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Fiscal Policy, Default and Emerging Market Business Cycles

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Abstract

Developing country fiscal policy outcomes documented in data point to stark differences compared with developed ones. Most prominent difference is the excessive volatility of government consumption and transfer payments and their positive correlation relative to output. This seemingly non-optimal behavior is puzzling since it is in contrast with standard theory prescriptions and likely to contribute to aggregate volatility. To study the possible roots of this I build a model by incorporating a detailed explicit fiscal sector to what is otherwise a standard sovereign default setup. The environment I define is one of incomplete markets that resembles small open developing economies with respect to existence of short-maturity non-state contingent defaultable debt as the only tradable asset for the sovereign government and financial frictions on private sector. I use this model to identify the contribution of market incompleteness due to the commitment problem of the sovereign. The findings point that the endogenous state-contingent borrowing constraints that sovereigns face as a result of commitment problem in debt repayment is a major factor in accounting for the pro-cyclicality of transfer payments and excessive relative volatility of transfers and government consumption in these countries. The effect of financial frictions of the type defined as working capital constraint on an imported input combined with debt sensitive private borrowing cost is increased volatility of fiscal policy due to debt loosing its buffer-stock property in smoothing out shocks to fiscal revenues.

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ABSTRACT

FISCAL POLICY, DEFAULT AND EMERGING MARKET BUSINESS CYCLES

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Developing country fiscal policy outcomes documented in data point to stark differences compared with developed ones. Most prominent difference is the excessive volatility of government consumption and transfer payments and their positive correlation relative to output. This seemingly non-optimal behavior is puzzling since it is in contrast with standard theory prescriptions and likely to contribute to aggregate volatility. To study the possible roots of this I build a model by incorporating a detailed explicit fiscal sector to what is otherwise a standard sovereign default setup. The environment I define is one of incomplete markets that resembles small open developing economies with respect to existence of short-maturity non-state contingent defaultable debt as the only tradable asset for the sovereign government and financial frictions on private sector. I use this model to identify the contribution of market incompleteness due to the commitment problem of the sovereign. The findings point that the endogenous state-contingent borrowing constraints that sovereigns face as a result of commitment problem in debt repayment is a major factor in accounting for the pro-cyclicality of transfer payments and excessive relative volatility of transfers and government consumption in these countries. The effect of financial frictions of the type defined as working capital constraint on an imported input combined with debt sensitive private borrowing cost is increased volatility of fiscal policy due to debt loosing its buffer-stock property in smoothing out shocks to fiscal revenues.

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Chapter 1

Introduction

The purpose of this dissertation is to investigate and understand the dynamics and linkage between emerging market business cycles and the conduct of fiscal policy in these small open economies. Developing open economy business cycle dynamics differ in many dimensions compared with their developed counterparts. While business cycles in developing world seem to get smoother over the decades, developing markets still have been experiencing rather large fluctuations. Among other work, Neumeyer and Perri (2005) and Aguiar and Gopinath (2007) find that, on average the volatility of output is twice, volatility of consumption relative to output and volatility of real interest rate is roughly one and a half times more in developing economies respectively. The discrepancy among these two groups of economies is not limited only to private aggregates. Fiscal policy related aggregates as outcome of policy also seem to behave different along the cycle across these countries. Standard theory based normative policy prescriptions, under complete market conditions would call for a stable discretionary government consumption spending, a-cyclical or counter-cyclical

tax rates and counter-cyclical transfer payments, smoothing out the provisions and distortions created in provision of fiscal outlays. This seems to be roughly the case in developed world, on the contrary, in developing countries, cyclical component of government expenditures seem to be excessively volatile and their correlation with output is and positively correlated.[1] My work focuses on the fiscal dimension of these differences and attempts to provide a theory that accounts for them.

In Chapter 2, I begin by providing a description and analysis of fiscal policy aggregates and document the differences in fiscal policy actions and their outcomes between developing and developed economies. I also briefly document the well known facts about the business cycle properties and highlight the dissimilarities. The set of empirical observations that point out the stark differences in terms of documented facts between these economies will lay out the motivation for our work and provide the structure for the quantitative exercises.

In Chapter 3, I investigate the optimal fiscal policy under the option of default for a fiscal authority where the government is the only agent with access to international borrowing. My contribution in this chapter is twofold. First, from an applied point of view I add on to the existing literature by accounting for another important dimension of fiscal policy property akin to less developed economies, that is excessively volatile as well as pro-cyclical fiscal aggregates. My model, calibrated to a typical

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[1] I use the term pro-cyclical fiscal policy to denote positive and high government consumption and transfer expenditure-output correlation for the cyclical component.

emerging market economy, is able to match the pro-cyclical and volatile nature of policy making jointly, not a question addressed in literature before to the best of my knowledge. Second, I provide a framework in which the way government deliver fiscal resources to the private sector potentially matter, both in terms of default incentives and output dynamics, a point not regarded in relevant literature so far. Overall, this chapter highlights the importance of accounting for the functional roles of different government outlays and dynamics of the interaction of government and household budgets investigating the spillovers from government budget constraint to private sector.

In Chapter 4, I look into the interaction of financial frictions faced by private and public sectors in these economies in an effort to provide a framework that would assess the relevance of financial frictions in generating observed outcomes. Financing frictions on firms in the form of working capital constraints has been an important model feature in accounting for emerging market business cycle properties in the literature. Neumeyer and Perri (2005) show that exogenous interest rate shocks that are negatively correlated with country fundamentals combined with these wedges does a good job replicating observed emerging market business cycles. Aguiar and Gopinath (2006b) report similar findings and among other candidates Chang and Fernández (2010)'s Bayesian encompassing model assigns a significant role in terms of likelihood to interest rate shocks and financial frictions jointly to account for the

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documented facts. Evidence reported from many other studies also point out the importance of these wedges from a modeling perspective in matching the excessive business cycle volatility (Aguiar and Gopinath, 2006b; Cicco et al., 2006, among others).

I build a model with endogenous output and interest rate with an explicit fiscal sector providing public consumption and transfers to households financed by income taxation and debt issue. I introduce the financial frictions faced by the private sector in the form of working capital constraint on an imported factor of production. The firms' financing costs for borrowing against this constraint is set as a consequence of government borrowing, that is both public and private sectors face the same borrowing rate determined by government indebtness. In such an environment, we have a dynamic interaction between government's willingness to use debt for public good provision and alleviation of tax distortions, and output. This feature of our model that generate an financial linkage between and distortionary government policy and private sectors does not exist in existing literature. The interaction works from fiscal authorities actions and constraints to factor prices and tax rate private sector face and becomes a source of disturbance on private sector. In particular, difficulties in government's budget constraint, translate into financing difficulties for private sector that has a negative effect on output. The evidence do support such linkages exist not just in times of severe crises but throughout normal times as well in developing

countries (Mendoza and Yue, 2008). To quantitatively asses the importance of this margin, we calibrate basic parameters of our model economy to standard values from the literature when available and estimate a set of them to match certain fiscal policy and aggregate statistics of interest for a typical emerging market economy, Mexico. To measure the contribution of financial frictions, we do a sensitivity analysis of different degrees of parameter controlling friction level, θ on the firms to measure the effect of this margin on behavior of variables of interest. My contribution in this chapter is to provide a framework that highlights this channel in emerging market business cycles and investigate its empirical importance in accounting for the joint excessive volatility of public and private spheres that seems to be a robust feature of these countries.

Chapter 2

Facts and Related Literature

2.1   Facts

The real business cycle literature on small open economies dates back to Mendoza
(1991). In that work, Mendoza investigates the ability of a standard real business
cycle model with small alterations, calibrated to Canada, in replicating the observed
facts. His findings was that to a great extent it did. This however was not to say
the standard model was a success in accounting for business cycles in all small open
economies.

Table 2.1: Business Cycle Moments

Statistic	Developing	Developed
$\sigma(y)$	2.74	1.34
$\frac{\sigma(c)}{\sigma(y)}$	1.45	0.94
$\sigma(r)$	2.32	1.66
$\rho(r,y)$	-0.55	0.20

Source: Aguiar and Gopinath (2007)

As briefly mentioned in Chapter 1 and Table 2.1 clearly shows[2], the observed characteristics of a large class of such economies, namely emerging markets, exhibited very different characteristics than developed ones . The most particular characteristics of these economies that caught attention of researchers was the excess volatility combined with a strong relation between interest rates and output that contradicted the insignificant role of interest rates in earlier models of standard business cycles in small open economies (see Mendoza (1991), and Correia et al. (1995)). These earlier models, as they were defined, lacked the possibility of explaining a fact most emerging market economies had to live with, which is frequent and significant fluctuations in their cost of financing on external borrowing in international markets and its countercyclical nature with their output. For these countries with relatively less developed financial systems and inadequate national saving, external borrowing was and still is an important source of finance for growth. Also excess macroeconomic volatility and considering most of them are in an transitional growth path, access to international borrowing is crucial for consumption smoothing as well. Experience show that trouble for these countries in international financial markets, which appears as capital outflow, usually have real effects. Considerable amount of study has been done on the area to understand the causes, consequences and dynamics of this relationship.

[2]Sample for table 2.1: Developing ; Argentina, Brazil, Ecuador, Israel, Korea, Malaysia, Mexico, Peru, Philippines, Slovak Republic, South Africa, Thailand, Turkey. Developed; Australia, Austria, Belgium, Canada, Denmark, Finland, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland.

The discrepancy among these two groups of economies is not limited only to private aggregates. Fiscal policy related aggregates also seem to behave differently along the cycle across these countries. Gavin and Perotti (1997) was the first one to document and point out these stark differences for Latin American countries. He found out that each component of fiscal layouts was substantially more volatile for the Latin American countries compared with industrialized ones, with the biggest difference being in government consumption and transfer payments. Talvi and Végh (2005) extended these findings in showing that these observations are not only a feature of Latin American countries but also a common thing among developing economies.

Standard normative policy prescriptions would call for a stable discretionary government consumption spending and a-cyclical or counter-cyclical tax rates that would generate a primary fiscal surplus that is somewhat pro-cyclical, smoothing out the provisions and distortions created in conduct of fiscal policy. As summarized in Table 2.2, this seems roughly to be the case in developed world. On the contrary in developing countries, cyclical component of discretionary government consumption and transfer payments are extremely volatile and their response to output seems to be strong, such that resulting primary fiscal surpluses that are not pro-cyclical. Perhaps, what is more striking to observe is as a form of an insurance by the public sector provided to households, one would expect especially the transfer payments to

be counter-cyclical in response to output fluctuations yet this does not seem to be the case for developing world. Transfer payments fluctuates very strongly and seem to follow the pattern of output over time. Suzuki (2010) for a subset of countries reports the volatility ratio of transfer payments to output in developing world in is twice as much in developing world compared with OECD average (2.86 vs. 4.27) and average correlation with output is significantly different (-.18 vs. .20). For the period 1960-2005[3] with annual data, grouping set of 55 countries according per-capita income, we find for the countries below the 60% of highest possible per-capita income (32 countries) the median ratio of government consumption-output volatility is 2.12 and correlation with output is 0.42 whereas for the developed ones (23 countries) the same statistics are 1.55 and 0.12 respectively. The behavior of primary fiscal surpluses also reflects the differences in as an outcome of fiscal policy conduct. For the period of 1988-2001 for 12 OECD countries, I find the average correlation of primary surplus with output is 0.61 as standard optimal policy would suggest. For a sample of 19 developing economies with a varying length of data availability on annual basis between 1970-2001, same statistic is only 0.04 for a set of developing countries. Furthermore, behavior of transfer payments for the two sets of economies differ as well. Talvi and Végh (2005) also find for the period of 1970-94, the correlation of government consumption with output for a set of 20 industrialized countries is 0.17

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[3]With varying individual country data periods.

(-0.02 for the subset of G7) and 0.53 for a set of 36 developing countries. Riascos and Végh (2003) report using annual data, in a sample of 16 developing countries, on average government consumption is 3.22 more volatile than output, whereas this ratio is 1.54 in their developed counterparts. Catao and Sutton (2002),Manesse (2006) and Kaminsky et al. (2004a) report similar results, for different time periods for different subset of countries grouped by their per-capita income level, that point out the same significant difference. Finally, Ilzetzki and Vegh (2008) using an extensive dataset and applying several econometric tests confirm that a developing economy fiscal policies are indeed very procyclical.

