Optimal Fiscal Policy with Risk Premium on Loans: Is it Pro-cyclical in Emerging Countries?

Subrata Sarker*

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Abstract

This paper examines the optimal fiscal policy in a small open economy where the interest rate on foreign loans depends on the net worth of the economy. The loan supply function, in this case, captures the observed negative correlation between the interest rate and output in emerging countries. It is well known that the fiscal policy is procyclical in many of the emerging countries in the sense that the policies often accentuate the business cycle booms and recessions. We show that this procyclical pattern of the fiscal variables may indeed be an optimal outcome for a Ramsey planner in such an economy. During a recession, as the debt financing of deficit becomes expensive due to decline in net worth, government may optimally choose to reduce expenditure, raise tax rates and reduce borrowing. The opposite happens during a boom and thereby leads to procyclical expenditure and tax policies and procyclical public debt accumulation.

Keywords: Procyclical fiscal policy, Ramsey optimal policy
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*PhD Candidate, Department of Economics, University of British Columbia, 997-1873 East Mall, Vancouver, BC, V6T 1Z1 Email: ssarker@interchange.ubc.ca. I am greatly indebted to my advisor, Amartya Lahiri, for his advice and encouragement. I am also especially thankful to Michael B. Devereux and Viktoria Hnatkovska for their helpful guidance. I have also benefited from discussions with Paul Beaudry, Henry Siu and from participants at the Canadian Economic Association meeting, Vancouver 2008, Small Open Economy in a Globalized World Conference, Waterloo, 2008, CIREQ Conference, Montreal 2009 and macro lunch seminars at UBC. All errors and omissions are mine.

1 Introduction

In developed countries, fiscal policy is either countercyclical, i.e. they are targeted to smooth the cyclical fluctuations in income and employment, or they are, at least, acyclical. However, in many of the emerging developing countries, it appears that the fiscal policy is procyclical. Procyclicality implies that business cycle booms and recessions are accentuated by the government policies. This may take place in several ways: tax rates fall in good times and rise in bad times, government consumption rises in good times and falls in bad times. These phenomena are often considered as significant contributors to the macroeconomic instability in emerging market economies.

These observations are contrary to the conventional wisdom in two major schools of macroeconomic thoughts. The Keynesian framework suggests that the fiscal policy should be countercyclical i.e. the government should cut taxes and increase expenditures during a recession and do the opposite during a boom. The neo-classical approach, on the other hand, suggests that fiscal policy should remain largely neutral over the business cycles[1]. This raises an important question: are policy procyclicalities simply the result of misguided macroeconomic policies or are they the results of specific circumstances in which the policy making authorities in these countries operate? Understanding these puzzling issues is an important step in macroeconomic stabilization in developing countries.

The purpose of this paper is to investigate the role of financial market imperfections in explaining the procyclical fiscal policy. Uribe and Yue (2006) and Neymeyer and Perri (2005) document that in emerging countries, the

[1]For example, see Barro (1979) or Lucas and Stockey (1983)

interest rate on foreign loan is negatively correlated with output whereas the correlation is either positive or zero for the developed countries. The difference in cost of borrowing is also reflected in the fact that these countries tend to borrow more during good times and lend during bad times i.e. net capital flow seems to be pro-cyclical as shown by Kaminsky, Reinhart and Végh (2004). Negative correlation between interest rate and economic condition implies that it is costly for the government of an emerging economy in recession to smooth consumption or reduce tax distortion using debts.

We examine this issue by deriving the optimal fiscal policy for a Ramsey planner in a standard small open economy model with the only friction being an incomplete international financial market where the rate of interest on foreign loans depends negatively on the net worth of the economy. The net worth is defined as the level of GDP relative to national indebtedness. Following a recession, the tax revenue declines. The government can then increase tax rates or reduce spending. Increasing tax rates during a recession creates further distortion. And since public goods provide direct utility to the households, the supply of public goods should be smoothed by debt-financing during a recession. But borrowing by the government during a recession further worsens the net worth of the economy and thereby increases the cost of borrowing for the whole economy. We numerically solve the problem of the Ramsey planner facing this trade-off by calibrating the model to Mexico, a representative emerging market economy. The optimal policy implies a procyclical pattern in both fiscal policy and flow of capital, as observed in the data.

The paper proceeds as follows: section 2 briefly discusses some of the stylized facts from the existing empirical studies on the procyclicality of fiscal policy and provides new evidence for procyclicality of the tax rates in some developing countries. Section 3 links this paper with the existing literature on procyclicality. Section 4 discusses the baseline model with exogenous public expenditure and derives optimal cyclical movement of tax rates in response to negative productivity shock. Section 5 extends the baseline model by incorporating endogenous public expenditure and discusses its implications. Section 6 provides the concluding remarks.

