods and for different size and age categories.[7] The results of t-test of differences between means of different debt ratios for different years, size and age categories are also given in Table 3.5 in Appendix 3.A.1. The test results indicate that there are significant differences between means for different categories. The financing of Czech firms, is on average, evenly divided between debt and shareholder funds (Figure 3.3, Panel a). More than three-quarters of the debt financing is of a short-term nature on average: total debt consists mainly of current liabilities, which is made up mostly of trade credit and other current liabilities, while short-term bank loans provide a relatively small proportion of the funds. Just over half of the non-current liabilities are in long-term bank debt. Panel b in Figure 3.3 depicts how the structure of the debt has changed over the last decade. We observe that there was very little variation in the debt structure during 2003-2007, when the share of total debt was slightly larger than that of shareholder funds. However, in 2011 the situation changed somewhat, with shareholder funds having a little more weight than the total debt.

There is heterogeneity of financing regarding the size and age of firms. We divide the sample of firms into three equally numerous groups; in terms of size into small, medium,

[7]In the descriptive part, we compare the top and bottom thirds of size and age, while in the regressions, we use continuous variables for each firm-specific indicator. Also we provide robustness tests where categorized firm specific variables are used instead of continuous variables.

and large, and in terms of age into young, medium, and old. This distinction reveals that small and young firms tend to have more debt and fewer shareholder funds than large and old companies (Figure 3.3, panels c and d). Firms in different size and age categories also differ in terms of maturity of debt: smaller and older firms hold more short-term debt than larger and younger firms, respectively. Larger firms have a higher share of short-term bank loans and trade credit in their current liabilities,[8] while age does not play a crucial role for the maturity of short-term debt.

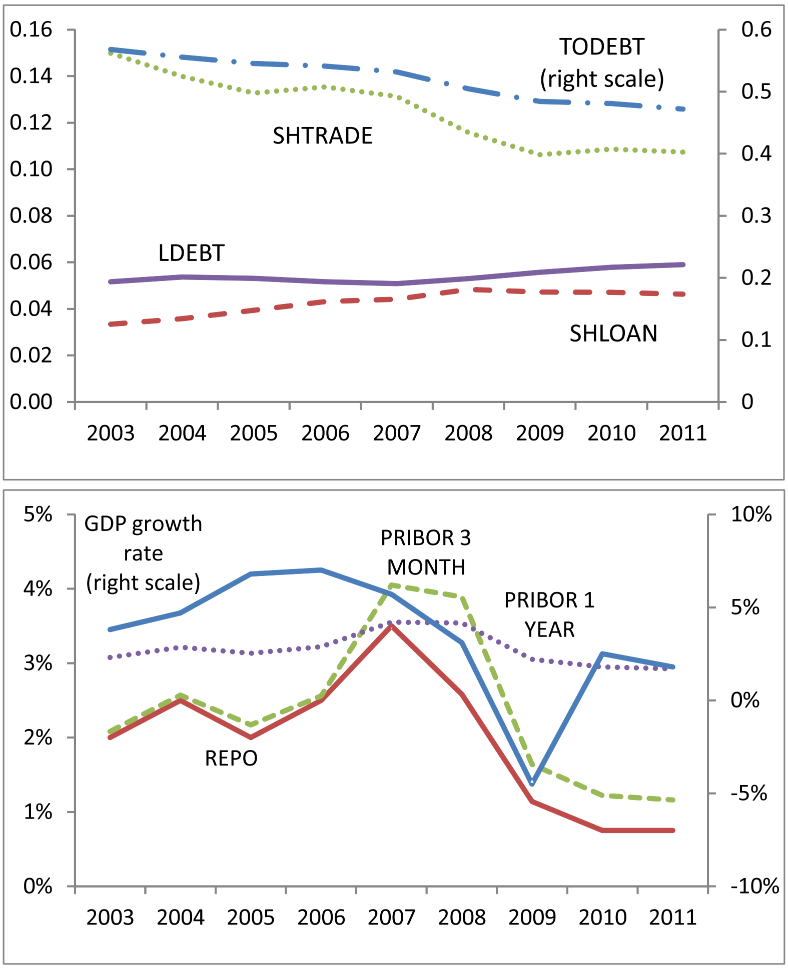

Figure 3.1: Change in the average debt structure and macro variables over time

Next, we describe the evolution of our debt ratios, which are depicted in Figure 3.1. The data reveals that total TODEBT decreased continuously between the beginning and end of the analyzed period, while the decline was more pronounced after 2006. This decline occurred mainly because of a drop in other current liabilities and SHTRADE.

[8]Other current liabilities appear to be quite important for small firms. Unfortunately, the data set does not yield more details about this item. Other current liabilities typically include taxes, payroll, customer advances, rental liabilities.

The variability of LDEBT and SHLOAN was smaller.

In the second graph, we see that the movements in market interest rates traced the changes in monetary policy rates, except for the years affected by the financial crisis, when monetary policy had to be more aggressive to ease the monetary conditions adequately. Since we use market rates in the regressions, we capture the part of the transmission that occurs between money market and client rates, which - in normal times - is a good representation of the transmission of monetary policy rates.

	TODEBT	*SHLOAN*	*SHTRADE*	*LDEBT*	*SIZE*	*AGE*
TODEBT	1.000					
SHLOAN	0.260	1.000				
SHTRADE	0.359	-0.013	1.000			
LDEBT	0.270	-0.047	-0.084	1.000		
SIZE	0.230	0.160	0.295	0.051	1.000	
AGE	-0.144	0.020	-0.021	-0.036	0.202	1.000
COLLATERAL	0.101	0.134	-0.074	0.185	0.309	0.118
PROFIT	-0.042	-0.022	-0.013	-0.037	0.065	-0.031
PRIBOR 3M	0.049	0.000	0.031	-0.015	-0.008	-0.190

Table 3.2: Correlation coefficients

The correlations between the debt ratios and other firm-specific indicators and the interest rate are shown in Table 3.2. TODEBT is positively correlated with all other debt ratios by construction. A positive correlation exists between SIZE and all the debt ratios, though the correlation with long-term debt is weaker. We also observe a negative correlation between AGE and TODEBT. AGE and SIZE are positively correlated, indicating that the older a firm becomes, the more assets it tends to accumulate.[9] PROFIT does not have strong correlations with the other variables. COLLATERAL is positively correlated with both short-term bank loans and long-term debt. The correlations between the 3-month PRIBOR and the debt ratios are negligible.

[9] To test for multicollinearity among the variables we estimate the variance inflation factor (VIF) and the condition index (Table 3.6 in Appendix 3.A.2). Test results indicate the presence of some multicollinearity, which is common in models that include interaction terms. Centering of multiplicative variables solves this problem. The final estimated VIFs are smaller than 10, and the condition index is smaller than 30, which indicates that there is no multicollinearity among the variables used in our analysis.