Table 2.2: Fiscal Facts

Statistic	Developing	Developed
$\sigma(g)$	3.90	1.83
$\sigma(g)/\sigma(y)$	2.12	1.55
$\sigma(T)/\sigma(y)$	4.27	2.86
$\rho(g,y)$	0.42	0.12
$\rho(ps,y)$	0.04	0.61
$\rho(T,y)$	0.20	-0.18

Source: See Appendix A for data sources and coverage

From the revenue side concerning the tax rates, availability of data is limiting factor for conclusive statements on their cyclical behavior. Kaminsky et al. (2004b) report a negative correlation with output for inflation tax for the non-OECD countries
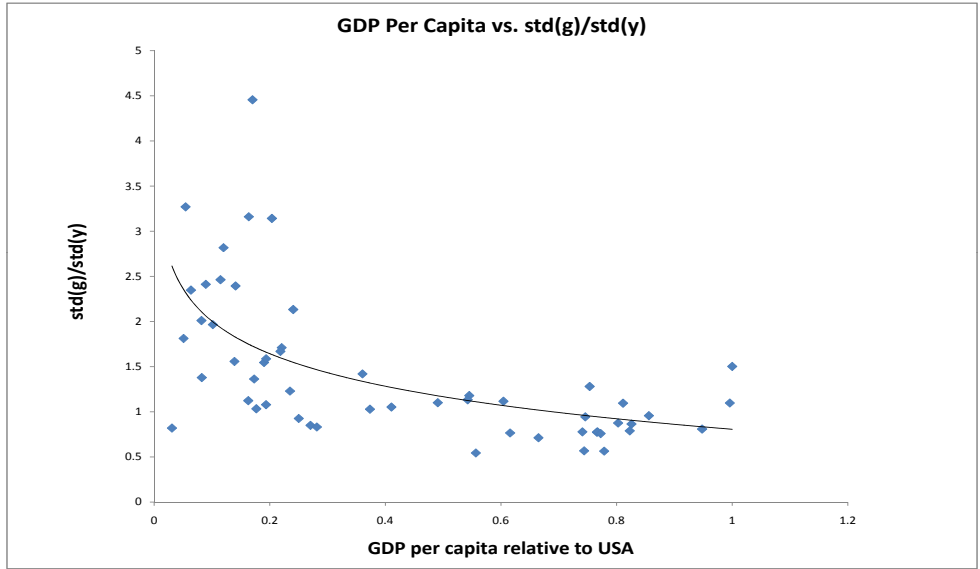
Figure 2.1: GDP per capita vs. Relative Volatility
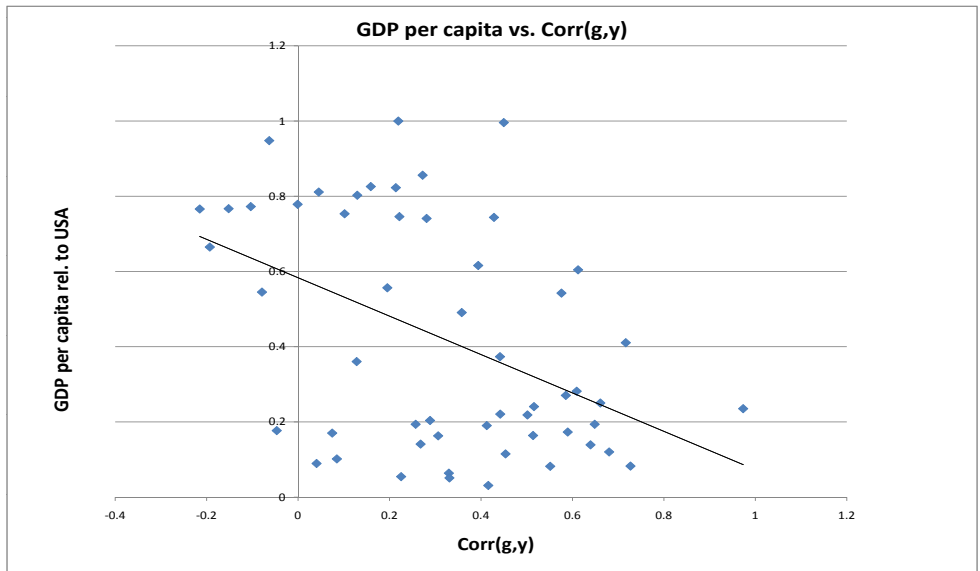
Figure 2.2: GDP per capita vs. Output-Government Consumption Correlation

in their sample, whereas it was positive for OECD members. Mailhos and Sosa (2000) finds for the case of Uruguay between the years 1975-1999 all relevant tax rates were procyclical. Talvi and Végh (2005) provides anecdotal evidence on how both Mexico and Argentina raised taxes to increase revenues in the midst of the crises, furthermore, fiscal austerity programs that involve tax hikes is not an uncommon phenomenon in case of crises for these countries. This again, is in contradiction with orthodox optimal taxation prescriptions.

We know from standard theory of insurance contracts higher risk faced in terms of higher volatility would make access to credit more valuable for the need of consumption smoothing yet Catao and Sutton (2002), in a study on the emerging market international borrowing, show that higher volatility implies lower credit ratings and higher borrowing costs in international markets. From this perspective, regarding the policy induced volatility due to pro-cyclicality of fiscal expenditures standard theory would imply, existing policy making choices seem irrational for these country governments. Understanding the underlying causes of this puzzling behavior is important and is the source of motivation for this study.

2.2   Related Literature

The theoretical part of my research is based on the sovereign default literature that dates back to the work of Eaton and Gersovitz (1981) and the motivation, as mentioned, comes from another literature that focus on fiscal policy peculiarities of developing world. In next two sections, I will briefly cover these recent research agendas to the extent of their connection to my work and identify the place of my work within these two strands of literature. I begin by briefly covering the emerging market business cycle research that flourished recently and have began to utilize the link between sovereign default and business cycle volatility. Then I cover the literature on fiscal policy properties and differences of developing world and research that attempted to provide explanations for them.

2.2.1   Sovereign Default and Emerging Market Business Cycles

The strand of literature that focused on private sector aggregates of emerging markets began with treating the real interest rate movements as exogenous shocks and the driving force of fluctuations in emerging markets (see Neumeyer and Perri (2005), Aguiar and Gopinath (2006b) and Kanczuk (2004) among others). Combining an interest rate wedge that is working on production with exogenous interest rate shocks, output volatility is amplified and models of this sort are able to explain a considerable

share of excess volatility of output and counter-cyclicality of interest rates. Modeling interest rates exogenous, or their relation to country fundamentals ad-hoc at best, could be seen as a shortcoming of this approach. Interest rate combined with productivity shocks partially succeeded in explaining business cycle fluctuations in these economies.

Another branch of recent literature focuses on explaining the volatility of interest rates paid by these countries, taking their excessively volatile output realizations as given (see Arellano (2008), Yue (2009) and Aguiar and Gopinath (2006a) among others). The basic idea, based on seminal work of Eaton and Gersovitz (1981) and on analysis on unsecured consumer default by Chatterjee et al. (2007), combines default incentives of the sovereigns with their finance costs. In these set of studies, the fluctuations in output is transmitted to fluctuations in risk premium the country has to pay, which makes the real interest rate, composed of risk free rate plus the risk premium, volatile. The link between output realizations and interest rate is based on lack of the emerging market sovereign's ability to commit to pay back the loans taken. This inability makes sovereign behave in an opportunistic way, paying back if and only if doing so makes sovereign better of than defaulting. Unlike an usual insurance contract, these models was able to generate higher incentives for default when the output realization is low, thus fluctuations in output is mirrored in real interest rate through default incentives and counter-cyclical dynamics. In these set of

models, the output is exogenous and decision maker, the sovereign, is treated as the sole actor behaving on behalf of the country with respect to borrowing and default choice with only constraint it has to optimize under being the resource constraint. In this respect, this strand of models keep out the output dynamics exogenously in one side and look into primarily on other business cycle aggregates and dynamics instigated by the output dynamics.

Finally Mendoza and Yue (2008) brings together two strands by endogenizing output and interest rates by having defaultable government debt and working capital requirement on firms. The way they make the connection is through their assumption of average firm's inability to borrow in better terms than its sovereign. This combined with the existing frictions in previous models on production decision in form of working capital requirement makes interest rate-output dynamic endogenous in both directions. Their important and critical assumption about the relation between private and public borrowing rates is not without empirical support. Thus sovereign's actions are directly linked with production decisions within this framework and does well accounting for both business cycle and sovereign default dynamics simultaneously. Similar to previous work on the area, Mendoza and Yue (2008) also find that the financing wedge on firms acts as a propagation mechanism in amplifying the productivity shocks and having an important role in generating the excessive volatility and default episodes observed in these countries.

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In Mendoza and Yue (2008), as well as the other mentioned studies of default, government is a passive entity, simply transferring the necessary optimal borrowing to households through non-distortionary lump-sum transfers and economy-wide resource constraint is the only one that matters. The lack of explicit public sector existence with a budget constraint makes the sovereign in these default risk models more like a central planner that coordinates private agent actions. Experience show that default decisions are linked very much to fiscal balances and usually not just the default itself but likelihood of default by the fiscal authority have important implications for country output. Although mostly smaller in terms of size their industrialized counterparts, public sector choices in these economies usually have more effect on the overall performance of the economy. So as we will be more explicit below, while taking the basic framework from this literature, I extend it with an explicit fiscal sector that interacts with household actions, in a way that is likely to generate the observed outcome as a constrained optimal.

2.2.2 Fiscal Policy in Developing Countries

Studies that attempt to explain the seemingly non-optimal fiscal behavior in developing countries can be grouped into two. The first group of these base their explanations in differences of institutions and political structure. Tornell and Lane (1999) provide an explanation along the lines of economics of public goods. They argue that in

economies without strong legal and political institutions that design and allocate public resources, a voracity effect may rise. An increase in public resources in form of fiscal revenues intensifies the competition to get them. Demanding without fully internalizing the taxation cost of the resources, public spending rise disproportionably. Although there is some truth in terms of inefficient allocation of public funds in most of these countries, this is a one-sided explanation at best. Talvi and Végh (2005) offers an explanation that combines the higher volatility of tax bases these countries face and their inability to run fiscal surpluses due to domestic institutional and political factors. The interaction between the ad-hoc convex cost associated with running primary surpluses and the high volatility of the tax base generate procyclical fiscal policy. As a criticism to both of these studies would be, as Gavin and Perotti (1997) documented, the procyclicality is more severe during downturns and government expenditure usually respond to output falls relatively more and a similar voracity effect would intensify the struggle for funds even more during these times and running fiscal surpluses should be even harder politically. All the evidence of recent default or near default episodes in these countries showed, no matter how politically costly it might be, fiscal austerity programs comes into place usually during the worst part of the recession.

Alesina et al. (2008) offers an explanation in a political economy framework by arguing in corrupt democracies procyclical expenditures are a way of minimizing rent

extraction of fiscal authority by the public. The public can observe output but not government debt so when the output is high, they demand higher expenditures and lower taxes to prevent waste of resources by the government, to push the government to its debt limit with a re-election constraint. The consequence is procyclical government spending and counter-cyclical tax rates. The problem with this approach is for the documented evidence for procyclicality is not a property of democratically elected governments only, the time and country coverage of the data pointing this includes non-democratic regimes and periods. Furthermore Thornton (2008) shows within the African countries, procyclicality is actually relatively lower for the democracies.

The second group mostly take credit market imperfections these countries face as the source of their behavior. Riascos and Vegh (2004) develop a neoclassical model of fiscal policy in which public consumption provides direct utility to households and government optimally chooses both the level of public consumption and the tax rate. When the markets are complete, as expected the optimal government consumption is acyclical, with government using state-contingent borrowing to fully insure the households against fluctuations. When state-contingent asset markets are closed, with the only asset available to the economy is risk-free debt, government consumption becomes closely correlated output. Although their assumption of incomplete menu of assets for these countries is empirically supported in terms of lack of ability to borrow in own currency and much shorter maturities compared to developed markets, they

put an ad-hoc limit on borrowing and misses the time and state varying borrowing constraint these countries seems to facing empirically. Their model also generates very high positive tax output correlations that are in odds with data.

Mendoza and Oviedo (2006) study setup is also one of incomplete markets without state-contingent borrowing to investigate properties of fiscal policy in a small open economy. Default is also not an option and the government is allowed trade assets only with households, thus international asset market is closed for the sovereign by assumption. Households are constrained by their natural debt limit, whereas sovereign's borrowing limit is ad-hoc. They define a Markov Perfect equilibrium in which exogenous shocks to the endowment and the tax rate drive the model. Their model is able to approximate several aspects of fiscal policy and debt dynamics for their calibrated economy Mexico.

The set of studies that are most related to my work are Cuadra et al. (2010), Doda (2007) and Suzuki (2010). Cuadra et al. (2009) and Doda (2007) focus on the same question in a similar environment in which a benevolent government is financing valued public consumption through distortionary taxation and defaultable debt while facing technology shocks. They focus on the widely documented pro-cyclical fiscal policy in these countries, which they summarize as the positive correlation of output with government consumption. While over-predicting these correlations(Mexico .55, Cuadra et al. (2009) model .97; Argentina .78, Doda (2007) model .99), they both

fail to match the other striking fact of the fiscal policy in these countries, that is the relative volatility of government consumption and since their models do not have transfers, puzzling behavior of the transfer payments. Suzuki (2010) also with a model sovereign default, exogenous endowment shocks, non-distortionary taxes and transfer payments fails to generate the volatility of expenditures documented in the data.

I build a setup with a more detailed structure of fiscal expenditures, including transfers as a part of government and household budget constraints. Different empirical dynamics of the types of expenditures and their interaction through government's budget constraint makes this is more than just an accounting improvement. Fiscal outlays has four main components; government consumption, transfers and subsidies, public investment and interest payments. Both models above focus on government consumption only, with a fiscal authority providing useful public consumption through distortionary taxation and borrowing. The point of interest on the expenditure side for previous studies, that is government consumption, is only 40% of the total government budget on average for a representative set of developing countries [4](Suzuki, 2010). On average transfers and subsidies constitute 32% of total government outlays and as reported in table 2.2 has a relative volatility of four times more than output and two times more than government consumption.

In light of these observations, in Chapter 3, my contribution is twofold. First, from

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[4] Mexico, Chile, Argentina, Korea, Thailand, Philippines, and Turkey

an applied point of view, I add on to the existing literature by accounting for another important dimension of fiscal policy property akin to less developed economies. My model is able to match the pro-cyclical and excessively volatile nature of policy making jointly, not a question addressed in literature before. Second, I provide a framework in which the way government deliver fiscal resources to the private sector potentially matter, both in terms of default incentives and output dynamics, a point disregarded in relevant literature so far.

In Chapter 4, I look into the interaction of financial frictions faced by private and public sectors in these economies in a similar setup that would jointly explain the dissimilarities in business cycle properties of developing and developed world as documented. Financing frictions on firms in the form of working capital constraints has been an important model feature in accounting for emerging market business cycle properties in the literature. In such an environment, we have a dynamic interaction between government's willingness to use debt for public good provision and alleviation of tax distortions, and output. This feature of my model that generate an financial linkage between and distortionary government policy and private sectors does not exist in existing literature and no study within this line of literature focuses on this particular dimension. My contribution in this chapter is to provide a framework that highlight this channel in emerging market business cycles and investigate its empirical importance in accounting for the joint excessive volatility of public and private spheres

that seems to be a robust feature of these countries.