2 Stylized Facts

Gavin and Perotti (1997), Braun (2001), Kaminsky, Reinhart and Végh (2004), Alesina, Campante and Tabellini (2007), Ilzetzki and Végh(2008) provide ample evidence in support of procyclical fiscal policies. Braun (2001) finds that while in OECD countries a one percentage point increase in GDP is associated with a reduction of 0.37 percentage point in the ratio of government expenditures to GDP; in developing countries this ratio remains unchanged. This implies, in developing economies, government expenditures increase by the same proportion during economic expansions and decline by the same proportion during recessions. Kaminsky, Reinhart and Végh (2004) is by far the most comprehensive empirical exercise in this regard. They document some key stylized features of the procyclical business cycle variation in fiscal policies in the developing countries using a dataset of 104 countries and covering a period between 1960 and 2003. Below we summarize and provide some more evidence of the cyclical pattern of the fiscal variables.

2.1 Cyclicality of Public Expenditure

Table 1 presents the correlation of the cyclical components of GDP with the general government expenditure as observed in Kaminsky, Reinhart and

Végh (2004). We extend their data till 2007. For the middle income and the low income countries, the government expenditure is clearly pro-cyclical whereas, for the OECD countries, there is an acyclical pattern. Alesina, Campante and Tabellini (2007) show similar evidence for a number of countries using the public expenditure to GDP ratio instead of the level of expenditure.

Table 1: **Correlation Between Public Expenditure and GDP**

Countries	HP Filter	Band-Pass Filter
OECD	-0.05	-0.02
Middle-High Income	0.43	0.45
Middle-Low Income	0.21	0.22
Low Income	0.38	0.35

Source:KRV(2004) data extended till 2007.

2.2 Cyclicality of Tax Rates

Time series on cyclical variation in actual tax rates are not readily availabe. There are, however, strong episodic evidences suggesting that tax rates are procyclical in developing countries. In a detailed case study on Uruguay, Mailhos and Sosa (2000) found that over the period between 1975 and 1999 almost all of the tax rates such as the value added tax rates, income tax rates, wage tax rates and certain commodity tax rates were procyclical. They also found that the tariffs charged by the state-owned-firms for public utilities, which often constitutes a form of implicit taxation, were significantly negatively correlated with the GDP. In addition, the taxes charged by the social welfare authorities on different pension funds and housing or construction funds were also procyclical. Talvi and Végh (2005) report that in 1995, in the midst of a severe recession, both Argentina and Mexico implemented major fiscal adjustments which involved large increases in tax rates along with cuts in public spending. In Mexico, for instance, the value-added tax rate was increased by five percentage points. In contrast, tax rates were reduced in Argentina during the economic boom in 1991 to 1994. Similarly, Vicente and Rial (2007) report that in the middle of a recession, during the debt-crisis of 2002-2003, the Uruguayan government dramatically increased the tax rates. And the rates were reduced back to their previous levels during the expansionary period in 2005. This episodic evidence is further confirmed by Cuadra, Sanchez and Sapriza (2009). They calculated a series of average consumption tax rate in Mexico for the 1980 to 2007 period and find the correlation between the tax rate and GDP to be -0.33.

Table 2: **Correlation between average tax rate and GDP**

India	-0.14	USA	0.22
Mexico	-0.14	UK	0.11
Brazil	-0.17	Canada	0.03

Source:Author's calculation.

The ratio of the tax revenue to GDP is often perceived as a measure of the average tax rate in an economy. Table 2 reports the correlation between the annual average tax rate and the cyclical component of GDP for the 1981 to 2007 period for a representative sample of countries from the emerging and developed world. The source of the data is IMF's Government Financial Statistics database. Clearly, a pattern of weak procyclicality of the fiscal policy is evident in emerging countries where the tax rates are negatively correlated with GDP[2]. This measure of average tax rate, however,

[2]The terminology is a bit confusing here. A policy is pro-cyclical when it accentuates the business cycle. In case of tax rate, a negative co-movement with output will be an example of a pro-cyclical policy.

is not perfect since tax revenue often moves endogenously with business cycle without any policy induced exogenous change in tax rate. For example, during a boom, imports go up and consequently the tariff revenue, which is often a big share of the tax revenue in developing countries, is also higher. In this case, the bias induces a positive correlation between tax revenue and GDP and, therefore, weakens our result of negative correlation in developing countries. Due to data limitation, it was not possible to look at only the non-tariff component for the developing countries.