3.5 Results

In this section, we present our estimation results and findings. The regression results are summarized in Table 3.3, where each column corresponds to one of the four measures of debt. We report the results of the regressions of the financing ratios on market interest rates while controlling for firm specificities, business cycles, and interaction terms between interest rates and firm-specific indicators, which would capture the heterogeneity of responses to monetary policy. While the majority of the explanatory variables have significant effects on the debt ratios, we find some heterogeneity in the reactions to monetary policy.

number of observations	312,366			
number of firms	56,631			
Y_{it}	*TODEBT*	*SHLOAN*	*SHTRADE*	*LDEBT*
	(1)	(2)	(3)	(4)
3 MONTH PRIBOR $_{t-1}$	0.008 ***	0.001 ***	0.0005 *	-0.001 ***
	[0.0009]	[0.0002]	[0.0003]	[0.0005]
SIZE $_{it}$	0.109 ***	0.011 ***	0.035 ***	0.013 ***
	[0.0013]	[0.0004]	[0.0008]	[0.0007]
3 MONTH PRIBOR $_{t-1}$ * *SIZE* $_{it}$	0.0032 ***	0.0004 ***	0.001 ***	0.000 ***
	[0.0001]	[0.0001]	[0.0001]	[0.0001]
AGE $_{it}$	-0.025 ***	0.001 ***	-0.006 ***	-0.002 ***
	[0.0003]	[0.0001]	[0.0002]	[0.0001]
3 MONTH PRIBOR $_{t-1}$ * *AGE* $_{it}$	-0.0016 ***	0.0001 ***	-0.0005 ***	-0.0001
	[0.0001]	[0.0000]	[0.0001]	[0.0001]
COLLATERAL $_{it}$	0.096 ***	0.066 ***	-0.086 ***	0.080 ***
	[0.0051]	[0.0025]	[0.0030]	[0.0036]
3 MONTH PRIBOR $_{t-1}$ * *COLLATERAL* $_{it}$	-0.008 ***	0.004 ***	-0.004 ***	-0.003 ***
	[0.0012]	[0.0007]	[0.0008]	[0.0011]
PROFIT $_{it}$	-0.050 ***	-0.008 ***	-0.016 ***	-0.006 ***
	[0.0031]	[0.0006]	[0.0012]	[0.0008]
3 MONTH PRIBOR $_{t-1}$ * *PROFIT* $_{it}$	0.012 ***	0.001	0.0001	0.0018 ***
	[0.0021]	[0.0004]	[0.0009]	[0.0005]
ΔGDP_t	0.038 ***	0.008 *	0.005	-0.008
	[0.0086]	[0.0043]	[0.0068]	[0.0057]
INTERCEPT	0.698 ***	0.044 ***	0.121 ***	0.053 ***
	[0.0003]	[0.0001]	[0.0002]	[0.0014]
R-squared	0.09	0.03	0.12	0.02

Robust standard errors in parentheses. Significantly different from zero at the 90% (*), 95% (**), and 99% (***) confidence levels.

Table 3.3: Estimation results

First, we describe the main effect of monetary policy and firm specific variables on debt ratios. Since we have interaction terms in the regression model, the coefficients in Table 3.3 cannot be interpreted directly. The pure effects of interest variables are estimated by holding remaining variables at their mean (Table 3.4). According to the interest rate channel, an increase in the price of external financing makes debt financing more expensive, which should be reflected in a decreasing share of debt. In our results, an increase in the lagged short-term interbank rate (3 MONTH PRIBOR) reduces the overall shares of total debt (TODEBT) and long-term debt (LDEBT). However we observe an increase in short-term bank loans (SHLOAN) and a negligible increase in short-term trade credit (SHTRADE). We explain this result by the following argument: loans of short nature are less flexible and are used to meet urgent needs of the firms. Therefore these types of financing do not instantaneously respond to changes in the price of external debt. However firms are not willing to borrow long-term debt at an increased interest rate.

The size and age of a firm are found to be important determinants of debt. For example, our results indicate that larger firms tend to have higher debt ratios than smaller firms, ceteris paribus. Large firms have more power, better contact and reputation. Moreover, greater amounts of information are available for larger firms that are monitored by more traders and professional analysts (Collins et al., 1987). Higher transparency eases access of larger firms to the external sources of financing.

In terms of age, older firms tend to have less total debt, trade credit, and long-term debt, and more short-term bank debt than younger firms do. Presumably, firms, after more years of establishment, use less external financing, especially debts of a long-term nature. However with more years of relations with commercial banks, they can easily access short-term bank loans.

The use of debt is also determined by the firm's COLLATERAL, which is measured as the ratio of tangible fixed assets to total assets. Firms with more collateral tend to have more total, short-term and long-term bank debt, but less trade credit. This would be in line with the hypothesis that - because of better guarantees - this subset of firms can easily access bank debt and therefore is not in need of trade credit.

PROFIT has a negative impact on all debt ratios, meaning that firms with higher earnings use less external financing. This result is reasonable, since more profitable firms may use more of their generated income - which tends to be less expensive - and hence be less dependent on external financing as compared to less profitable firms.

Finally, higher shares of total debt and short-term bank loans coincide with higher GDP growth rates. This result would be in line with the hypothesis that more credit is issued in good times because of better economic prospects and higher profitability of investment perceived by both banks and firms. However, according to the results for the long-term bank debt this hypothesis does not hold since GDP growth rate has an insignificant coefficient for this debt ratio.

	TODEBT	*SHLOAN*	*SHTRADE*	*LDEBT*
3 MONTH PRIBOR $_{t-1}$	-0.006	0.001	0.0005	-0.002
SIZE $_{it}$	0.109	0.011	0.035	0.013
AGE $_{it}$	-0.025	0.001	-0.006	-0.002
COLLATERAL $_{it}$	0.096	0.066	-0.086	0.080
PROFIT $_{it}$	-0.050	-0.008	-0.016	-0.006

Table 3.4: Main effects

We have to note that according to our econometric model the effect of interest rate cannot be studied independently. As we mentioned above, there are firm specific parameters that influence how interest rate affects the financing decisions of the firms. To analyze how firms respond to changes in interest rate depending on their characteristics, we focus on the interaction terms between the interest rate and firm specific characteristics. The marginal effects of PRIBOR_3M on debt ratios for different firm specific parameters are summarized in Figure 3.2.

As we can see, smaller firms decrease and larger firms increase their external financing in response to monetary contraction. This effect is more pronounced for total debt and weaker for other external debt measures. Small firms may be more informationally opaque and therefore more likely to be sensitive to external debt price changes compared to large firms. This argument is supported by Pospíšil and Schwarz (2014), who find that small and medium-sized Czech firms are sensitive to external debt, which is not the case for larger companies. Observed diverse responses can be explained by the supply-side effects: the interest rate is high when the economy is growing and there is excess demand for credit. In this situation large companies are less financially constrained and can access bank credit more easily to finance their expansion. In contrast, small firms are more financially constrained and should decrease the share of external debt in financing their investments.

Surprisingly, age works in the reverse direction: total debt and short-term trade credit decreases for older firms and increases for younger firms if the interest rate is rising. On average younger firms do not change the share of short-term bank loans, though older firms increase their short-term bank borrowing in response to monetary contraction. We also observe a decrease in long-term debt among both groups, hence this decrease is stronger for older firms. One explanation could be the fact that older firms are relatively mature and are not as in need of external financing as younger firms.