Chapter 3

Fiscal Policy Volatility and Default

3.1   The Model

Our unit of analysis is a small open economy (SOE) with 4 set of actors, households

consuming public and private good and providing hours, firms owned by these house-

holds with access to CRTS technology, international financial intermediaries and a

benevolent government that conducts fiscal policy by provision of public consumption,

investment, transfer payments through income taxation and international borrowing.

3.1.1   Firms

Firms, owned by households, have access to the following CRTS technology,

$$y_t = z_t f(n_t, i_t) = z_t n_t^{\alpha} i_t^{1-\alpha} \tag{3.1}$$

where z_t is productivity shock, n_t is hours and i_t is the factor of production to be

provided by the government and more will be said about it below in government

problem. To keep the production sector simple, it is assumed no stock variable is used in production.

The firm maximizes its profits given the cost of the factors of production;

$$\max_{n_t} \pi_t^f = y_t - n_t^f w_t \tag{3.2}$$

and the output share that corresponds to government's input is an indirect transfer to the households that owns the firms as profits.

3.1.2 Households

Households enjoy private, public consumption, provide hours and pay tax on their labor and profit income. They own shares of the firms producing final goods that is non-storable, hence the profit generated by them, and they do not have access to asset markets to trade claims on future consumption. The household problem, for given prices and government policy is,

$$\max_{c,n} E[\sum_{t=0}^{\infty} \beta^t U(c_t, 1 - n_t, g_t)] \tag{3.3}$$

subject to the following budget and time constraints;

$$c_t = (w_t n_t + \pi_t^f)(1 - \tau_t) + T_t \tag{3.4}$$

$$n_t + l_t = 1 \tag{3.5}$$

where T_t is the direct government transfers. The factor share due to public investment is an indirect transfer to households that owns the shares of the firms [5]. The utility function satisfies the usual properties, the households solve sequence of consumption-hours problems given prices and policy. As defined, consumption good is perishable and households are not allowed to trade in financial markets and the problem of the households does not require a dynamic decision. The dynamics of the model will be driven by government actions responding to productivity shocks and the focus will be on government policy behavior and its interaction with household choices.

3.1.3 Government

The benevolent government maximizes the utility of the households and is the only agent with the ability to trade assets in international markets. State contingent borrowing is not available and government can only trade one period, zero-coupon, non state-contingent discount bonds at rate q_t. The amount of bonds bond holdings to be repaid next period is denoted by b_{t+1} and borrowing implies $b_{t+1} < 0$. The bor-

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[5]Households are homogenous and per-capita shares are identical in equilibrium

rowing is bounded below by $\frac{\bar{y}}{r}$, where $\bar{y}$ is a theoretical maximum level of revenue the sovereign can raise but in equilibrium, sensitivity of the bond price schedule to total debt will imply a much tighter condition and this limit never binds. Unlike most of the literature on sovereign default, our government is running a full-blown fiscal policy with proportional income taxation and bond issue to finance its expenditures. On the expenditure side of the government budget, there is public investment, government current consumption, interest on existing debt and transfer payments. Public investment, i_t, is assumed to be fully depreciating [6], and for the benchmark model, tax rate will be exogenous [7].

The sovereign government lacks the ability to commit paying back its debt. As in standard Eaton and Gersovitz (1981) setup, the government only pays back its debt when the value of doing so is higher than the alternative. The default alternative clears all existing debt and implies immediate exclusion from the international asset markets with a exogenous random probability of regaining access. The sovereign is also not allowed to save when in state of default since with that option equilibrium with debt is not supportable (Bulow and Rogoff, 1989).

The timing of the actions of the government private sector and events in a period is as follows. Productivity shock $\{z_t\}$ is revealed first then government, conditional

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[6]Modeling public investment dynamically would complicate the problem with an addition of another state variable without contributing to our results.

[7]A version of model with endogenous tax rates will also be studied.

on having a good credit standing, decides on its default decision on loans that mature from $t-1$. The current default decision has current and possibly future consequences. When a sovereign is in default, either due to defaulting this period or a default in its history carried from past, it is not allowed to borrow or lend for that particular period. A sovereign in default this period remain in that state next period with positive probability $1 - \gamma$ and face the same consequences. Based on default position chosen in the beginning of the period if that option existed or carried stochastically from previous period as being in default, government chooses the amount of public good and investment[8],transfers to households and borrowing $\{g_t, i_t, T_t, b_{t+1}\}$ accordingly. Given z_t, policy $\{T_t, i_t, g_t, b_{t+1}\}$ and price vector $\{w_t, q_t\}$, firms and households solve their problems. The state variables are the government borrowing b_t, TFP shock z_t and credit standing of the government $\delta_t \in \{d, nd\}$.

A sovereign in good credit standing, $\delta_t = nd$, with assets $b_t < 0$, i.e. with an option to default, facing shock z_t solves the standard discrete default choice problem,

$$V(z_t, b_t) = \max \{V^{nd}(z_t, b_t), V^d(z_t)\} \tag{3.6}$$

where for asset values $b_t > 0$, $V(z_t, b_t) = V^{nd}(z_t, b_t)$. The recursive problem of the sovereign with good credit standing that choose not to default in current period is to

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[8]As it will be apparent from the government budget constraint, I assume public sector has access to a technology that can transform consumption good to investment good at a rate one

conduct fiscal policy to maximize the welfare of households, for a given set of private

sector choices $\{c_t, n_t\}$;

$$V^{nd}(z_t, b_t) = \max_{\{T_t, i_t, g_t, b_{t+1}\}} \{U(c_t, 1 - n_t, g_t) + \beta \int V(z_{t+1}, b_{t+1}) dF(z_{t+1}|t)\} \qquad (3.7)$$

$$s.t. \quad g_t = \tau_t(\pi_t + w_t n_t) + b_t - q_t b_{t+1} - i_t - T_t \qquad (3.8)$$

There is also an upper limit on borrowing as mentioned $b' \geq \xi = \frac{\bar{y}}{r}$ to prevent

Ponzi schemes, and will not bind in equilibrium. $V^d(z_t)$, value of being in default,

with all existing sovereign debt cleared, government excluded from credit markets in

current period remaining in default with positive probability γ next period is;

$$V^d(z_t) = \max_{T_t, g_t, i_t} \{U(c_t, 1 - n_t, g_t) + \beta \int [(1 - \gamma)V^d(z_{t+1}) + \gamma V^{nd}(z_{t+1}, 0)] dF(z_{t+1}|t)\}$$
$$(3.9)$$

$$s.t. \quad g_t = \tau(\pi_t + w_t n_t) - i_t - T_t \qquad (3.10)$$

Property of the CRTS technology and optimality conditions from the static firm

and household problems give us;

$$c_t = z_t f(n_t, i_t)(1 - \tau_t) + T_t \tag{3.11}$$

$$-\frac{U_l(c_t, 1 - n_t, g_t)}{U_c(c_t, 1 - n_t, g_t)} = (1 - \tau_t)w_t \tag{3.12}$$

$$w_t = z_t f_n(n_t, i_t). \tag{3.13}$$

Using the set of private sector optimality conditions, the state variable $s = \{z, b\}$ and policy vectors $\psi = \{g, T, b', i\}$, where prime variables denote the next period, and approximating stochastic TFP shocks with a first-order Markov chain [9], for a given set of prices $\{w, q\}$ we can re-write the problem of the sovereign that has not defaulted in a compact form;

$$V^{nd}(z, b) = \max_{\psi} \left\{ U(c(s; \psi), 1 - n(s; \psi), g) + \beta \sum_{z'} \Gamma_{zz'} V(z', b') \right\} \tag{3.14}$$

$$s.t. \quad g = z f(n(s; \psi), i) - c(s; \psi) + b - qb' - i - T \tag{3.15}$$

$$(1 - \tau)w = -\frac{U_l(c(s; \psi), 1 - n(s; \psi), g)}{U_c(c(s; \psi), 1 - n(s; \psi), g)} \tag{3.16}$$

$$w = w(s; \psi) \tag{3.17}$$

$$q = q(z, b') \tag{3.18}$$

where 3.15 is the economy-wide resource constraint. This representation of sovereign

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[9]The TFP shocks will be assumed to follow an AR(1) process

problem explicitly shows the margins the government faces conducting fiscal policy, it maximizes the welfare of its households subject to private sector optimality and the resource constraint of the economy. Fiscal authority acts being fully aware of the distortionary consequences of its actions on private sector behavior by internalizing their optimality conditions. If the sovereign chooses to default in the beginning of a period, it is relived of its current debt $b = 0$, excluded from credit markets this period and not allowed to save, $b' = 0$, the problem is;

$$V^d(z) = \max_{\psi^d} \{U(c(s; \psi^d), 1 - n(s; \psi^d), g)+ \tag{3.19}$$

$$\beta \sum_{z'} \Gamma_{zz'}[\gamma V(z', 0) + (1 - \gamma)V^d(z')]\}$$

$$s.t. \quad g = zf(n(s; \psi^d), i) - c(s; \psi^d) - i - T \tag{3.20}$$

$$(1 - \tau)w = -\frac{U_l(c(s; \psi^d), 1 - n(s; \psi^d), g)}{U_c(c(s; \psi^d), 1 - n(s; \psi^d), g)} \tag{3.21}$$

$$w = w(s; \psi^d) \tag{3.22}$$

Government's default decision for a given level of savings can be characterized as repayment and complementing default sets in terms of rest of the state variables. For a debt level b, there exist a set of productivity shocks for which it is optimal to default;

$$\Delta(b) = \{z \in \{Z\} : V^{nd}(z,b) < V^d(z)\} \tag{3.23}$$

where Z is the domain of productivity shocks. Given the stochastic properties of the shock process, this set defines the probability of default for a given level of debt, which will characterize the pricing decisions of the international investors below.

3.1.4 International Financial Intermediaries

International intermediaries consist of perfectly competitive, risk-neutral and fully informed agents. They invest in government bonds. They have access to funds at the cost of risk-free world interest rate. Perfect competition implies zero expected profits, that is equalized expected return on loans and the world's risk-free asset in equilibrium. When intermediaries are net lenders, their expected profits are,

$$\pi^i = -q(z,b')b' + \frac{Pr(z' \notin \Delta(b'); z)}{1 + r^w} b' \tag{3.24}$$

where $Pr(z' \notin \Delta(b'); a)$ is the probability of government not defaulting and lenders getting their loan paid back and r^w is the risk-free interest rate. Profit maximization implies,

$$q(z,b') = \frac{Pr(z' \notin \Delta(b'); z)}{1 + r^w} \tag{3.25}$$

The discount rate on deposits, $b_{t+1} > 0$, is the risk free rate $q(s_t, b_{t+1}) = \frac{1}{1+r^w}$.

The model laid out allows us to investigate the effect of default option on sovereign debt on fiscal behavior and . The dynamics of output is driven by productivity shocks and fiscal actions of the government which creates wedges created by particularities of a developing economy interacts with this.

3.1.5 Equilibrium

With the environment stated we can define the equilibrium. Before going on to that step couple of words are still in order about the commitment ability of the fiscal authority. We already stripped the government of being able to commit to pay back its debt and in absence of reputational mechanisms put a punishment mechanism making default costly in terms of utility to have equilibrium with debt. Our environment consist of small households that take current and future policy as given, government on the other hand is aware of the fact that its actions effect private decisions directly and possibly through expectations. The extent to which government can commit to a policy announced now would warrant different equilibrium concepts. We assume there is no within period commitment problem, once the policy is announced in the beginning of period, government has full commitment on both. The non-storable nature of the consumption good, household exclusion from asset markets and the usual static firm structure make private sector problem and optimality conditions, which appear

as government constraints, static. In this environment, the interaction between the private and public sector is solely limited to within period actions thus government do not inherit a constraint with future policy or state variables for which the today's sovereign would have to announce and private sector base their expectations on, i.e. there is no inherent dynamic inconsistency. State variables in this problem $\{s, b\}$, are either exogenous or chosen by policy maker. Non-dynamic nature of private sector problem leaves out the possibility of a dynamic interaction between private and public sectors and incentives for a Markov government to manipulate its successors à la Klein et al. (2008). We also treat successive sovereigns to share identical preferences and possibility of political disagreement is ruled out.

Definition 1. *An equilibrium of this economy is characterized by,(i) Value functions $V(z,b)$, $V^{nd}(z,b)$, $V^d(z)$ and associated default sets $\Delta(b)$ (ii) A set of private agent decision rules for demand and supply for hours, consumption; $n(z,b)$, $n^f(z,b)$ and $c(z,b)$, (iii) A vector of policy rules for transfer payments, public good and investment, and debt $\psi(z,b)$, (iv) Price functions $q(z,b')$, $w(z,b)$ such that;*

(a) *Given policy and price functions, decision rules $c(z,b)$, $n(z,b)$ solve the household and firm problems respectively and $w(z,b)$ clear the labor market,*

(b) *Given the price functions and decision rules for private sector, policy rules $\psi(s,b)$ and value functions $V(b)$, $V^{nd}(z,b)$, $V^d(z)$ solve government's problem and generate the default set $\Delta(b)$,*

(c) *Given households and firms optimize, the function $q(s, b')$ is consistent with $\Delta(b)$*

and satisfies zero-profit condition of the international financial intermediaries.

(d) *Resource constraint (eq. 3.15) holds.*

The way we proceed in characterizing equilibrium will exploit the fact that households and firms can solve their problem completely as a function of government policy. If default is chosen in the beginning of a period, the government problem also becomes static and trivialized.

The interaction between private and public sectors in our environment is relatively straightforward. Government acts as a leader within a period and announces its policy in terms of default and based on that transfer, public good and borrowing decisions. Households and the firms solve a sequence of static problems given policy and prices. Consumption good is not storable and households cannot participate in asset markets to borrow or lend and only endogenous state variable in this setup, government debt, is chosen by the fiscal authority. In what follows, we will derive the static first order condition and an euler equation (EE) for the government that characterizes government's decision dynamics given the constraints it faces[10].