2.3 Cyclicality of Capital Flow and Interest Rate

Table 3: **Fluctuations in Capital Flow**

Countries	Net Capital Inflows/GDP		
	Good Times (1)	Bad Times (2)	Amplitude (1)-(2)
OECD	0.5	0.4	0.1
Middle-High Income	4.4	3	1.4
Middle-Low Income	4.2	3	1.2
Low Income	3.9	3.6	0.3

Note: Good (bad) times are defined as those years in which GDP growth is above (below) the median. Net Capital flow to GDP ratios in percentage term.
Source: Kaminski, Reinhart and Végh (2004).

Kaminsky, Reinhart and Végh (2004) document that the middle-income countries tend to borrow more during good times and lend during bad times i.e. net capital flow seems to be pro-cyclical[3]. As reported in Table 3, the difference between the net capital flow to GDP ratio during the good and the bad times are highest for the middle income countries. They further show that there is almost no difference in credit ratings for the OECD countries

[3]Aghion and Marinescu (2007) report that, even within the OECD countries, less financially developed or more open economies display less countercyclical public debt growth.

during good and bad times whereas ratings are clearly pro-cyclical for the middle income countries[4]. This evidence, coupled with the negative correlation between interest rate and output in emerging countries, as documented in Uribe and Yue (2006) and Neymeyer and Perri (2005) (see Table 4), suggests that these countries face a positive premium on interest rate when their output is low and they need to borrow more to smooth consumption.

Table 4: **Correlation between interest rate and output**

Emerging Countries		Developed Countries	
Argentina	-0.63	Australia	0.37
Brazil	-0.38	Canada	0.25
Korea	-0.70	Netherlands	0.34
Mexico	-0.49	New Zealand	0.07
Philippines	-0.53	Sweden	-0.05
Average	-0.55	Average	0.20

Source: Neumeyer and Perri (2005)

3 Existing explanations and link to the literature

Existing explanations of procyclical fiscal policy have followed two main strands:

- Political-economic explanations by Talvi and Végh (2005), Alesina, Campante and Tabellini (2007), Ilzetzki (2008) and others.
- Explanations based on international credit market imperfections as in Gavin and Perotti (1997), Aizenman, Gavin and Hausmann (1996) or more recently by Riascos and Végh (2003) and Cuadra, Sanchez and Sapriza (2009).

[4]There is almost no variation in capital flow or credit ratings for the low income countries but that may be because of the fact that at such low ratings they are already shut out of the international credit markets.

This paper provides a formalization of the credit market channel. However, to motivate the discussion, we first discuss very briefly the alternative explanation based on political economic frictions and then move on to the credit market imperfection.

3.1 Political-economic Explanations

Talvi and Végh (2005) argue that budget surpluses create political pressure for increased public spending from different interest groups. And it is the inability of the governments to maintain primary surplus during booms, to pay off debt, that forces them to lower public expenditures and raise tax rates during recessions. Alesina, Campante and Tabellini (2007) and Ilzetzki (2008) highlight the role of rent seeking in generating procyclical fiscal behaviour. In particular, Alesina, Campante and Tabellini (2007) argue that in corrupt democracies voters minimize rent extraction by demanding pro-cyclical policy. When a positive income shock hits the economy, voters demand immediate benefits in the form of tax cuts or increases in productive government spending or transfers. They fear that otherwise the available extra resources would be wasted in rents. Consequently governments can not accumulate reserves in good times to run a countercyclial policy. They show that in the data covering 83 countries over the period between 1960 and 2003, pro-cyclicality of government expenditure is highly correlated with corruption and the correlation is stronger in democracies. However, the causality is difficult to establish since corruption is highly correlated with credit rating in the data. Moreover Thornton (2008) provided contrasting evidence from 37 low-income African countries during 1960-2004 that the procyclicality is rather relatively weaker in democracies.

3.2 Credit Market based Explanations

The key argument is that the total or partial loss of access or costly access to international credit in difficult times forces developing countries to contract government spending and raise taxes in bad times. Gavin and Perotti (1997) made this claim based on empirical observations from Latin American countries.