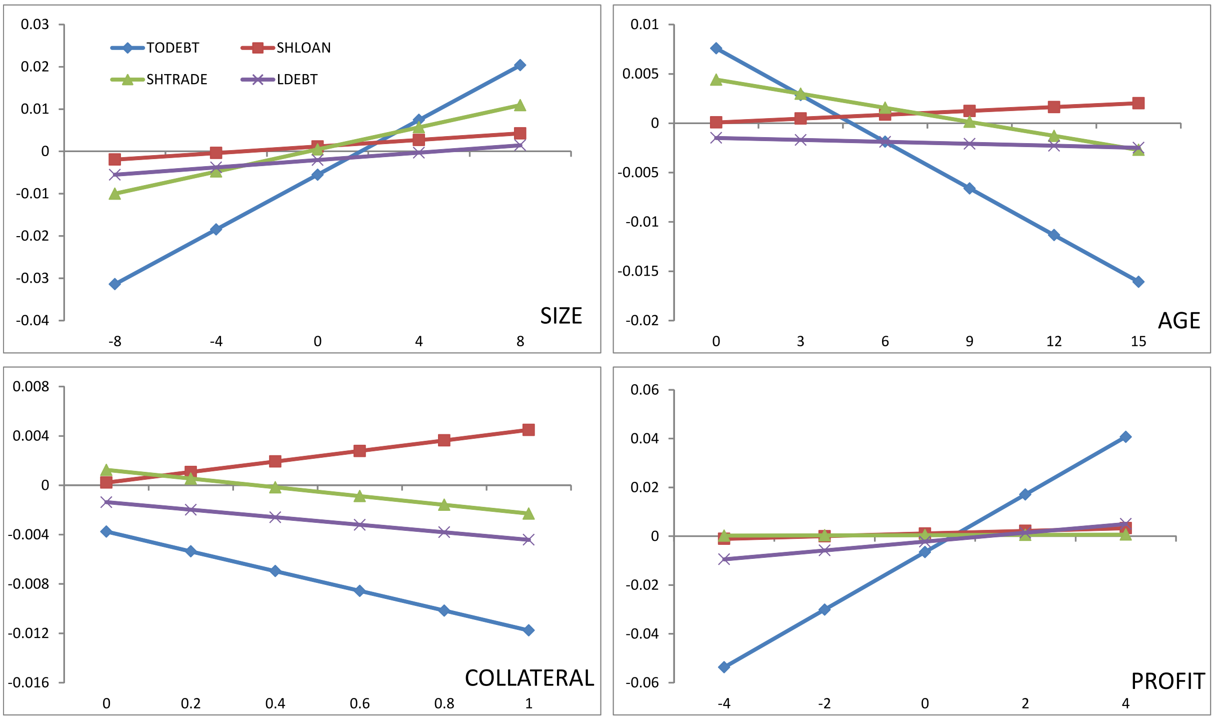

Figure 3.2: The effect of 3 MONTH PRIBOR on different external financing decisions for different firm specific characteristics

The data also reveal that during a monetary tightening, more collateralized firms reduce their total debt and long-term bank credit more than less collateralized ones do. The effect of monetary contraction on short-term debt is trivial for less collateralized firms. In contrast firms with more collateral decrease short-term trade credit and increase short-term bank loans if the interest rate rises. More collateral means better backing of debt and therefore higher credibility among banks. In other words, highly collateralized firms, which have better access to short-term bank debt, may be more flexible in shifting from long-term to short-term debt during periods of expensive money.

Profit has a similar effect on monetary transmission to size: firms that generate positive profit increase and those that operate with loss decrease their external financing in response to a monetary tightening. The effect is stronger for total debt and weaker for other external debt measures. The explanation for this finding could be similar to the one provided for the size effect.

3.5.1 Robustness Checks

In this subsection we provide three robustness tests by using longer term interest rates for monetary policy, by including the available data for the year 2012 and by categorizing firm specific characteristics. The outcomes of the tests are provided in Appendix 3.A.3. In general, our previous findings are robust to these tests, although there are some interesting differences vis-à-vis our baseline model.

Three month interbank rates are more commonly used in the literature as a measure of short-term interest rate, since these rates more accurately reflect the monetary conditions. However, in order to check the robustness of our results we re-estimate them by using a longer term interest rate, the 1-year PRIBOR instead of the benchmark measure, the 3-month PRIBOR. The 1-year PRIBOR might better capture the pricing of different financing measures (e.g. short-term bank loans) of the firms. As we can see, the results are qualitatively identical to our previous estimates (Table 3.7 and Figure 3.4 in Appendix 3.A.3).

In our benchmark regressions, we excluded the year 2012 due to missing data for about half of the firms. We do have a significant chunk of data for 2012 (about 22,000 observations, or 7% of the total), but we did not include it in our baseline estimation because of concerns about sample selection bias. If we include the year 2012, the results do not significantly differ from those where it is excluded (Table 3.8 and Figure 3.5 in Appendix 3.A.3).

Finally, instead of continuous variables we use dummy variables to capture the effects of firm specific variables. Sometimes this method is used to obtain more straightforward interpretations for the estimation results. We categorize the firm-specific variables into three groups: the top 33 percent, the middle 33 percent, and the top 33 percent. The distribution of each firm-specific variable (Figure 3.7) and the categorization criteria, i.e., the cutpoints between groups (Table 3.10) are given in Appendix 3.A.4. The regression results with dummy variables are summarized in Table 3.9 and in Figure 3.6 in Appendix 3.A.3.

If we compare Figure 3.2 with Figure 3.6 we can see that the relative trends for different firm specific characteristics are identical. However we observe differences in the relative effects. For instance, when we use dummies, large firms also decrease their long-term debt in response to monetary tightening, though this decrease is smaller compared to small firms. Everything else is almost identical to the case where a continuous size variable is used. In terms of age, now both age categories increase their total debt and short-term trade credit ratios when interest rate rises. However this increase is smaller for old firms. Firms with low collateral increase and those with high collateral decrease total debt ratio if the cost of borrowing is rising. The effect of profit on monetary transmission is not changed substantially when profit dummies are used.

3.6 Conclusion

In this study we look for evidence of balance sheet, bank lending, and relationship channels of monetary policy transmission in the Czech Republic. We concentrate on the heterogeneous response of firms' financing decisions to monetary shocks depending on their size, age, collateral, and profit. We use the Amadeus firm-level database from Bureau van Dijk and our sample contains financial and other yearly data for about 57,000 firms over the 2003-2011 period.

The data show that - for Czech firms - the firms' own capital makes up on average about one half of total liabilities and that financial loans account for about 20 percent of liabilities.[10] The share of shareholder funds in total liabilities increased from 48.1% to 52.3% during 2003-2011. About 16-18 percent of the total liabilities of Czech firms are in the form of trade credit.

Our regression results indicate that a monetary contraction leads to a reduction in the shares of total debt and long-term debt and an increase in the shares of short-term bank loans and trade credit. We also confirm that the size, age, collateral, and profitability of a firm are important determinants of debt. For example, larger firms tend to have higher debt ratios than smaller firms, ceteris paribus. In terms of age, older firms tend to have less total debt, trade credit, and long-term debt, and more short-term bank debt than younger firms do. Firms with more collateral tend to have more total, short-term and long-term bank debt, but less trade credit. The profitability of a firm has a negative impact on all debt ratios, meaning that firms with higher earnings use less external

[10] This is confirmed by aggregate information from the Quarterly Financial Accounts, a statistical system produced by the Czech National Bank which records the financial relationships within the economy.

financing.

Our main finding is that smaller and less profitable firms are affected more by a monetary contraction compared to larger and more profitable firms. Specifically, smaller and less profitable firms reduce their external financing, while larger and more profitable firms increase their external financing during periods of tight monetary policy. The data also show that higher interest rates lead to an increase of total debt among young firms and a decrease among old firms. We also find that more collateralized firms increase their short-term bank credit and reduce short-term trade credit when the interest rate rises. Total debt and long-term debt decreases for all firms, while this decrease is higher for more collateralized firms.