The EE of the government is derived by using envelope condition to substitute the derivative of the value function that appears in government's first order condition

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[10]Even though the value function of the problem is not concave and non-differentiable due to the discrete nature of default choice and dynamic first order condition will not be utilized for the solution, this exercise is still useful for understanding the dynamics of the government's problem

with respect to debt. The way we proceed in characterizing equilibrium this way will exploit the fact that households and firms can solve their problem completely as a function of government policy. If default is chosen in the beginning of a period, the government problem also becomes static and trivialized so the focus below will be on the case in which fiscal authority chooses not to default. Writing out the economy-wide feasibility constraint, $\mathcal{C}(s; \psi)$ where $\psi = \{b', T, i, g\}$ is the policy vector to be chosen.

$$\mathcal{C}(s; n, b', g, T) = zf(n, i) - g + b - q(z, b')b' - i \qquad (3.26)$$

Note that, given private sector choice, the government budget constraint implicitly defines a relationship between transfer policy T and state-policy vector $\{s; b', g, i\}$;

$$\chi(s; b', g, i, T) = g - zf(n, i)\tau - b + q(z, b')b' + i + T = 0. \qquad (3.27)$$

Under certain regularity conditions and a given state and public good-investment and debt policy, there exist a transfer function $\mathcal{T}(s; b', g, i)$ such that;

$$\chi(s, b', g, i, \mathcal{T}) = 0 \qquad (3.28)$$

i.e. equation (3.28) defines a mapping from policy and state to transfer payment amount. Prices plugged from optimality conditions of the private sector with the

feasibility constraint, household optimality condition 3.12 defines the optimal labor

as a function of policy and state vector, i.e. there exists a $n(s, b; g, b', i, \mathcal{T})$ such that;

$$\frac{U_l(\mathcal{C}, n(s; g, b', \mathcal{T}), g)}{U_c(\mathcal{C}, n(s; g, b', \mathcal{T}), g)} + (1 - \tau)zf_n(n(s; g, b', \mathcal{T}), i) = 0. \qquad (3.29)$$

This is possible due to the time-line of the events, i.e. choice and policy sequence,

that is first current shocks realized, then policy is chosen and private sector acts based

on existing state and policy. So using this characterization to plug in for n in feasibility

and government budget constraints allows us to present benevolent government's

problem in a compact manner below. With the policy vector $\psi = \{b', g, i, \mathcal{T}\}$, the

government's problem subject to its budget constraint, when default option is not

exercised is,

$$V^{nd}(z, b) = \max_{b', g, i}\{U(\mathcal{C}(s; \psi), n(s; \psi), g) + \beta \sum_{z'} \Gamma_{zz'} \int V(z', b')dF(z')\}. \qquad (3.30)$$

or writing out $V(z', b') = max\{V^{nd}(z', b'), V^d(z')\}$,

$$V^{nd}(z, b) = \max_{b', g, i}\{U(\mathcal{C}(s; \psi), n(s; \psi), g)$$

$$+ \beta \sum_{zz'} \Gamma_{zz'}[\int_{z' \in \Delta(b')} V^d(z')dF(z') + \int_{z' \notin \Delta(b')} V^{nd}(z', b')dF(z')]\}.$$

$$(3.31)$$

The first order condition that characterizes optimal public good provision is;

$$U_c[\mathcal{C}_g + \mathcal{C}_T \mathcal{T}_g] + U_l[n_g + n_T \mathcal{T}_g] + U_g = 0 \tag{3.32}$$

where under certain regularity conditions required by Implicit Function Theorem (IFT), $\mathcal{T}_g = -\frac{\chi_g}{\chi_T}$ from 3.27. Expanding the term $[\mathcal{C}_g + \mathcal{C}_T \mathcal{T}_g]$;

$$U_c(zf_n - 1)[n_g + n_T \mathcal{T}_g] + U_l[n_g + n_T \mathcal{T}_g] + U_g = 0 \tag{3.33}$$

after some simplification we get;

$$(U_g - U_c) + (U_c f_n + U_l)[n_g + n_T \mathcal{T}_g] = 0 \tag{3.34}$$

The first term is the usual private-public consumption trade-off from the feasibility constraint, the second appears as a result of labor and output fluctuation due to policy and depends on sensitivity of equilibrium labor to policy. Note that n_g, n_T can be derived from 3.29 to give;

$$n_g = \frac{\Omega_c - \Omega_g}{F_n \Omega_c + \Omega_n + U_c F_{nn}(1 - \mathcal{T})} \tag{3.35}$$

where;

$$\Omega_i = U_{ci}(1 - \mathcal{T})F_n + U_{ni} \tag{3.36}$$

and;

$$n_T = \frac{U_c F_n}{F_n \Omega_c + \Omega_n + U_c F_{nn}(1 - \mathcal{T})} \tag{3.37}$$

Similarly the static optimality condition for public investment after some simplification we get;

$$(z f_n U_c + U_l)[n_i + n_T \mathcal{T}_i] + U_c(z f_i - 1) = 0 \tag{3.38}$$

For the generic optimal policy choice without default, letting $z^*(b')$ be the value of cut-off productivity level for non-default for a given level of savings, we have,

$$V^{nd}(z, b) = \max_{b', g, T}\{U(\mathcal{C}(s; \psi), n(s; \psi), g)$$

$$+ \beta \sum_{zz'} \Gamma_{zz'}[\int_{\underline{z}}^{z^*(b')} V^d(z')dF(z') + \int_{z^*(b')}^{\bar{z}} V^{nd}(z', b')dF(z')]\}. \tag{3.39}$$

Noting the fact $V^d(z^*) = V^{nd}(z^*, b')$ for all b' by definition, $V^d_{b'}(z') = 0$ and with the Leibnitz rule the dynamic decision made by the government about borrowing reveals;

$$U_c[\mathcal{C}_{b'} + \mathcal{C}_T \mathcal{T}_{b'}] + U_l[n_{b'} + n_T \mathcal{T}_{b'}] + \beta \sum_{z'} \Gamma_{zz'} \int_{z^*(b')}^{\bar{z}} V_{b'}^{nd} dF(z(b')) = 0 \qquad (3.40)$$

since $V_{b'}^d(s', 0) = 0$ and substituting for $\mathcal{C}_{b'}$ and $\mathcal{C}_\tau$ and suppressing the variable of integration $dF(z(b'))$ rearranging and manipulations gives;

$$[zf_n U_c + U_l][n_{b'} + n_T \mathcal{T}_{b'}] - U_c[q_{b'} b' + q] + \beta \sum_{z'} \Gamma_{zz'} \int_{z^*(s,b')}^{\bar{z}} V_{b'}^{nd} = 0. \qquad (3.41)$$

To obtain the government's EE we need to substitute for the derivative of the value function in 3.41 via the usual envelope condition. Letting optimal policy functions, $b' = \phi(s)$, $g = \varphi(s)$, $i = \iota(s)$ and $T = \mathcal{T}(s; \psi, \varphi, \iota)$, we have;

$$V^{nd}(z, b) = U\big(\, \mathcal{C}(s; \phi, \varphi, \iota, \mathcal{T}), n(s; \phi, \varphi, \iota, \mathcal{T})\, \big)$$

$$+ \beta \sum_{zz'} \Gamma_{zz'} [\int_{\underline{z}}^{z^*(b')} V^d(z') + \int_{z^*(b')}^{\bar{z}} V^{nd}(z', \phi)] . \qquad (3.42)$$

where,

$$\mathcal{C}(s, b; \phi, \varphi, \iota, \mathcal{T}) = zf[n(s; \phi, \varphi, \iota, \mathcal{T}), \iota] - \varphi + b$$

$$- q(z, \phi)\phi - \iota + \mathcal{T} \qquad (3.43)$$

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Taking the derivative of the value function with respect to b [11]; re-arranging and canceling out the usual terms that correspond the static and dynamic first order conditions we get;

$$V_b = U_c. \tag{3.44}$$

Forwarding it one period ahead and substituting $V_{b'}$ in terms of primitives and decision rules in equation 3.41 we get the EE of the government that characterizes the solution to its dynamic problem when it is not in state of default;

$$[z f_n U_c + U_l][n_{b'} + n_T \mathcal{T}_{b'}] - U_c[q_{b'} b' + q] + \beta \sum_{z'} \Gamma_{zz'} \int_{z^*(s,b')}^{\bar{z}} U_{c'} dF(z') = 0 \tag{3.45}$$

This is a functional equation with policy rules of the sovereign as well as optimal decision rules of private sector and their derivatives as its arguments. This gives an explicit picture of the wedges sovereign has to take into account in its savings decision. The margins are, the direct one effecting household's inter-temporal consumption margin and the policy wedge working on the household's static consumption-leisure choice.

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[11]Similar manipulation for the differentiation under integral as above eliminates all but the term with $V_{b'}^{nd}$

3.2 Quantitative Analysis

3.2.1 Data

To calibrate my model I choose Mexican fiscal sector annual data. The choice of Mexico is common in this literature since characteristics of its fiscal sector data conforms with the documented facts and it has a default history. The detailed structure of the model requires capital expenditures, subsidies and transfers, debt service as well as government current expenditures. Thus the choice of annual data has two reasons, one is practical from the fact that it is hard obtain reliable detailed fiscal data on a quarterly frequency, the other relates to the decision making in fiscal budgeting, which is done on an annual basis.

Main part of the fiscal data used is from Mexican Ministry of Finance, national income data is from International Financial Statistics Database of IMF. From the expenditure side, between the years 1990-2009, the size of government sector on average constitutes about 23% of GDP in Mexico. The current expenditure on goods and services, which corresponds to national income account government consumption is 48% (See Figure 3.2.1). Capital expenditures and debt service both make up about 15% each and transfers are around 10%. Their second moments and behavior over the cycle is summarized in table 3.1 and is in line with the average behavior of emerging markets documented before.
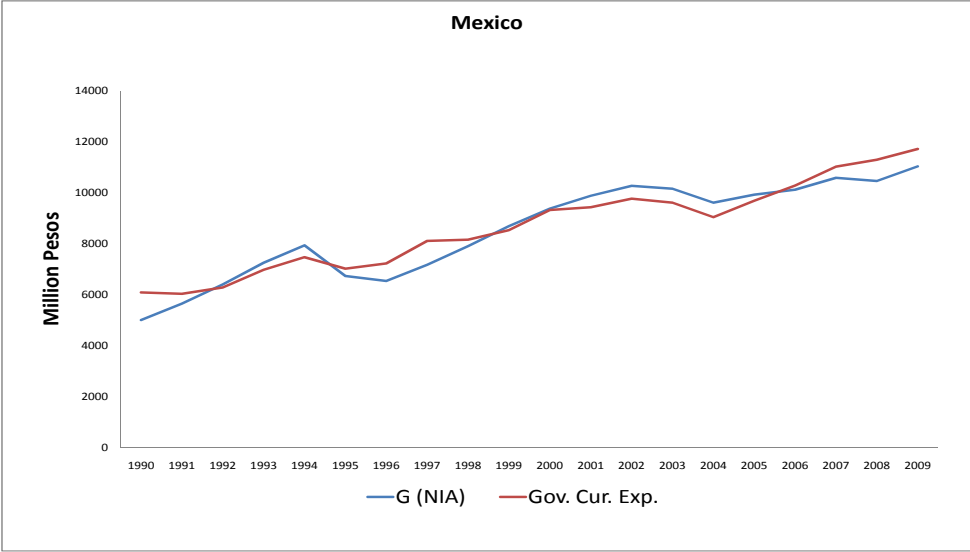
Figure 3.1: Government Consumption Expenditure (NIA,IFS) vs. Government Current Expenditure (Ministry of Finance, Mexico)

Table 3.1: Mexican Business Cycle

Series	σ	σ_i/σ_y	$\rho(i,y)$
GDP	3.03	1	1
Consumption	4.39	1.45	.83
Government Consumption	7.17	2.36	.43
Trade Balance/GDP	1.55	.51	-.75
Spread	1.97	.68	-.45
Fiscal Accounts			
Exp. on Goods and Services	5.23	1.73	.48
Transfers and Subsidies	18.7	.30	.49
Debt Service	22.3	7.36	-.23
Capital Expenditure	9	2.99	.44
Tax rate	.57	.19	-.33

3.2.2 Functional forms and Calibration

For the preferences I use GHH (Greenwood et al., 1988) specification with a separable public-private consumption. This type of preferences is widely used in SOE literature and has the property that marginal rate of substitution is independent of consumption and income effect on labor supply vanish [12]. This type of preferences plays an important role in allowing international real business cycle models to explain observed business cycle facts in these countries.

$$U(c, n, g) = \mu \frac{(c - \frac{n^v}{v})^{1-\sigma}}{1 - \sigma} + (1 - \mu) \frac{g^{1-\sigma}}{1 - \sigma} \tag{3.46}$$

The risk aversion parameter σ is set to 2 and the annual world risk-free interest rate r is set to 4%, which are standard values in quantitative business cycle and sovereign default studies. The curvature of labor disutility in the utility function is set to $v = 1.455$, and implies a Frisch wage elasticity of labor supply of 2.2, which is used in SOE models (Mendoza (1991), Neumeyer and Perri (2005) and Mendoza and Yue (2008)). Government investment share parameter α_m is set to match the average public investment-output ratio for Mexican fiscal sector, which is 3.36% for the relevant period. The probability of re-entry after default is $\gamma = 0.22$, which implies that the country gets full access to international markets about 4.5 years after default

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[12]Doda (2007) using Cobb-Douglas specification finds very similar results as Cuadra et al. (2010) that use GHH specification for almost identical models.

on average. This estimate is in line with the estimates reported by Richmond and Dias (2008) for the period of 1980-2000.

As discussed by Aguiar and Gopinath (2006a), a simple analysis à la Lucas shows welfare cost of financial exclusion by itself is not enough to support positive debt levels in equilibrium within this general framework and an exogenous output cost is usually needed for non-trivial borrowing. Even though our model allows for a potential endogenous output cost due to default, quantitative analysis have shown us with reasonable parameter values, our model does not generate enough cost of default to allow for non-trivial debt, so we also allow for an exogenous output cost due to default. The particular specification used implies for better states of the world, default is relatively more costly;

$$
z_t = \left\{ \begin{array}{ccc} \hat{z} & if & z_t > \hat{z} \\ \\ z_t & if & z_t \leq \hat{z} \end{array} \right\} \tag{3.47}
$$

and this asymmetric cost of default makes the value of default less sensitive to productivity shocks and increase the range of risky borrowing (Arellano, 2008).

Productivity shocks follow an AR(1) process:

$$
\log(z_t) = \rho_A \log(z_{t-1}) + \epsilon_t. \tag{3.48}
$$

Lack of data prohibits direct estimation of the parameters governing variance and autocorrelation of productivity shocks so ρ_A and $\sigma\epsilon$ are (with another set of parameters below) set to match the variance and autocorrelation of Mexican output. Remaining parameters are calibrated using SMM are $\mu, \beta, \hat{z}, \tau$. These are targeted to match average public-private consumption ratio, annual default frequency, correlation of transfer payments with output, average transfer payments-consumption ratio and average debt service-output ratio. Reinhart et al. (2003) reports Mexico has defaulted on its sovereign debt 3 times between the years of 1901-2002, and no default has occurred since, this gives roughly a 2.73% annual default frequency for Mexico. The government current expenditure to private consumption ratio is 16% for the relevant period. The average debt service-output for 1980-2005 for Mexican government is 5.0%, and the parameter τ is calibrated to match transfer payments-consumption ratio of 3.00%.

3.2.3 Results

Table 3.3 shows that the model yields consistent results with the stylized facts of emerging markets in fiscal policy and other dimensions. A common shortcoming of these class of models is the unrealistic levels of debt stock they generate in standard

Table 3.2: Benchmark Model Calibration

Calibrated Parameters		Value	Target
Risk-free interest rate	r	4%	Standard RBC
Public investment share	α_m	0.034	Public investment GDP ratio
CRRA risk aversion	σ	2	Standard RBC
Labor supply curvature	υ	1.455	Standard SOE RBC
Probability of re-entry	γ	.22	Length of exclusion
Estimated Parameters		Value	Targets
Discount factor	β	.82	Frequency of default
TFP persistence	ρ_A	.85	Autocorrelation of output
TFP innovation std.	ϵ	.0095	Variance of otput
Public cons. coeff.	μ	.17	Public/Private cons. ratio
Default TFP cutoff	$\hat{A}$	.98	Debt service-GDP ratio
Tax rate	τ	.195	Consumption-Transfer payment ratio

Table 3.3: Benchmark Simulation Results

Statistic	Data	Benchmark Model
$\sigma(y)$	3.03	3.03
$\sigma(g)/\sigma(y)$	1.73	1.65
$\sigma(c)/\sigma(y)$	1.45	1.20
$\sigma(T)$	18.7	43.2
$\rho(y,g)$	.43	.86
$\rho(y,spread)$	-.45	-.60
$\rho(y,T)$	.49	.46
$\rho(y,tb/y)$	-.75	-.40
$\rho(g,tb/y)$	-.74	-.60
$\rho(T,tb/y)$	-.85	-.65
$\rho(g,T)$	.81	.77
$\rho(c,T)$	.78	.62
b^*/y^*	.32	0.05
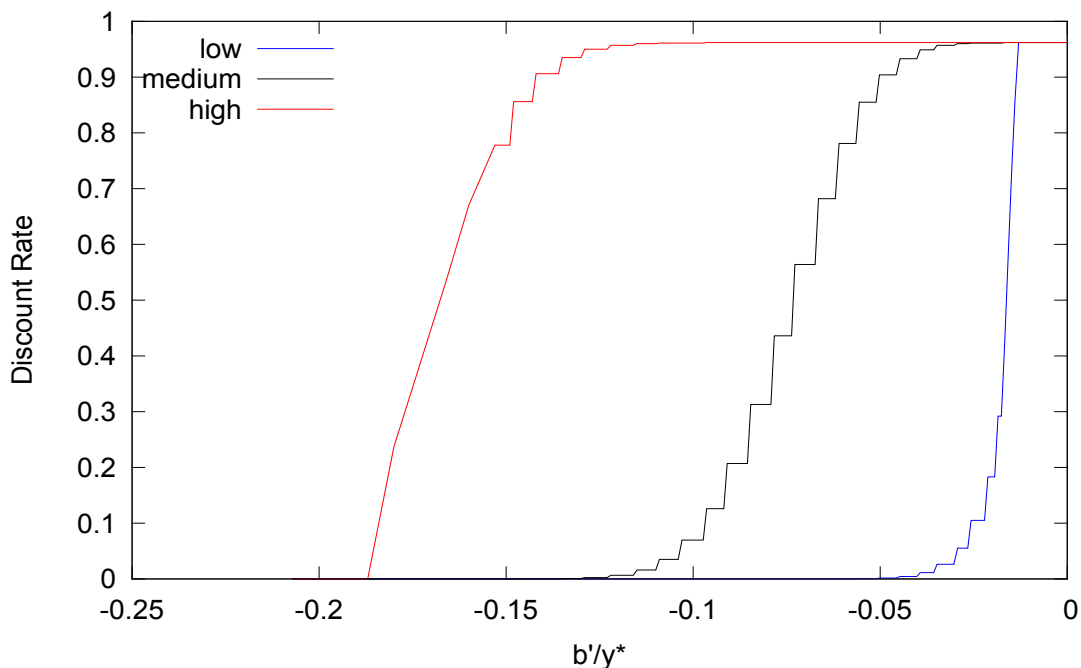
Figure 3.2: Discount Rate as a Function of Current Productivity

setup and my model shares this characteristic[13]. In terms of business cycle properties,

model generates a negative correlation between spreads and GDP as the sovereign

have a higher default risk in bad states of the world. The counter-cyclical trade bal-

ance due to state-contingent nature of the price schedule it face and excess volatility

across the board is also in line with data. In bad states of the world, the steepness

of the market discount rate overcomes overly impatient sovereign's marginal utility

of borrowing and sovereign is unable to use debt to smooth out the effects of the

negative shock and increase level of consumption both private and public.

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[13]See Yue (2010) for an extension with debt renegotiation and Aguiar and Gopinath (2006a) with third-party bailouts for versions generating higher debt levels.
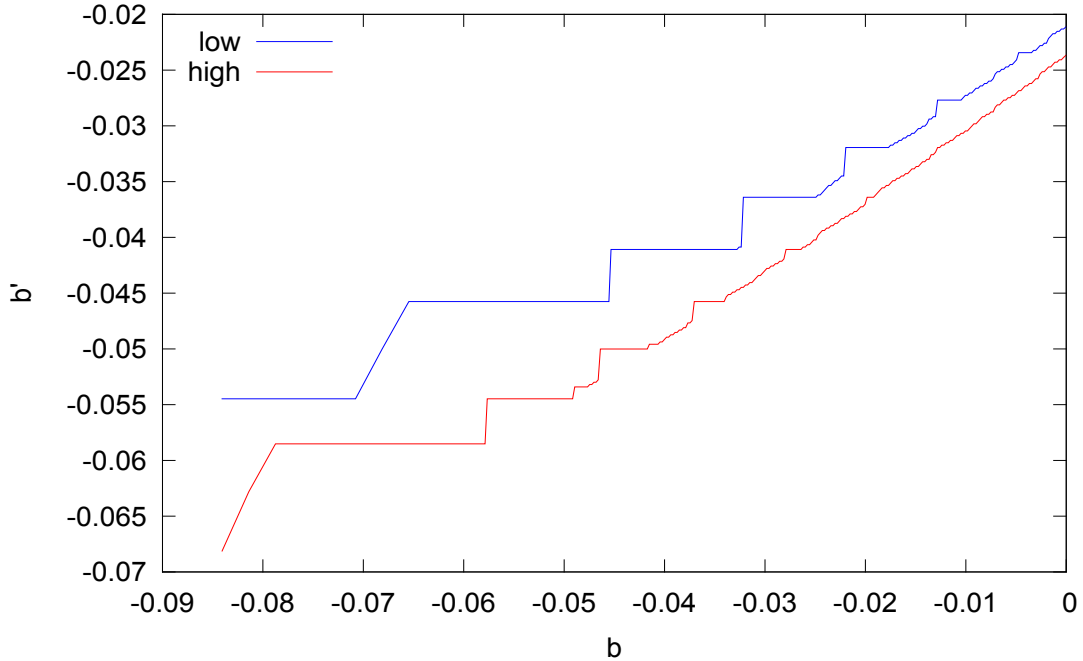
Figure 3.3: Asset Choice as a Function of Current Productivity

As in all types of these models, the equilibrium has the feature that default incentives are higher in times of negative shocks, which is in contrast with models of enforcement constraints in incomplete markets (Kehoe and Perri, 2002). With the persistent nature of calibrated TFP process, this is also reflected in price schedules in figure 3.2. Note that default is a state contingent optimal action for the sovereign in smoothing consumption of its households. In fact, the asymmetric costs from default amplifies the role of default as a policy for completing markets. As Arellano (2008) puts it, due to concavity of preferences net repayment is more costly when income is low, increasing default incentives. For a highly indebted sovereign the available contracts might not be a useful instrument for consumption smoothing if the available

options without default cannot increase consumption relative to income and default-
ing may be optimal. This is internalized by the loan suppliers and reflected by the
steep discount rates the sovereign faces. As a result, sovereign with higher shock
borrows more due to better terms of the contracts available (see figure 3.3)

The strong negative correlations of fiscal expenditures with the trade balance in
model as well as in data point out that international borrowing is an important source
of finance for fiscal outlays. The benchmark model does a good job of replicating
general characteristics of fiscal policy in Mexico. Relative volatility of government
consumption is high, with a pro-cylical character and strongly negatively correlated
with trade balance as in data. Furthermore, the model matches correlation of transfer
payments with output very well and generates excessive relative volatility for them.
The effect of market incompleteness on the sovereign combined with the commitment
problem has its toll on fiscal policy conduct and is able to generate seemingly non-
optimal policy.

The roots of pro-cyclicality of transfer payments can be traced in figure 3.4. The
level of transfer payments are inversely related to productivity shocks such that house-
holds get a lower level of transfer payments in harder times. From an constrained
optimal policy point of view this not so surprising, since productivity shocks results
in a fall in output due to lower level of demand for labor. This is likely to results in a
fall in household income as well as consumption. Sovereign with the only one able to
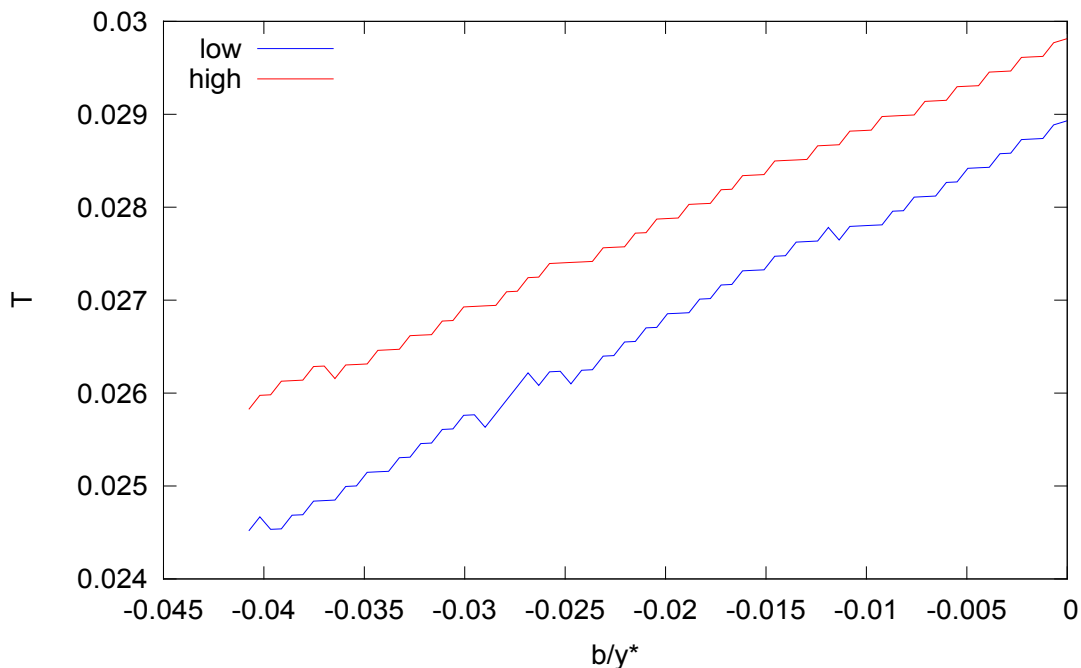
Figure 3.4: Transfer Payments as a Function of Current Productivity

smooth out these fluctuations faces a tighter constraint in international markets when it needs it the most. But at the same time concavity of household utility implies a higher marginal utility of consumption, which relieves sovereign's public-private consumption margin. The higher marginal utility of consumption means the government can manage public-private consumption margin with lesser transfer payments and public consumption. The net effect in this case results in a procyclical expenditure structure. In the next section, I will look into the fiscal side from the optimal taxation by endogenizing taxes while matching the level and cyclical properties of transfer payments exogenously.
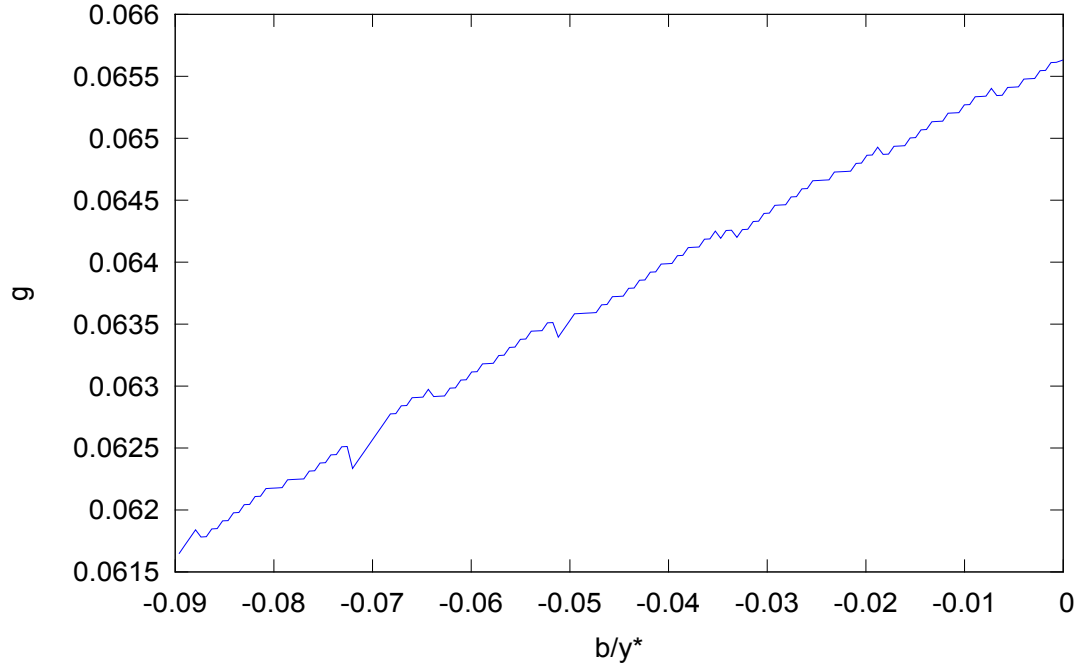
Figure 3.5: Optimal Government Consumption