The evidence of the heterogeneity of reactions to interest rate changes, depending on firm's size, age, and balance sheet positions, indicates the presence of informational frictions in the markets for firm financing in the Czech Republic. The heterogeneous response of firms with different balance sheet positions points to the existence of a balance sheet channel in the Czech Republic. The varying response of small firms observed, which are more dependent on external financing, versus large firms, which are less dependent on external financing, may be an indirect indicator of the existence of a bank lending channel, with the caveat that we do not control for the supply of loans. In general all these findings provide some evidence of broad credit channels in the Czech Republic.

3.7 References

Acharya, V., Naqvi, H., 2012. The Seeds of a Crisis: A Theory of Bank Liquidity and Risk-Taking over the Business Cycle. Journal of Financial Economics, 106 (2): 349-366.

Arellano, M., Bond, S., 1991. Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. Review of Economic Studies, 58: 277-297.

Bernanke, B., Gertler, M., 1995. Inside the Black Box: The Credit Channel of Monetary Policy Transmission. Journal of Economic Perspectives, 9 (4): 27-48.

Boot, A. W. A., 2000. Relationship Lending: What Do We Know? Journal of Financial Intermediation, 9: 7-25.

Bougheas, S., Mizen, P., Yalcin, C., 2006. Access to External Finance: Theory and Evidence on the Impact of Monetary Policy and Firm-Specific Characteristics. Journal of Banking and Finance, 30: 199-227.

Collins, D. W., Kothari, S. P., Rayburn, J. D., 1987. Firm Size and the Information Content of Prices with Respect to Earnings. Journal of Accounting and Economics, 9: 111-138.

Ciccarelli, M., Maddaloni, A., Peydró J-L., 2010. Trusting the Bankers: A New Look at the Credit Channel of Monetary Policy. ECB Working Paper Series, No. 1228.

CNB, (2011): Analyses of the Czech Republic's Current Economic Alignment with the Euro Area, http://www.cnb.cz/miranda2/export/sites/www.cnb.cz/en/monetary_policy /strategic_documents/download/analyses_of_alignment_2011.pdf.

Crespo-Cuaresma, J., Égert, B., Reininger, T., 2007. Interest Rate Pass-Through in Central and Eastern Europe: Reborn from Ashes Merely to Pass Away? Journal of Policy Modeling, 29: 209-225.

De Haan L., Sterken, E., 2000. Capital Structure, Corporate Governance, and Monetary Policy: Firm-Level Evidence for the Euro Area. De Nederlandsche Bank, Research Memorandum WO&E No. 637.

De Haan L., Sterken, E., 2006. The Impact of Monetary Policy on the Financing Behaviour of Firms in the Euro Area and the UK. European Journal of Finance, 12 (5): 401-420.

Dell'Ariccia, G., Marquez, R., 2006. Lending Booms and Lending Standards. The Journal of Finance, LXI (5): 2511-2546.

Égert, B., 2009. Monetary Transmission Mechanisms in Central and Eastern Europe:

Surveying the Surveyable. Journal of Economic Surveys, 23(2): 277-327.

Elsas, R., 2005. Empirical Determinants of Relationship Lending. Journal of Financial Intermediation, 14: 32-57.

Elsas, R., Krahnen, J. P., 1998. Is Relationship Lending Special? Evidence from Credit Files in Germany. Journal of Banking and Finance, 22: 1283-1316.

Fidrmuc, J., HorvĂˇth, R., Horváthová, E., 2010. Corporate Interest Rates and the Financial Accelerator in the Czech Republic. Emerging Markets Finance and Trade, 46(4): 41-54.

Geršl, A., Jakubík, P., 2010. Relationship Lending in the Czech Republic. Comparative Economic Studies, 53(4): 575-596.

Gertler, M., Gilchrist, S., 1994. Monetary Policy, Business Cycles, and the Behavior of Small Manufacturing Firms. Quarterly Journal of Economics, 109 (2): 309-340.

Harhoff, D., Korting, T., 1998. Lending Relationships in Germany: Empirical Evidence from Survey Data. Journal of Banking and Finance, 22: 1317-1353.

Horváth, R., 2006. Financial Accelerator Effects in the Balance Sheets of Czech Firms. MPRA Paper No. 829.

Horváth, R., 2009. The Determinants of Interest Rate Margins. Czech Journal of Economics and Finance, 59(2): 128-136.

Horváth, R., Podpiera, A., 2012. Heterogeneity in Bank Pricing Policies: The Czech Evidence. Economic Systems, 36 (1): 87-108.

Jiménez, G., Ongena, S., Peydró, J-L., Saurina, J., 2012. Credit Supply and Monetary Policy: Identifying the Bank Balance-Sheet Channel with Loan Applications. American Economic Review, 102(5): 2301-26.

Kashyap, A. K., Stein, J. C., Wilcox, D W, 1993. Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance. American Economic Review, 83 (1): 78-98.

Kashyap, A. K., Stein, J. C., and Wilcox, D. W., 1996. Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance: Reply, American Economic Review, 86 (1): 310-314.

Matousek, R., Sarantis, N., 2009. The Bank Lending Channel and Monetary Transmission in Central and Eastern European Countries. Journal of Comparative Economics, 37 (2): 321-334.

Mizen, P., Yalcin, C., 2002. Corporate Finance When Monetary Policy Tightens. University of Nottingham Working Paper No. 03-1.

Oliner, S. D., Rudebusch, G. D., 1996a. Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance: Comment. American Economic Review, 86 (1): 300-309.

Oliner, S. D., Rudebusch, G. D., 1996b. Is There a Broad Credit Channel for Monetary Policy? FRBSF Economic Review, Number 1.

Petersen, M. A., Rajan, R. G., 1994. The Benefits of Lending Relationships: Evidence from Small Business Data. Journal of Finance, 49: 3-37.

Petersen, M. A., Rajan, R. G., 1997. Trade Credit: Theories and Evidence. The Review of Financial Studies, 10(3): 661-691.

Pospíšil, M., Schwarz, J., 2014. Bankruptcy, Investment, and Financial Constraints: Evidence from a Post-Transition Economy. CNB Working Paper 1/2014.

Prasad, A., Ghosh, S., 2005. Monetary Policy and Corporate Behavior in India, IMF WP/05/25.

Pruteanu-Podpiera, A. M., 2007. The Role of Banks in the Czech Monetary Policy Transmission Mechanism. Economics of Transition, 15 (2): 393-428.

Sørensen, C. K., Werner, T., 2006. Bank Interest Rate Pass-Through in the Euro Area: A Cross Country Comparison. ECB Working Paper Series, No. 580.