3.2.4 Endogenous Tax Rate

In this section, we treat tax rate as an endogenous policy variable and investigate optimal taxation in this environment. The transfer payments are treated as exogenous function of income,

$$T(y; \bar{y}, \pi) = \pi \bar{y}(1 + |\frac{y - \bar{y}}{\bar{y}}|) \tag{3.49}$$

and the additional two parameters are calibrated to match correlation of transfers with output and consumption-transfer payments ratios. The results are given in table 3.4.

Table 3.4: Endogenous Tax Simulation Results

Statistic	Data	Endogenous Tax
$\sigma(g)/\sigma(y)$	1.73	1.98
$\sigma(c)/\sigma(y)$	1.44	1.15
$\sigma(\tau)$	.50	.54
$\rho(y, spread)$	-.45	-.70
$\rho(y, g)$	.43	.95
$\rho(y, \tau)$	-.35	-.75
$\rho(y, tb/y)$	-.75	-.55
$\rho(g, tb/y)$	-.74	-.60

An important observation on emerging market tax policy is the counter-cyclicality of tax rates as documented. The model with endogenous taxes captures this dimension of data and still does a good job in matching other key facts. With the given structure of the model, government's interaction with households is through taxes and public good provision. Unlike the benchmark model, our government now have another option that it can choose to finance the expenditures, income taxation. Unfortunately their cost of use are closely correlated as policy instruments. We already know that cost of borrowing is higher during a bad productivity shock, and this is the time when alternative ways of finance is needed most yet this is also the time when relative cost of distortionary income taxation is higher. An indebted sovereign's marginal problem now includes wedge in household optimality conditions. The decision to default or

not has to include the potential distortionary effects of taxation. The increased relative volatility of government consumption due to endogenous taxation is due to this new channel of transmission of shocks to production. When a shock hits, first it goes directly to production as TFP, then it has secondary effects that goes through government budget and comes back to production.

3.2.5 Sensitivity Analysis

No Default Case

To better understand the role of commitment problem of the sovereign on fiscal procyclicality and volatility I do the following sensitivity analysis. Matching certain statistics from the benchmark model with default and Mexico, I take away the option to default from the sovereign, and ask the question how would a sovereign that acted in the benchmark model would behave if there was no commitment problem with respect to paying back its debt. Closing the model with a price schedule sensitive to debt , we calibrate the model to debt/income ratio of benchmark and macro statistics from Mexico. The price function is;

$$q(b) = 1 + r + \varphi(e^{d/\bar{d}} - 1). \tag{3.50}$$

The value of $\varphi = 0.00072$ taken from Uribe and Yue (2006) and $\bar{d}$ is set to match the debt/income ratio generated by the benchmark model. The results reported in

Table 3.5

The results point out important implications for the relationship between the commitment problem and procyclicality and volatility. As the borrowing constraints is relaxed, debt is used extensively to smooth out fluctuations, this is evident in strong positive correlations of main aggregates with the trade balance, which are negative for the benchmark and endogenous tax models with default. In terms of relative volatilities this model generates a quite stable outcomes. The consumption and government consumption is nearly half as volatile as output and 3 to 4 times less compared with default model. Regarding the procyclicality of government consumption, even though it is considerably lower than the benchmark model, it is still quite high. This is not surprising since Riascos and Vegh (2004) and Mendoza and Oviedo (2006) models with incomplete markets are also able to generate similar statistics and this is a well known property of incompleteness in asset markets.

The transfer payments comparatively show a drastic change in cyclical behavior and they become strongly counter-cyclical as theory would suggest. The volatility of transfer payments however still remains very high, this has to do with the inherent volatility that is fed into the model and the low transfer payment-consumption ratio calibration that results in excessive fluctuations to keep consumption stable. However this is not say that the benchmark model's results was mainly due to a compositional effect since for one thing excess volatility is a phenomenon regardless of the type of

Table 3.5: No Default Simulation Results

Statistic	Data	Benchmark	No Default
$\sigma(g)/\sigma(y)$	1.73	1.68	.43
$\sigma(c)/\sigma(y)$	1.45	1.20	.77
$\sigma(T)$	18.7	48.7	43.2
$\rho(y,g)$	.43	.86	.82
$\rho(y,T)$	.49	.46	-.74
$\rho(y,tb/y)$	-.75	-.40	.74
$\rho(g,tb/y)$	-.74	-.60	.63
$\rho(g,T)$	.81	.77	-.47
$\rho(c,T)$	.78	.62	-.71

the expenditures and procyclicality is a property of not just transfer payments but all other parts of the government's budget in developing countries.

3.3 Conclusion

In this chapter, I have investigated the effects of market incompleteness, due to the commitment problem of a sovereign in repayment of debt, in conducting fiscal policy. I have incorporated a detailed explicit fiscal sector what is otherwise a standard sovereign default model to account for properties of fiscal policy outcomes in emerging market economies. The environment we defined resembles small open developing

economies with respect to existence of short-maturity non-state contingent default-able debt as the only tradable asset for sovereign governments. The model performs well in matching the properties of business cycles and fiscal policy conduct in these countries. One such particular property in the data is the excessive volatility of trans-fer payments and government consumption expenditures relative to output and their pro-cyclical nature over the business cycle. My benchmark model with endogenous transfers and government consumption, replicates these characteristics. Furthermore, a version of the model with endogenous tax generates counter-cyclical tax rates that is also a differentiating characteristic of fiscal policy conduct in developing world. To assess the role of defaultable debt in generating these results I also calibrate the bench-mark model without default and with only short-maturity non-state contingent debt. The results point that the state-contingent borrowing constraints that sovereigns face which endogenously rise as a result of commitment problem in debt repayment is a major factor in accounting for the pro-cyclicality of transfer payments and excessive relative volatility of transfers and government consumption in these countries.

Chapter 4

Financial Frictions, Fiscal Policy and Aggregate Volatility

4.1 Introduction

Financing frictions on firms in the form of working capital constraints has been an important modelling feature in accounting for emerging market business cycle properties in the literature. Neumeyer and Perri (2005) has a model with exogenous interest rate shocks that are negatively correlated with country fundamentals interacts with a financing wedge on firms that does a good job replicating observed emerging market business cycles. Aguiar and Gopinath (2006b) also report similar findings and among other candidates Chang and Fernández (2010)'s Bayesian encompassing model assigns a significant role in terms of likelihood to interest rate shocks and financial frictions jointly to account for the documented facts for developing countries. Cicco et al. (2006) find that that their estimated financial-friction model with country premium shocks provides a remarkably good account of business cycles in emerging

markets. Evidence reported from many other studies also point out the relevance of these wedges from a modeling perspective in matching the excessive business cycle volatility (Aguiar and Gopinath, 2006b; Uribe and Yue, 2006, among others).

In this chapter, I look into the effects of financial frictions in conduct of fiscal policy and their joint aggregate effects on business cycle volatility. I build a model with endogenous output and interest rate with an explicit fiscal sector providing public consumption to households financed by income taxation and debt issue. The way of introducing financial frictions is in the form of working capital constraint on an imported factor of production in spirit of Mendoza and Yue (2008). The firms are forced to pay in advance a part of their imported input bill and financing of this is done through intra-period loans repaid at the end of the period and provided by international creditors at the ongoing market rate for the country. The explicit link between government actions and private sector is through the assumption that cost of finance from the international markets is set by the discount rates of government bonds. This implies in the eyes of international loan suppliers, domestic firms are only as credible as their sovereign in paying back their working capital loans. The evidence do support such a linkage between corporate and sovereign borrowing exist not just in times of severe crises but throughout normal times as well in developing countries. Table 4.1, taken from Mendoza and Yue (2008), clearly shows that for the median firm there's a sovereign ceiling under which firm cannot borrow and the

country risk and firm specific risk is strongly correlated. Also, Arteta and Hale (2008) documents severe falls in credit of the private sector of a defaulting sovereign, which points, whatever the reasons underneath possibility of sovereign default has drastic consequences on corporate borrowing. To link default probabilities of sovereign and corporate debt in our model, it will be assumed that all the payments through capital account flows through public accounts and the sovereign diverts these payments back to households as transfers in case of default on its own debt.

In such an environment, we have a dynamic interaction between government's willingness to use debt for public good provision and output. The interaction works through fiscal authorities actions and constraints to factor prices private sector face and becomes a source of disturbance on private sector. In our model the effect of TFP shocks on private sector will have two transmission mechanisms on output, first the direct one through the usual productivity fluctuations, second through government's budget as a result of fiscal actions. The importance of the second channel is a quantitative matter and to asses this, I will assume the existence of such frictions to full extent and will calibrate my model to match the existing statistics of Mexico. Assuming the data observed comes from a world of financial frictions I will measure consequences of them by measuring sensitivity of the policy outcomes to different degrees of frictions friction on the firms, measured by the parameter θ. My contribution in this chapter is to provide a framework that highlights the quantitative importance

Table 4.1: Sovereign and Corporate Interest Rates

Country	Sovereign Rates	Median Firm	Correlation
Argentina	13.32	10.66	0.87
Brazil	12.67	24.60	0.14
Chile	5.81	7.95	0.72
China	6.11	5.89	0.52
Colombia	9.48	19.27	0.86
Egypt	5.94	8.62	0.58
Malaysia	5.16	6.56	0.96
Mexico	9.40	11.84	0.74
Morocco	9.78	13.66	0.32
Pakistan	9.71	12.13	0.84
Peru	9.23	11.42	0.72
Philippines	8.78	9.27	0.34
Poland	7.10	24.27	0.62
Russia	15.69	11.86	-0.21
South Africa	5.34	15.19	0.68
Thailand	6.15	7.30	0.94
Turkey	9.80	29.26	0.88
Venezuela	14.05	19.64	0.16

Source: Mendoza and Yue (2008)

of financial frictions of the defined type in emerging market business cycles and investigate its empirical importance in accounting for the joint excessive volatility of public and private spheres that seems to be a robust feature of these countries.

4.2   The Model

The model is similar to the one in chapter 3 with an explicit fiscal sector and imported input in production. There are 4 set of actors, households consuming public and private good and providing hours, firms owned by these households with access to CRTS technology, international financial intermediaries and a benevolent government that conducts fiscal policy through distortionary labor taxation, public investment and transfer payments.

4.2.1   Firms

Firms, owned by households, have access to the following CRTS technology,

$$y_t = z_t f(n_t, m_t) = z_t n_t^\alpha m_t^{1-\alpha} \tag{4.1}$$

where z_t is productivity shock, n_t is hours and m_t is the imported input.

There are two types of international suppliers of the imported input m_t. One with

superior technology of production that require a proportion of the input cost in advance and others with inferior technology but no such requirement. The international prices of these two suppliers fixed at p_s^m and p_i^m. Since when the sovereign is in default state firms have no access to international credit to finance advance payments, only inferior technology suppliers are available for the firm. When the sovereign is not in default the firms choose to supply from whichever is optimal to minimize total cost for a given policy. The necessary funds to finance advance payments are obtained through intra-period loans at rate r_t which are paid at the end of the period after production takes place [14]. When sovereign is not in default and $p_m^s(1 + \theta r_t) \leq p_m^i$ the firm solves the following problem to maximize its profits given the cost of the factors of production;

$$\max_{m_t, n_t} \pi_t^{nd} = y_t - n_t w_t - (1 + \tau)p_s^m m_t - \theta r_t p_s^m m_t \qquad (4.2)$$

where θ is the share of imported input cost that has to be paid in advance, τ_t is the tax rate on imports[15] and $r_t = \frac{1 - q(z_t, b_{t+1})}{q(z_t, b_{t+1})}$ is the interest rate charged on working capital of the firms[16]. The link between government policy and firm problem is explicitly stated

[14]See Uribe and Yue (2006))for a fully specified firm problem showing that the rate determining the cost of intra-period working capital loans is the same as the between period rate on one-period loans

[15]The tax rate on income and imports is assumed to be equal and finance cost of imported good is not taxed.