3.A Appendix

3.A.1 Structure of Liabilities

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
r_t~2003	17490	.5679598	.0022351	.2955968	.5635787	.5723409
r_t~2011	37913	.4718966	.0015682	.3053457	.4688229	.4749703
combined	55403	.5022225	.0012982	.305579	.4996779	.5047671
diff		.0960631	.0027632		.0906472	.1014791

diff = mean(r_tdta_2003) - mean(r_tdta_2011)   t = 34.7647
Ho: diff = 0   degrees of freedom = 55401

Ha: diff < 0   Ha: diff != 0   Ha: diff > 0
Pr(T < t) = 1.0000   Pr(|T| > |t|) = 0.0000   Pr(T > t) = 0.0000

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
r_c~2003	17490	.1498956	.0017079	.225872	.146548	.1532433
r_c~2011	37913	.1074108	.000906	.1764135	.105635	.1091866
combined	55403	.1208227	.0008259	.1944014	.1192039	.1224415
diff		.0424848	.0017678		.03902	.0459497

diff = mean(r_credta_2003) - mean(r_credta_2011)   t = 24.0328
Ho: diff = 0   degrees of freedom = 55401

Ha: diff < 0   Ha: diff != 0   Ha: diff > 0
Pr(T < t) = 1.0000   Pr(|T| > |t|) = 0.0000   Pr(T > t) = 0.0000

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
r_l~2003	17490	.0333791	.0006953	.0919539	.0320162	.034742
r_l~2011	37913	.0463875	.0005467	.1064402	.0453161	.047459
combined	55403	.0422809	.0004345	.1022674	.0414293	.0431325
diff		-.0130084	.0009332		-.0148374	-.0111794

diff = mean(r_loanta_2003) - mean(r_loanta_2011)   t = -13.9401
Ho: diff = 0   degrees of freedom = 55401

Ha: diff < 0   Ha: diff != 0   Ha: diff > 0
Pr(T < t) = 0.0000   Pr(|T| > |t|) = 0.0000   Pr(T > t) = 1.0000

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
r_ltdt~3	17490	.051639	.0011091	.1466823	.0494649	.053813
r_ltdt~1	37913	.0589831	.0008084	.1574	.0573986	.0605675
combined	55403	.0566646	.0006548	.1541336	.0553812	.0579481
diff		-.0073441	.0014086		-.0101049	-.0045834

diff = mean(r_ltdta_2003) - mean(r_ltdta_2011)   t = -5.2140
Ho: diff = 0   degrees of freedom = 55401

Ha: diff < 0   Ha: diff != 0   Ha: diff > 0
Pr(T < t) = 0.0000   Pr(|T| > |t|) = 0.0000   Pr(T > t) = 1.0000

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
r_tdta~l	104140	.4222899	.0010324	.3331479	.4202665	.4243133
r_tdta~e	104124	.5395972	.0008357	.2696753	.5379592	.5412352
combined	208264	.480939	.0006764	.3087028	.4796132	.4822648
diff		-.1173073	.0013283		-.1199106	-.1147039

diff = mean(r_tdta_small) - mean(r_tdta_large)   t = -88.3170
Ho: diff = 0   degrees of freedom = 208262

Ha: diff < 0   Ha: diff != 0   Ha: diff > 0
Pr(T < t) = 0.0000   Pr(|T| > |t|) = 0.0000   Pr(T > t) = 1.0000

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
r_cred~l	104140	.0508828	.0004396	.1418701	.0500212	.0517445
r_cred~e	104124	.1919968	.0006356	.2050887	.1907511	.1932425
combined	208264	.1214344	.0004162	.1899251	.1206187	.1222501
diff		-.141114	.0007728		-.1426286	-.1395993

diff = mean(r_credta_small) - mean(r_credta_large)   t = -1.8e+02
Ho: diff = 0   degrees of freedom = 208262

Ha: diff < 0   Ha: diff != 0   Ha: diff > 0
Pr(T < t) = 0.0000   Pr(|T| > |t|) = 0.0000   Pr(T > t) = 1.0000

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
r_loan~l	104140	.024063	.0002849	.0919393	.0235046	.0246214
r_loan~e	104124	.0601947	.0003367	.108643	.0595348	.0608546
combined	208264	.0421274	.000224	.1022461	.0416883	.0425666
diff		-.0361317	.000441		-.0369961	-.0352673

diff = mean(r_loanta_small) - mean(r_loanta_large)   t = -81.9228
Ho: diff = 0   degrees of freedom = 208262

Ha: diff < 0   Ha: diff != 0   Ha: diff > 0
Pr(T < t) = 0.0000   Pr(|T| > |t|) = 0.0000   Pr(T > t) = 1.0000

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
r_ltdt~l	104140	.0460761	.0004812	.1552751	.045133	.0470192
r_ltdt~e	104124	.0579658	.0004271	.1378296	.0571286	.058803
combined	208264	.0520205	.000322	.1469323	.0513895	.0526515
diff		-.0118897	.0006434		-.0131508	-.0106286

diff = mean(r_ltdta_small) - mean(r_ltdta_large)   t = -18.4793
Ho: diff = 0   degrees of freedom = 208262

Ha: diff < 0   Ha: diff != 0   Ha: diff > 0
Pr(T < t) = 0.0000   Pr(|T| > |t|) = 0.0000   Pr(T > t) = 1.0000

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
r_tdta~g	126860	.5579752	.0008749	.3116307	.5562603	.5596901
r_tdta~d	80323	.4506497	.0010385	.2943126	.4486143	.452685
combined	207183	.5163661	.0006799	.3094823	.5150334	.5176987
diff		.1073255	.0013754		.1046297	.1100214

diff = mean(r_tdta_young) - mean(r_tdta_old)   t = 78.0299
Ho: diff = 0   degrees of freedom = 207181

Ha: diff < 0   Ha: diff != 0   Ha: diff > 0
Pr(T < t) = 1.0000   Pr(|T| > |t|) = 0.0000   Pr(T > t) = 0.0000

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
r_cred~g	126860	.1250684	.0006028	.2146912	.123887	.1262498
r_cred~d	80323	.1096197	.000596	.1689213	.1084515	.1107879
combined	207183	.1190791	.0004358	.1983476	.118225	.1199332
diff		.0154487	.0008937		.013697	.0172004

diff = mean(r_credta_young) - mean(r_credta_old)   t = 17.2855
Ho: diff = 0   degrees of freedom = 207181

Ha: diff < 0   Ha: diff != 0   Ha: diff > 0
Pr(T < t) = 1.0000   Pr(|T| > |t|) = 0.0000   Pr(T > t) = 0.0000

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
r_loan~g	126860	.0424174	.0003069	.1093068	.0418159	.0430189
r_loan~d	80323	.0453844	.0003612	.1023613	.0446765	.0460923
combined	207183	.0435677	.0002344	.1066773	.0431083	.044027
diff		-.002967	.000481		-.0039097	-.0020243

diff = mean(r_loanta_young) - mean(r_loanta_old)   t = -6.1686
Ho: diff = 0   degrees of freedom = 207181

Ha: diff < 0   Ha: diff != 0   Ha: diff > 0
Pr(T < t) = 0.0000   Pr(|T| > |t|) = 0.0000   Pr(T > t) = 1.0000

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
r_ltdt~g	126860	.0605638	.0004687	.1669397	.0596452	.0614825
r_ltdt~d	80323	.0493948	.0004881	.1383221	.0484382	.0503514
combined	207183	.0562337	.000344	.1565616	.0555595	.0569078
diff		.011169	.0007055		.0097862	.0125519

diff = mean(r_ltdta_young) - mean(r_ltdta_old)   t = 15.8306
Ho: diff = 0   degrees of freedom = 207181

Ha: diff < 0   Ha: diff != 0   Ha: diff > 0
Pr(T < t) = 1.0000   Pr(|T| > |t|) = 0.0000   Pr(T > t) = 0.0000

Table 3.5: T-test of differences between means of different debt ratios for different years, size and age categories

Figure 3.3: Average structure of liabilities

3.A.2 Testing for Multicollinearity

Variable	VIF	SQRT VIF	Tolerance	R-Squared
pribor_3m0	7.65	2.77	0.13	0.87
size0	1.15	1.07	0.87	0.13
size0_pribor3m0	1.15	1.07	0.87	0.13
age	1.12	1.06	0.89	0.11
age_pribor3m0	6.13	2.48	0.16	0.84
r_tfas	1.12	1.06	0.90	0.10
r_tfas_pribor3m0	1.92	1.39	0.52	0.48
r_ebit	1.01	1.01	0.99	0.01
r_ebit_pribor3m0	1.07	1.03	0.94	0.06
r_gdp_gl	2.14	1.46	0.47	0.53