[16]p_m^s will be calibrated to a value from Mendoza (2008) relative to numeriare consumption good

in this as the two distortions fiscal policy creates are tax and finance cost wedges. The optimal working capital is;

$$
\kappa_t = \begin{cases} \theta p_s^m (1 + r_t) & if \quad p_i^m \geq p_s^m \\ \\ 0 & if \quad p_i^m < p_s^m \end{cases} \tag{4.3}
$$

In state of default or the case $p_s^m(1 + \theta r_t) > p_i^m$ firm problem is simplified to;

$$
\max_{m_t, n_t} \pi_t^d = y_t - n_t w_t - (1 + \tau) p_i^m m_t. \tag{4.4}
$$

Note that the relative price of alternative imported input supplies also governs the cost of default. From a national income accounting perspective gross national income is total production less cost of imported inputs, $gdp_t = y_t - p_t^m m_t$ where $p_t^m = \min\{p_i^m, p_s^m(1 + \theta r)\}$.

4.2.2 Households

Households enjoy private, public consumption, provide hours and pay tax on their labor income. They own shares of the firms producing final goods that is non-storable, hence the profit generated by them, and they do not have access to asset markets to

---

price and p_m^i to match a statistic from data such that $p_m^i > p_m^s(1 + \theta r)$, where r is the risk free rate, always holds.

trade claims on consumption. The household problem, for a given government policy is,

$$\max_{c,n} E[\sum_{t=0}^{\infty} \beta^t U(c_t, 1 - n_t, g_t)] \tag{4.5}$$

subject to the following constraint;

$$c_t = w_t n_t (1 - \tau) + T_t \tag{4.6}$$

where T_t is the government transfers and is $T_t = \kappa_{t-1}$ in the period default is chosen as government diverts firm's payments on working capital to households as transfers and zero every period else. The utility function satisfies the usual properties, the households solve sequence of consumption-hours problems given prices and policy and stated problem does not require a dynamic decision making by the households.

4.2.3 Government

The benevolent government maximizes the utility of the households and is the only one with the ability to borrow and lend in international markets. State contingent borrowing is not available and government can only borrow or save through a one period non state-contingent bond. On the expenditure side of the government budget, there is government consumption, transfer payments and debt service. For financing

these expenditures government uses proportional taxation on household income and firm imports.

The timing of the actions of the government private sector and events in a period is as follows [17]. Productivity shock $\{z_t\}$ is revealed first then government, conditional on having a good credit standing, decides on its default decision on loans that mature from $t-1$ and consequently transfer of last periods working capital to households. The current default decision has current and possibly future consequences. A sovereign in default this period remain in that state next period with positive probability $1-\gamma$ and face the same consequences. Based on default position chosen in the beginning of the period if that option existed or carried stochastically from previous period as being in default, government chooses the amount of public good, transfer payments and borrowing $\{g_t, T_t, b_{t+1}\}$ accordingly. Given $\{z_t\}$, policy vector $\{g_t, T_t, b_{t+1}\}$ and prices, firms and households solve their problems. The state variables are the government borrowing b_t, TFP shock z_t, working capital from last period κ_{t-1} and credit standing of the government $\delta_t \in \{d, nd\}$. A sovereign in good credit standing, $\delta_t = nd$, with assets $b_t < 0$, i.e. with an option to default, carrying working capital decision of firms from last period κ_{t-1} and facing shock z_t solves the standard discrete default choice problem,

---

[17]To make default decision timing with repayment of working capital loans from last period consistent, it is assumed there exists 2 sub-periods within a period t, t^+ and t^- that are arbitrarily close to t and TFP shock, on which the default decision is based for a given debt level, is revealed at t^-, which is the time working capital loans from $t-1$ is due.

$$V(z_t, \kappa_{t-1}, b_t) = \max \{V^{nd}(z_t, b_t), V^d(z_t, \kappa_{t-1})\} \qquad (4.7)$$

where for asset values $b_t > 0$, $V(z_t, \kappa_{t-1}, b_t) = V^{nd}(z_t, b_t)$. Unlike the model in chapter 3, there's an extra state variable that needs to be tracked, working capital decisions of firms from last period. However, the working capital choice of firms is only a function of current shock and asset choice of the sovereign and as will be shown in section 4.2.4 the discount rate can be recovered just as a function of z_t, and b_{t+1}. The recursive problem of the sovereign with good credit standing that choose not to default in current period is to conduct fiscal policy to maximize the welfare of households for a given set of private sector choices $\{c_t, n_t, m_t\}$ and prices;

$$V^{nd}(z_t, b_t) = \max_{\{T_t, g_t, b_{t+1}\}} \{U(c_t, 1 - n_t, g_t) + \beta \int V(z_{t+1}, \kappa_t, b_{t+1})dF(z_{t+1}|t)\} \qquad (4.8)$$

$$s.t. \quad g_t = \tau(w_t n_t + M_t) + b_t - q_t b_{t+1} \qquad (4.9)$$

where $M_t = p_s^m m_t$ if $p_s^m(1 + \theta r_t) \le p_i^m m_t$ and $M_t = p_i^m m_t$ otherwise.

$V^d(z_t, \kappa_{t-1})$, value of being in default, with all existing sovereign debt cleared, government excluded from credit markets in current period remaining in default with positive probability γ next period is;

$$V^d(z_t) = \max_{T_t, g_t} \{U(c_t, 1 - n_t, g_t) + \beta \int [(1 - \gamma)V^d(z_{t+1}) + \gamma V^{nd}(z_{t+1}, 0)]dF(z_{t+1}|t)\}$$

$$(4.10)$$

$$s.t. \quad g_t = \tau(w_t n_t + p_i^m m_t) \tag{4.11}$$

Property of the CRTS technology and optimality conditions from the static firm and household problems give us the set of private sector constraints that will appear in government's problem for non-default state;

$$c_t = \alpha z_t f(n_t, m_t)(1 - \tau_t) \tag{4.12}$$

$$-\frac{U_l(c_t, 1 - n_t, g_t)}{U_c(c_t, 1 - n_t, g_t)} = (1 - \tau)w_t \tag{4.13}$$

$$w_t = z_t f_n(n_t, m_t). \tag{4.14}$$

$$p_t^m = \min \{p_s^m(1 + \theta r_t), \ p_i^m\} \tag{4.15}$$

$$r_t = \frac{1 - q(z_t, b_{t+1})}{q(z_t, b_{t+1})} \tag{4.16}$$

$$\kappa_t = \begin{cases} \theta p_s^m m_t(1 + r_t) & \text{if } p_i^m(1 + \theta r_t) \geq p_s^m \\ \\ 0 & \text{otherwise} \end{cases}. \tag{4.17}$$

Using these, the state variable $s = \{z, b\}$ and policy vectors $\psi = \{g, b', T\}$, where prime variables denote the next period, and approximating stochastic TFP shocks

with a first-order Markov chain, for a given set of prices $\{w, q\}$ we can re-write the problem of the sovereign that has not defaulted in a compact form;

$$V^{nd}(z, b) = \max_{\psi} \{U(c(s; \psi), 1 - n(s; \psi), g) + \beta \sum_{z'} \Gamma_{zz'} V(z', \kappa(s; \psi), b')\} \quad (4.18)$$

$$s.t. \quad g = zf(n(s; \psi), m(s; \psi)) - c(s; \psi) + b - qb' - p_m m(s; \psi) \quad (4.19)$$

$$(1 - \tau)w = -\frac{U_l(c(s; \psi), 1 - n(s; \psi), g)}{U_c(c(s; \psi), 1 - n(s; \psi), g)} \quad (4.20)$$

$$w = w(s; \psi) \quad (4.21)$$

$$p^m = p(q; \theta, p_m^i, p_m^s) \quad (4.22)$$

$$q = q(z, b') \quad (4.23)$$

where 4.19 is the economy-wide resource constraint. This representation of sovereign problem explicitly shows the margins the government faces conducting fiscal policy, it maximizes the welfare of its households subject to private sector optimality and the resource constraint of the economy. Fiscal authority being aware of the distortionary consequences of its actions on private sector, fully internalizes private sector's response to policy actions. If the sovereign chooses to default in the beginning of a period, it is relived of its current debt $b = 0$, excluded from credit markets this period and not allowed to save $b' = 0$, diverts private firms' working capital repayments, κ to households as transfers, and chooses $\psi^d = \{g, T\}$ the problem becomes;

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$$V^d(z, \kappa) = \max_{\psi^d} \{U(c(s; \psi^d), 1 - n(s; \psi^d), g) + \tag{4.24}$$

$$\beta \sum_{z'} \Gamma_{zz'}[\gamma V(z', 0, 0) + (1 - \gamma)V^d(z', 0)]\}$$

$$s.t. \quad g = zf(n(s; \psi^d), m(s; \psi^d)) - c(s; \psi^d) - p_i^m m(s; \psi^d) + \kappa_{t-1} \tag{4.25}$$

$$(1 - \tau)w = -\frac{U_l(c(s; \psi^d), 1 - n(s; \psi^d), g)}{U_c(c(s; \psi^d), 1 - n(s; \psi^d), g)} \tag{4.26}$$

$$w = w(s; \psi^d) \tag{4.27}$$

where $\kappa_{t-1} = 0$ if government is carried to default state not by choice this period but

by stochastic transition due to a previous default.

Government's default decision for a given level of savings and working capital can

be characterized as repayment and default sets in terms of rest of the state variables.

For a couple b', κ, there exist a set of productivity shocks for which it is optimal to

default;

$$\Delta(\kappa, b') = \{z' \in \{Z\} : V^{nd}(z', b') < V^d(z', \kappa)|z\}. \tag{4.28}$$

4.2.4 International Financial Intermediaries

International intermediaries consist of perfectly competitive, risk-neutral and fully

informed agents. They invest in government and private firm loans. They have access

to funds at the cost of risk-free world interest rate. As before, perfect competition implies zero expected profits, that is equalized expected return on loans and the world's risk-free asset in equilibrium. Unlike chapter 3 the discount rate the loan suppliers charge is also a function of the working capital choice of firms, that will be a factor in next period's default decision of the sovereign.

When intermediaries are net lenders, their expected profits are,

$$\pi_t^i = -q(z, \kappa, b')b' + \frac{Pr(z' \notin \Delta(\kappa, b'); z)}{1 + r^w}b' \tag{4.29}$$

where $Pr(z' \notin \Delta(\kappa, b'); z)$ is the probability of government not defaulting and lenders getting their loan paid back and r^w is the risk-free interest rate. Profit maximization implies,

$$q(z, \kappa, b') = \frac{Pr(z' \notin \Delta(\kappa, b'); z)}{1 + r^w} \tag{4.30}$$

where Z is the domain of productivity shocks.

Even though default set is a function of κ, probabilities of default still only depends on b' and z only and can be extracted through,

$$Pr(z' \in \Delta(\kappa, b'); z) = \sum_{\Delta(\kappa(z,b'),b')} \Gamma_{zz'} \tag{4.31}$$

Given the state of the economy and asset choice of the sovereign, this set defines the probability of default, which will characterize the pricing decisions of the international investors only as functions of b' and z, $q(z, b')$. The discount rate on deposits, $b' > 0$, is the risk free rate $q(z, b') = \frac{1}{1+r^w}$. With the model explicitly defined, we now define the recursive equilibrium of this economy.

4.2.5 Equilibrium

Definition 2. *An equilibrium of this economy is characterized by,(i) Value functions $V^{nd}(z, b)$, $V^d(z, \kappa)$ and associated default set $\Delta(\kappa, b')$ (ii) A set of private agent decision rules for demand and supply for hours, consumption; $n^h(z, b, \kappa)$, $n^f(z, b, \kappa)$ and $c(z, b, \kappa)$, (iii) A vector of policy rules for public good, transfers and asset choice $\psi(z, b, \kappa)$, (iv) Price functions $q(z, b'), w(z, b)$ such that;*

(a) *Given policy and price functions, decision rules $n^h(z, b, \kappa)$, $n^f(z, b, \kappa)$ and $c(z, b, \kappa)$ solve the household and firm problems respectively and $w(z, b)$ clear the labor market $n^h(z, b, \kappa) = n^f(z, b, \kappa)$,*

(b) *Given the price functions and decision rules for private sector, policy rules $\psi(s, b)$ and value functions $V^{nd}(z, b), V^d(z, \kappa)$ solve government's problem and generate the default set $\Delta(\kappa, b')$,*

(c) *Given households and firms optimize, the function $q(s, b')$ is consistent with*

$\Delta(\kappa, b')$ *and satisfies profit maximization condition of the international financial*

intermediaries.

(d) Economy resource constraint (eq. 4.19) holds.

In the next section, I will quantitatively solve the model to investigate the implications of financial frictions in an environment as defined.

4.3 Quantitative Analysis

4.3.1 Data

To calibrate my model I chose Mexico, a country with a default history and fragile financial system throughout data period the from which the statistics to match comes from. The quarterly national income account data is from International Financial Statistics database of IMF, covers the period 1990-2009, fiscal data is from Ministry of Finance of Mexico and statistics of interest are given in table 4.2.