	Eigenval	Cond Index
1	3.1	1.0
2	2.7	1.1
3	1.1	1.7
4	1.0	1.7
5	1.0	1.8
6	0.9	1.9
7	0.4	2.8
8	0.4	2.8
9	0.2	3.9
10	0.1	5.9
11	0.1	6.9
Condition Number	6.9	
Eigenvalues & Cond Index computed from scaled raw sscp (w/ intercept)		
Det(correlation matrix)		0.0309

Table 3.6: Collinearity diagnostics

3.A.3 Robustness Tests

number of observations	312,366			
number of firms	56,631			
Y_{it}	*TODEBT*	*SHLOAN*	*SHTRADE*	*LDEBT*
	(1)	(2)	(3)	(4)
1 YEAR PRIBOR $_{t-1}$	0.008 ***	-0.001 *	0.005 ***	-0.001 **
	(0.0010)	(0.0004)	(0.0007)	(0.0006)
SIZE $_{it}$	0.109 ***	0.011 ***	0.035 ***	0.013 ***
	(0.0013)	(0.0004)	(0.0008)	(0.0007)
1 YEAR PRIBOR $_{t-1}$ * *SIZE* $_{it}$	0.0034 ***	0.0004 ***	0.0014 ***	0.0004 ***
	(0.0002)	(0.0001)	(0.0001)	(0.0001)
AGE $_{it}$	-0.025 ***	0.001 ***	-0.006 ***	-0.002 ***
	(0.0003)	(0.0001)	(0.0002)	(0.0001)
1 YEAR PRIBOR $_{t-1}$ * *AGE* $_{it}$	-0.0016 ***	0.0001 ***	-0.0005 ***	0.0000
	(0.0001)	(0.0000)	(0.0001)	(0.0001)
COLLATERAL $_{it}$	0.096 ***	0.066 ***	-0.086 ***	0.080 ***
	(0.0051)	(0.0025)	(0.0030)	(0.0036)
1 YEAR PRIBOR $_{t-1}$ * *COLLATERAL* $_{it}$	-0.007 ***	0.005 ***	-0.003 ***	-0.004 ***
	(0.0014)	(0.0008)	(0.0009)	(0.0012)
PROFIT $_{it}$	-0.050 ***	-0.008 ***	-0.016 ***	-0.006 ***
	(0.0031)	(0.0006)	(0.0012)	(0.0008)
1 YEAR PRIBOR $_{t-1}$ * *PROFIT* $_{it}$	0.011 ***	0.000	0.000 ***	0.002 ***
	(0.0023)	(0.0005)	(0.0010)	(0.0006)
ΔGDP_t	0.044 ***	0.007	0.009	-0.007
	(0.0085)	(0.0043)	(0.0067)	(0.0057)
INTERCEPT	0.697 ***	0.019 ***	0.193 ***	0.053 ***
	(0.0025)	(0.0010)	(0.0018)	(0.0014)
R-squared	0.09	0.03	0.12	0.02

Robust standard errors in parentheses. Significantly different from zero at the 90% (*), 95% (**), and 99% (***) confidence levels.

Table 3.7: Estimation results: with 1 YEAR PRIBOR

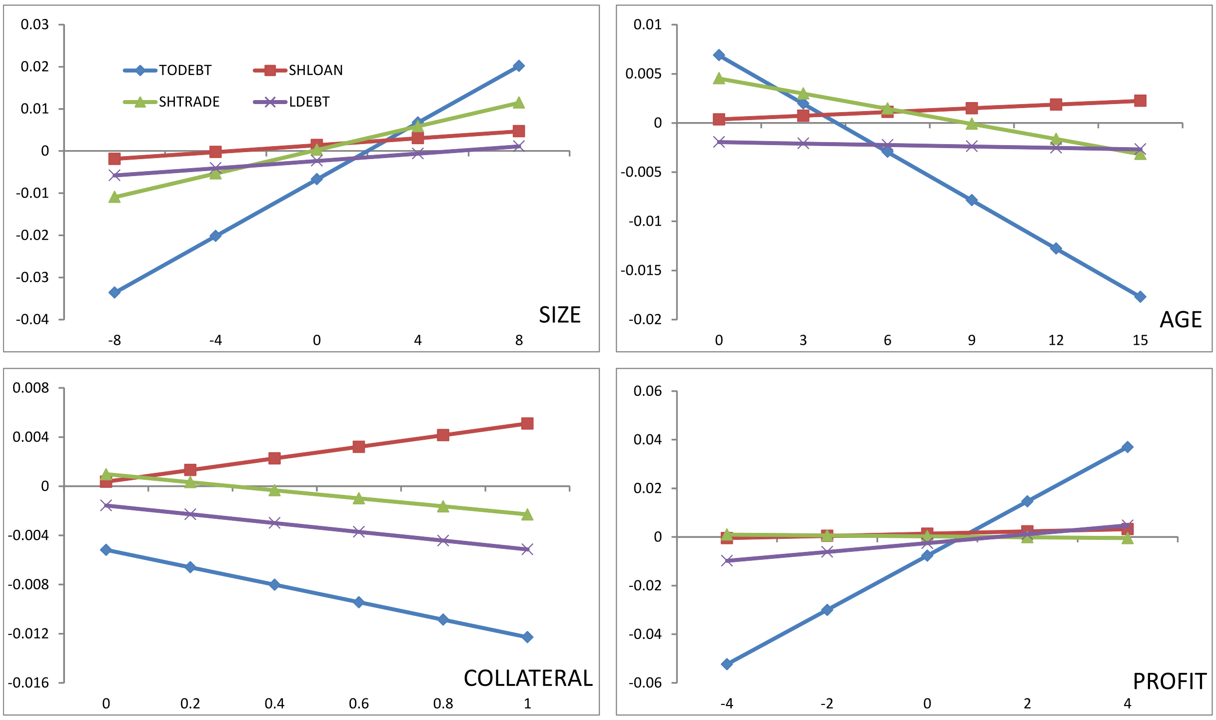

Figure 3.4: The effect of 1 YEAR PRIBOR on different external financing decisions for different firm specific characteristics

number of observations	334,737			
number of firms	56,816			
Y_{it}	*TODEBT*	*SHLOAN*	*SHTRADE*	*LDEBT*
	(1)	(2)	(3)	(4)
3 MONTH PRIBOR $_{t-1}$	0.010 ***	-0.001 **	0.006 ***	-0.001 ***
	(0.0009)	(0.0004)	(0.0006)	(0.0005)
SIZE $_{it}$	0.107 ***	0.011 ***	0.034 ***	0.013 ***
	(0.0013)	(0.0004)	(0.0008)	(0.0007)
3 MONTH PRIBOR $_{t-1}$ * *SIZE* $_{it}$	0.004 ***	0.000 ***	0.001 ***	0.001 ***
	(0.0002)	(0.0001)	(0.0001)	(0.0001)
AGE $_{it}$	-0.024 ***	0.001 ***	-0.006 ***	-0.002 ***
	(0.0003)	(0.0001)	(0.0002)	(0.0001)
3 MONTH PRIBOR $_{t-1}$ * *AGE* $_{it}$	-0.002 ***	0.000 ***	-0.001 ***	0.000 *
	(0.0001)	(0.0000)	(0.0001)	(0.0001)
COLLATERAL $_{it}$	0.098 ***	0.065 ***	-0.085 ***	0.081 ***
	(0.0049)	(0.0024)	(0.0029)	(0.0035)
3 MONTH PRIBOR $_{t-1}$ * *COLLATERAL* $_{it}$	-0.009 ***	0.005 ***	-0.004 ***	-0.003 ***
	(0.0012)	(0.0007)	(0.0008)	(0.0011)
PROFIT $_{it}$	-0.049 ***	-0.008 ***	-0.015 ***	-0.006 ***
	(0.0029)	(0.0006)	(0.0011)	(0.0007)
3 MONTH PRIBOR $_{t-1}$ * *PROFIT* $_{it}$	0.012 ***	0.001 **	0.000	0.002 ***
	(0.0020)	(0.0004)	(0.0008)	(0.0005)
ΔGDP $_{t}$	0.064 ***	0.003	0.017 ***	0.003
	(0.0088)	(0.0043)	(0.0067)	(0.0058)
INTERCEPT	0.692 ***	0.020 ***	0.191 ***	0.052 ***
	(0.0025)	(0.0010)	(0.0017)	(0.0014)
R-squared	0.09	0.03	0.12	

Robust standard errors in parentheses. Significantly different from zero at the 90% (*), 95% (**), and 99% (***) confidence levels.

Table 3.8: Estimation results: with year 2012

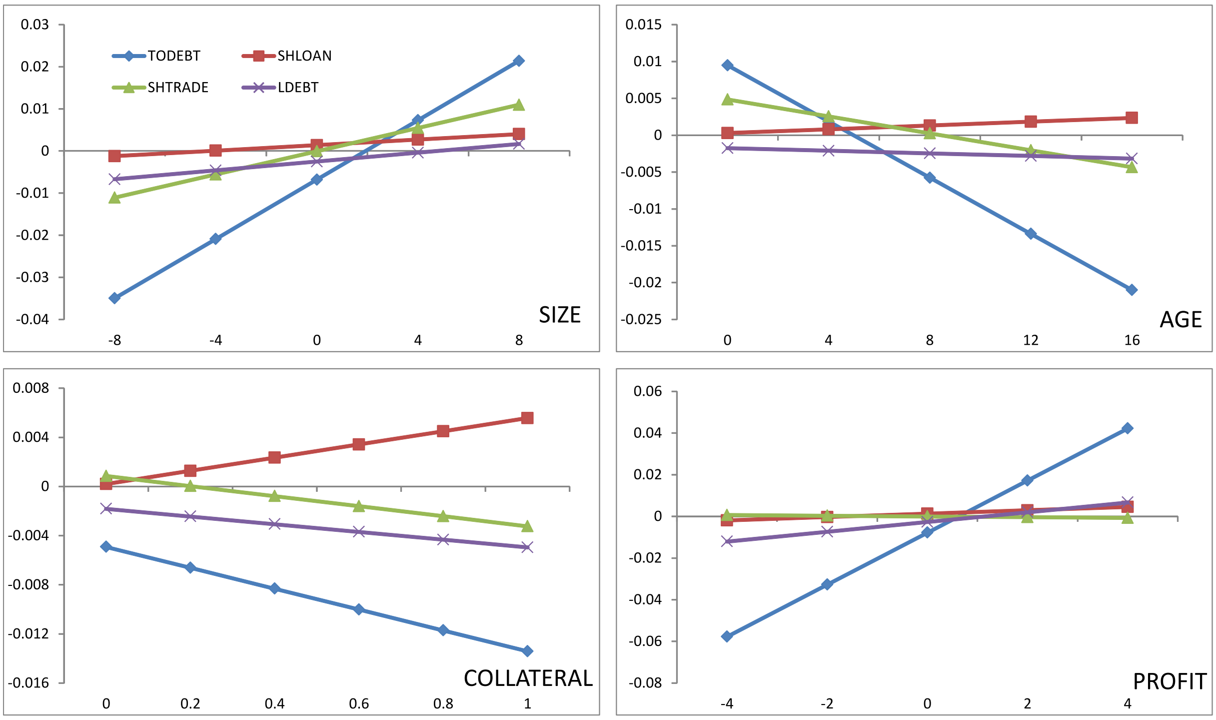

Figure 3.5: The effect of 3 MONTH PRIBOR on different external financing decisions for different firm specific characteristics: with year 2012

number of observations	312,394			
number of firms	56,637			

Y_{it}	TODEBT (1)	SHLOAN (2)	SHTRADE (3)	LDEBT (4)
3 MONTH PRIBOR $_{t-1}$	-0.008 *** (0.001)	-0.001 *** (0.000)	0.001 (0.001)	-0.004 *** (0.001)
SIZE $_{it}^{med}$	0.126 *** (0.003)	0.022 *** (0.001)	0.044 *** (0.002)	0.017 *** (0.002)
3 MONTH PRIBOR $_{t-1}$ * *SIZE* $_{it}^{med}$	0.010 *** (0.001)	0.001 *** (0.000)	0.003 *** (0.001)	0.001 * (0.001)
SIZE $_{it}^{large}$	0.169 *** (0.004)	0.035 *** (0.001)	0.072 *** (0.003)	0.023 *** (0.002)
3 MONTH PRIBOR $_{t-1}$ * *SIZE* $_{it}^{large}$	0.010 *** (0.001)	0.003 *** (0.000)	0.005 *** (0.001)	0.001 ** (0.001)
AGE $_{it}^{med}$	-0.067 *** (0.001)	0.006 *** (0.001)	-0.016 *** (0.001)	-0.006 *** (0.001)
3 MONTH PRIBOR $_{t-1}$ * *AGE* $_{it}^{med}$	-0.011 *** (0.001)	0.001 * (0.000)	-0.003 *** (0.001)	0.000 (0.000)
AGE $_{it}^{old}$	-0.116 *** (0.002)	0.008 *** (0.001)	-0.031 *** (0.001)	-0.008 *** (0.001)
3 MONTH PRIBOR $_{t-1}$ * *AGE* $_{it}^{old}$	-0.003 *** (0.001)	0.000 (0.000)	-0.003 *** (0.001)	0.001 * (0.000)
COLLATERAL $_{it}^{med}$	0.035 *** (0.002)	0.012 *** (0.001)	-0.001 (0.001)	0.012 *** (0.001)
3 MONTH PRIBOR $_{t-1}$ * *COLLATERAL* $_{it}^{med}$	0.001 (0.001)	-0.001 ** (0.000)	0.000 (0.001)	-0.001 (0.000)
COLLATERAL $_{it}^{high}$	0.059 *** (0.003)	0.032 *** (0.001)	-0.023 *** (0.002)	0.031 *** (0.001)
3 MONTH PRIBOR $_{t-1}$ * *COLLATERAL* $_{it}^{high}$	-0.004 *** (0.001)	0.001 *** (0.000)	-0.001 * (0.001)	-0.002 *** (0.001)
PROFIT $_{it}^{med}$	0.004 *** (0.001)	-0.001 (0.000)	0.004 *** (0.001)	-0.003 *** (0.001)
3 MONTH PRIBOR $_{t-1}$ * *PROFIT* $_{it}^{med}$	0.012 *** (0.001)	0.000 (0.000)	0.002 *** (0.001)	0.002 *** (0.000)
PROFIT $_{it}^{high}$	-0.035 *** (0.001)	-0.011 *** (0.000)	-0.007 *** (0.001)	-0.010 *** (0.001)
3 MONTH PRIBOR $_{t-1}$ * *PROFIT* $_{it}^{high}$	0.015 *** (0.001)	0.001 *** (0.000)	0.001 ** (0.001)	0.004 *** (0.000)
ΔGDP $_{t}$	0.204 *** (0.010)	-0.006 (0.004)	0.045 *** (0.007)	0.005 (0.006)
INTERCEPT	0.439 *** (0.003)	0.010 *** (0.001)	0.104 *** (0.002)	0.035 *** (0.001)
R-squared	0.09	0.03	0.11	0.02

Robust standard errors in parentheses. Significantly different from zero at the 90% (*), 95% (**), and 99% (***) confidence levels.