4.3.2 Functional forms and Calibration

In this section the quantitative implications of the model by conducting numerical simulations is tested. For preferences I use GHH (Greenwood et al., 1988) for the with a separable public-private consumption good. As mentioned, this type of pref-

Table 4.2: Mexico: Business Cycle Moments

Statistic	Value
$\sigma(y)$	3.43
$\sigma(c)$	4.45
$\sigma(g)$	5.81
$\sigma(T)$	19.4
$\sigma(g)/\sigma(y)$	1.69
$\rho(g,y)$	0.40
$\rho(T,y)$	0.32
$\rho(c,y)$	0.71

erences is the common choice in SOE literature due to their success in matching the particularities of small open economies Mendoza (1991).

$$U(c,n,g) = \mu \frac{(c - \frac{n^v}{v})^{1-\sigma}}{1-\sigma} + (1-\mu)\frac{g^{1-\sigma}}{1-\sigma} \qquad (4.32)$$

The risk aversion parameter σ is set to 2 and the quarterly world risk-free interest rate r is set to 1%, which are standard values in quantitative business cycle and sovereign default studies. The curvature parameter of labor in the utility function is set to $v = 1.455$, and implies a Frisch wage elasticity of labor supply of 2.2, which is standard in SOE models (Mendoza, 1991; Neumeyer and Perri, 2005; Mendoza and Yue, 2008). The probability of re-entry after default is $\gamma=0.055$, which implies that the country stays in exclusion for roughly 4.5 years after default on average. This estimate

is in line with the estimates reported by Richmond and Dias (2008) for the period of 1980-2000. For imported input share in gross output we use $\varphi = .14$, estimated from Mexican data by Mendoza (2008) for the period of 1993-2005 and corrected for the missing capital share. The model's relative price between inferior technology imported input prices and superior ones with advance payment constraint, $\frac{p_m^i}{p_m^s(1+\theta r)}$, also govern relative cost of default and sensitive to productivity shocks through interest rate. The price of imported goods relative to consumption goods is taken from Mendoza (2008), which is estimated for the period 1993-2005, by the ratio of values of imported intermediate goods to gross output in current and constant prices 1.028.

We also allow for asymmetric cost of default allow for non-trivial amounts of debt;

$$z_t = \left\{ \begin{array}{ccc} \hat{z} & if & z_t > \hat{z} \\ \\ z_t & if & z_t \leq \hat{z} \end{array} \right\} \tag{4.33}$$

and this asymmetric cost of default makes the value of default less sensitive to productivity shocks and increase the range of risky borrowing.

Productivity shocks follow an AR(1) process:

$$\log(z_t) = \rho_A \log(z_{t-1}) + \epsilon_t. \tag{4.34}$$

and lack of data prohibits direct estimation of the parameters governing variance and autocorrelation of productivity shocks so ρ_A and $\sigma \epsilon$ are estimated with a set of other parameters to match the variance and autocorrelation of Mexican quarterly

GDP. Rest of the parameters $\mu, \beta, p_i^m, \hat{z}$ are estimated to match, private-public consumption ratio, default frequency, debt-output ratio volatility and output drop after a default episode for Mexico. The number of defaults for Mexico between the years of 1901-2009 is 3, which comes down to 0.68% probability per quarter. The government consumption is roughly 16% of household consumption for the relevant period and standard deviation of trade balance is 2.35. Mexico has experienced one default since quarterly data has been available in year 1982, during which the output deviation from HP-trend during the quarter after was 5%, we take this value to match the output drop in default.

As mentioned earlier in the chapter, our assumption is the frictions are in full force, i.e. $\theta = 1$, and private and public sectors are generating the observed data facing these frictions. Neumeyer and Perri (2005) uses the same value, with much higher and volatile interest rates shocks than our model is likely to generate, and on the the wage-bill which is calibrated to 6 times higher relative to output then our imported input. Uribe and Yue (2006) also finds high values of θ is required to match the data, so our running hypothesis is not implausible. The calibration exercise will proceed with decreasing the value of θ gradually and observe the sensitivity of the model to this parameter as a proxy to importance of financial frictions in these markets in terms of policy and private outcomes.

Table 4.3: Model Calibration

Calibrated Parameters		Value	Target
Risk-free interest rate	r	1%	Standard RBC
Imported good share	α_m	0.14	Imported Interm. Inp. GDP ratio
CRRA risk aversion	σ	2	Standard RBC
Labor supply curvature	υ	1.455	Standard SOE RBC
Probability of re-entry	γ	.055	Length of exclusion
Estimated Parameters		Value	Targets
Discount factor	β	.95	Frequency of default
TFP persistence	ρ_z	.85	Autocorrelation of output
TFP innovation std.	ϵ	.008	Variance of otput
p_i^m/p_s^m	p_i^m	1.04	Output drop after Default
Public cons. coeff.	μ	.09	Public/Private cons. ratio
Default TFP cutoff	$\hat{z}$	.97	Volatility of Debt-GDP ratio
Tax rate	τ	.153	Consumption-Transfer ratio

Table 4.4: Simulation Results

Statistic	Data	$\theta_{max} = 1$	$\theta/\theta_{max} = .75$	$\theta/\theta_{max} = .50$	$\theta/\theta_{max} = .25$
$\sigma(y)$	3.43	1	0.99	.98	.98
$\sigma(b/y)$	9.98	1	0.88	.73	.55
$\sigma(g)/\sigma(y)$	1.69	1.47	1.38	1.29	1.22
$\sigma(T)/\sigma(y)$	6.10	12.47	9.38	8.29	8.22
$\rho(y, g)$	.40	.79	.85	.90	.94
$\rho(y, T)$	.32	.40	.61	.63	.64
$\rho(spread, y)$	-.45	-.38	-.39	-.41	-.41
$pdef(\%)$	.68	1	.70	.49	.22

4.3.3 Results

The results reported in table 4.4 point to importance of financial frictions in conduct of fiscal policy [18]. For a given level of debt and shock, figure 4.1 shows a decreasing discount rate for level of working capital since incentives for default rises as the transfers as a result of default rise with working capital. Aggregate volatility is is not very sensitive to the level of frictions, this is in contrast with the general findings in literature ((Neumeyer and Perri, 2005),(Cicco et al., 2006), (Mendoza and Yue, 2008)) which find these frictions usually work as an amplifying factor in transmitting exogenous shocks to output. The underlying reason in this difference is the fact that in our model, interest rate is endogenous and sensitive to fiscal policy. In such an

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[18]The volatilites in table 4.4 are reported relative to the benchmark model, $\theta = 1$.
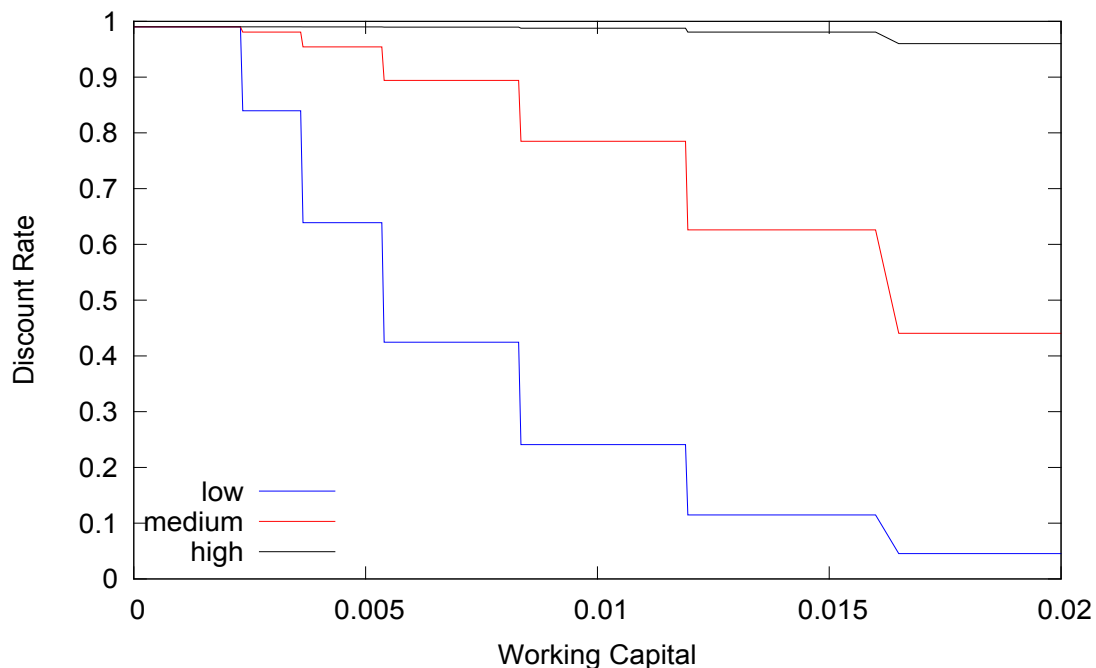
Figure 4.1: Discount Rate as a function of current shock

environment, benevolent government has the option and chooses to let the fiscal sector absorb the shocks and since interest rate is sensitive to debt level, it is the provision of public goods and transfer payments that fluctuates over the cycle, minimizing the effect of shock transmission through debt level and interest rate to output. This can be seen in increasing levels of relative volatility of government consumption and transfer payments as the level of frictions get higher.

Pro-cyclicality is also inversely related to financial frictions. As the level of frictions rise, both government and transfer payments become less pro-cyclical. This seems counter-intuitive as with lower friction level, one would expect debt to become a less costly tool for policy smoothing and the linkage between output and fiscal ag-

gregates should get looser. However, the sovereign in our model is always close to its endogenous borrowing limits and in risky debt area. This makes lowering debt level very attractive to the sovereign since in doing so it alleviates the borrowing costs on private firms and increase output. So at the debt levels very close to the limit, which is mostly the case in these models, the incentive to move away from risky borrowing dominates and pro-cyclicality soothes. This is also reflected in high volatility of debt-output ratio, higher volatility of fiscal policy comes together with higher levels of volatility in debt. We know from standard theory, high volatilities of debt as a buffer-stock is usually implied by policy smoothing, but in our case, due to combination of debt-sensitive endogenous interest rate and working capital constraint, debt itself is no longer a tool to passively adjust to fluctuations.

Another interesting fact is the default behavior of the sovereign changes considerably with level of frictions. Default is used much more often as a state contingent action by the government when financial frictions are high. Considering the finance cost of non-default, the relative cost of default is less with higher frictions at higher levels of debt which increases the incentives of the sovereign to use default as a way of partially completing the non-state contingent nature of its debt and this finding is in line with Mendoza and Yue (2008).

4.3.4 Conlusion

In this chapter, I have investigated the effects of financial frictions combined with the market incompleteness and commitment problem of the sovereign, in conducting fiscal policy. I introduced the financial frictions in the form of working capital constraint on private firm's imported input of production. The additional and crucial linkage between the fiscal policy and private sector came in the form of sovereign debt sensitive borrowing cost on working capital borrowing of private firms. To summarize, I find that the level of financial frictions have important implications for the behavior of the government and characterization of fiscal policy. As the cost of the debt within this particular environment is no longer just the interest rate charged, government optimally internalize the negative externality it creates through borrowing. Such optimal behavior generates a fiscal policy, increasingly volatile and less pro-cyclical in level of financial frictions.

Chapter 5

Conclusion

In this dissertation I investigated the the effects of market incompleteness and financial frictions in small open developing economies on conduct of fiscal policy and aggregate volatility. Specifically I asked, what is the relevance of;

- Commitment problem of a sovereign in debt repayment

- Market incompleteness due non-existence of state-contingent long maturity borrowing

- Financial frictions of a particular type

in accounting for the observed differences of fiscal policy in developing and developed countries with respect to pro-cyclicality and excess volatility?

In Chapter 3, I looked into the optimal fiscal policy under the option of default for a fiscal authority where the government is the only agent with access to international borrowing. I built a model by incorporating a detailed explicit fiscal sector to what is

otherwise a standard sovereign default setup. The environment I define is an incomplete market setup that resembles small open developing economies with respect to existence of short-maturity non-state contingent defaultable debt as the only tradable asset for sovereign government. I use this model to identify the contribution of market incompleteness due to the commitment problem of the sovereign and found that commitment problem is a key element in generating excess volatility through endogenous borrowing constraints it creates on the sovereign but market incompleteness due non-existence of state-contingent long maturity borrowing generates pro-cyclicality but not enough by itself for excess volatility.

In Chapter 4, I look into the interaction of financial frictions faced by private and public sectors in these economies in an effort to provide a framework that would assess the relevance of financial frictions in generating observed outcomes. I built a model with endogenous output and interest rate with an explicit fiscal sector providing public consumption to households financed by income taxation and debt issue. I introduce the financial frictions faced by the private sector in the form of working capital constraint on an imported factor of production. The firms' financing costs for borrowing against this constraint is set as a consequence of government borrowing, that is both public and private sectors face the same borrowing rate determined by government indebtness. In such an environment, I find that the level of financial frictions have important implications for the behavior of the government and charac-

terization of fiscal policy. As the cost of the debt within this particular environment is no longer just the interest rate charged, government optimally internalize the negative externality it creates through borrowing and this results in an optimal behavior that generate a fiscal policy, increasingly volatile and less pro-cyclical in level of financial frictions.

Overall, my results point to the relevance of the set of factors listed above in explaining the observed differences in fiscal policy conduct and further research on the area is likely to help us understand the roots and causes of seemingly non-optimal fiscal policy conduct in small open developing economies.

Appendix

Data Sources and Coverage

For Chapter 2, Table 2.2;

Government Consumption Data: Period of 1960-2005, 55 countries grouped according per-capita income yearly data (60%), with varying individual country data periods, 32 developing, 23 developed.

- **Developing:** Nigeria, Senegal, Pakistan, India, Indonesia, Bolivia, Honduras, Egypt, Mauritius, Ecuador, Philippines, Nicaragua, Thailand, Paraguay, Dominican Republic, Peru, Tunisia, Panama, Turkey, Algeria, Colombia, Malaysia, Venezuela, Chile, Brazil, Uruguay, Mexico, South Africa, South Korea, Argentina, Malta, Taiwan,

- **Developed:** Czechoslovakia, Greece, Singapore, Spain, New Zealand, Israel, Hong Kong, Germany, Finland, Italy, Austria, France, Great Britain, Sweden, Japan, Belgium, Canada, Netherlands, Australia, Denmark, Norway, Switzerland, USA

Primary Surplus Data: Period of 1988-2001 for 12 OECD countries. Period of

1970-2001, 19 developing economies, varying length of yearly data.

- **Developing:** Bolivia, Colombia, Costa Rica, Dominican Republic, India, Indonesia, Korea, Malaysia, Mexico, Morocco, Panama,Paraguay, Peru, Philippines, South Africa, Thailand, Tunisia, Uruguay, Venezuela

- **Developed:** Australia, Austria, Belgium, Canada, Denmark, France, Germany, Japan, Netherlands, Sweden, United Kingdom,United States

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