Table 3.9: Estimation results: with categorization

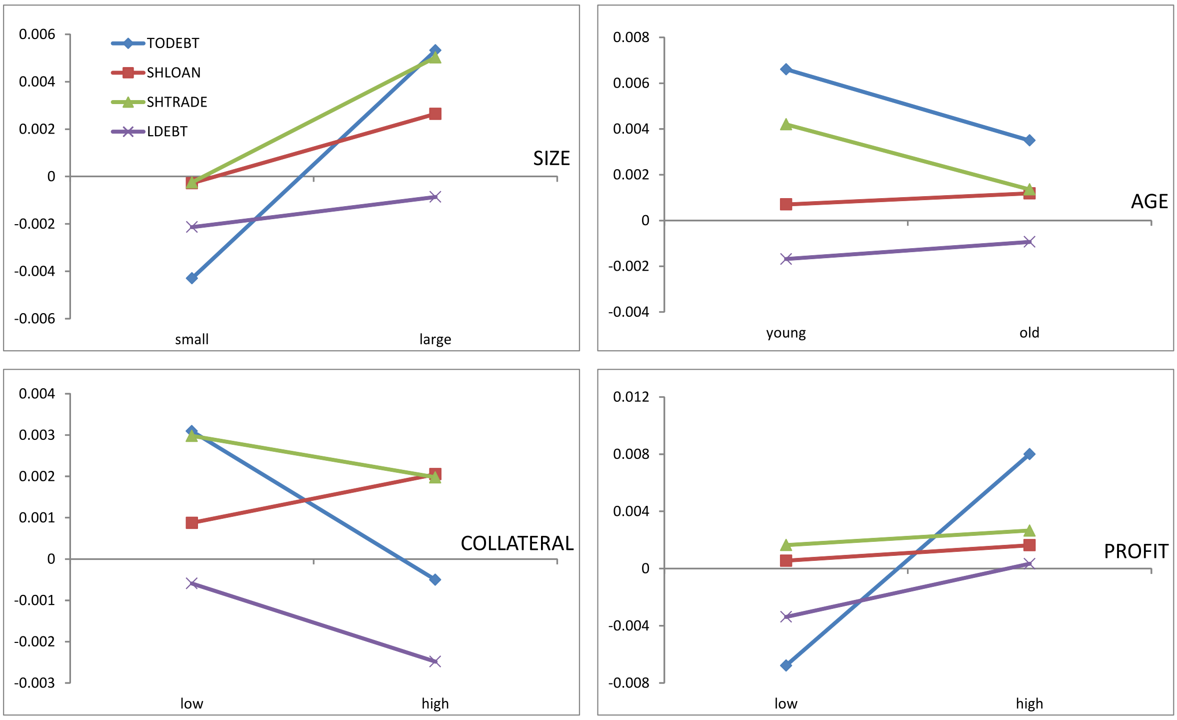

Figure 3.6: The effect of 3 MONTH PRIBOR on different external financing decisions for different firm specific characteristics: with categorization

3.A.4 Categorization Criteria for Firm-specific Variables

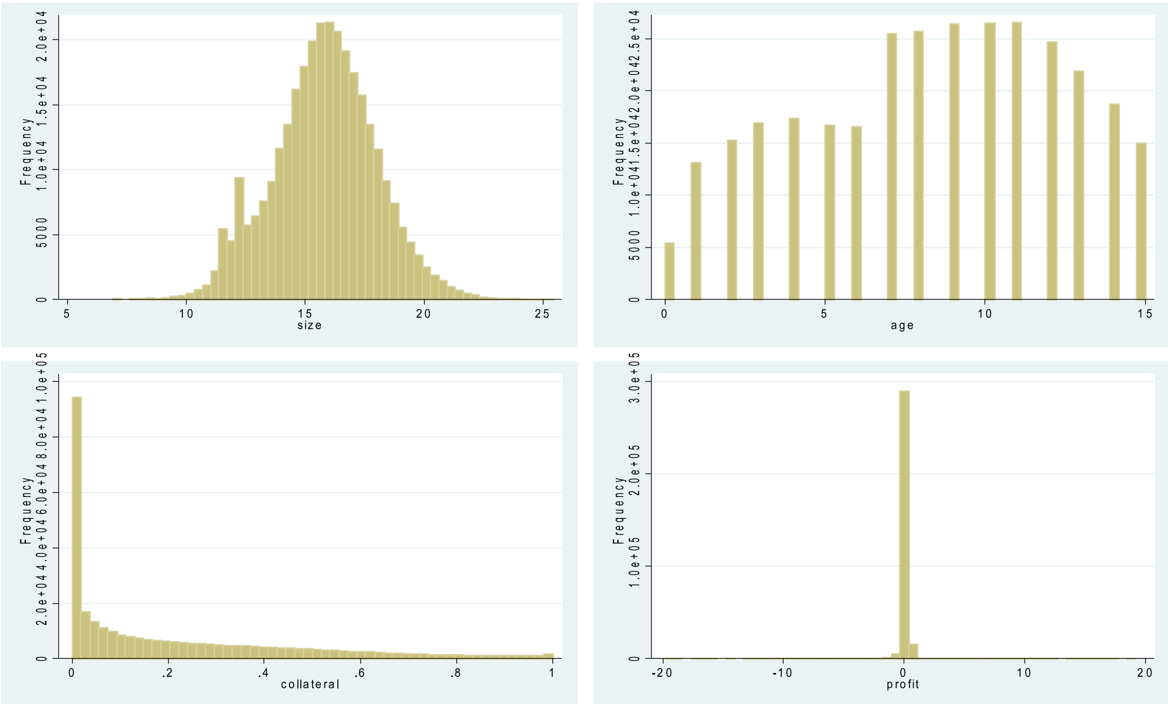

Figure 3.7: Distribution of firm specific variables

Variable	Number of observations	Mean	Standard deviation	Minimum	Maximum
SIZE					
small	104140	13.4	1.2	6.9	15.0
medium	104102	15.8	0.5	15	16.7
large	104124	18.1	1.2	16.7	25.4
AGE					
young	126860	4.1	2.2	0	7
medium	105211	9.5	1.1	8	11
old	80323	13.3	1.1	12	15
COLLATERAL					
low	104131	0.004	0.008	0	0.028
medium	104130	0.126	0.069	0.028	0.265
high	104133	0.528	0.198	0.265	1
PROFIT					
low	104131	-0.091	0.398	-19.840	0.019
medium	104130	0.059	0.025	0.019	0.110
high	104133	0.280	0.376	0.110	19.183

Table 3.10: Categorization criteria and summary statistics for different groups