Riascos and Végh (2003) were the first paper to formalize this argument. They consider a setting where government consumption provides direct utility to the representative agent in an endowment economy model. Government finances its expenditure either by taxing private consumption or by borrowing from abroad. They distinguished developed countries by allowing them access to a complete set of state-contingent claims. In contrast, developing countries only have access to a one-period non-contingent international bond so that asset markets are incomplete. They show that under incomplete market, optimal government expenditure will be pro-cyclical. In contrast, under complete market both private and government consumption are constant across the states of the economy. While this paper is an important first step, there are several directions in which further examination is called for. Firstly, there is no production in their model and consequently no consumption-leisure choice. If labour is introduced in their model, then consumption (both public and private) will co-move positively with output under both complete and incomplete market setting[5]. Merely an incomplete credit market, therefore, is not sufficient to capture the distinguishing characteristic of the credit market faced by the emerging countries. Endogenizing public expenditure either by introducing it in the utility function as a normal

[5]Except when the utility function is additively separable between consumption and leisure.

consumption good or by introducing it in the production function as a flow of input (or stock of public capital) easily leads to procyclical pattern in a business cycle model. The challenge, instead, is to show whether the other instrument of public policy (i.e. the tax rate) is also moving procyclically or not. Riascos and Végh (2003) predict a counter-cyclical optimal consumption tax policy. This happens because the capital flow is counter-cyclical in their model. Both the private agent and the government can borrow more during bad times as the interest rate remains constant. So the government does not need to resort to distortionary taxes to generate revenue during bad times. However, counter-cyclicality of capital flow is completely counter-factual for the emerging countries as documented by Kaminsky, Reinhart and Végh (2004).

Cuadra, Sanchez and Sapriza (2009) use a model of sovereign default and show that public expenditure and tax rates are optimally procyclical. Their model also matches the observed pattern in interest rate and flow of public debt. However, absence of capital in their model implies that the taxation of income does not have any intertemporal distortion. Moreover, their infinite period dynamic model assumes that household does not have access to credit to smooth consumption on their own. This puts the entire burden of consumption smoothing on the government[6]. When households can borrow and save, and invest in physical capital, the Ramsey planner faces additional intertemporal constraints which make her problem non-recursive. This problem is difficult to solve in a model of sovereign default since, as we will see below, recursive transformation of the optimal policy problem increases the state space. In models of sovereign defaults, the typical solution method is

[6]Cuadra, Sanchez and Sapriza (2009) provides a two period extension of their model with private borrowing and show that their result holds in that environment. However, the validity of that result for a Ramsey planner with infinite horizon is not obvious.

to use value function iteration by discretizing the state space. When the state space is very large, this solution method is no longer useful. In this paper, we allow household to access the credit market and introduce capital and allow the government to tax both labour and capital income using a common income tax rate. To generate counter-cyclical interest rate, we assume a particular structure of the loan supply function where the interest rate depends on the net worth of the economy. This allows us to solve the recursive transformation of the originally non-recursive Ramsey optimal policy problem using a standard solution method.

4 Benchmark Model

Consider a small open economy with three agents: representative households, competitive firms and the government. The credit market faced by the economy is incomplete in the sense that both the households and the governments have access only to one period real discounted bond. The interest rate on that bond is negatively related to the deviation of the real net-worth of the economy from its steady state level. The net worth is defined as the value of current output adjusted for the current level of total debt obligation. Other things constant, borrowing by the households or the government decreases the net worth of the economy and, therefore, increases the cost of borrowing. I assume the following functional form for the interest rate:

$$r_t = r + \psi \left(e^{\left((\overline{y}-\overline{d}-\overline{b})-(y_t-d_t-b_t)\right)} - 1 \right)$$

where y_t denotes current output and d_t and b_t are the real private and public debt holdings at time t and $\overline{y}$, $\overline{d}$ and $\overline{b}$ are their steady state levels respectively. Note r is the rate of interest without the risk premium. It is assumed that $\beta(1+r) = 1$ where $\beta \in (0,1)$ denotes the subjective discount factor. This formulation of interest rate implies that the risk premium is a function of the productivity shock and debt. Recently similar approach has been adopted in Aguiar and Gopinath (2007), Garcia-Cicco, Pancrazi and Uribe (2006) and Li (2009). The idea is based on models of endogenous default by Eaton and Gersovitz (1981) or Arellano (2003) in which default probabilities are high when productivity is low and consequently the risk premium is high. This helps to generate a negative correlation between the output and the interest rate in our model. Our reduced form approach is subject to the usual criticism but our goal here is not to provide a theory of the risk premium in the international credit market but to show that how it's presence affects the optimal formulation of fiscal policies in emerging countries.

4.1 Households

The lifetime utility of the infinitely-lived representative household is given by:

$$E_0 \left[\sum_{t=0}^{\infty} \beta^t U(c_t, h_t) \right] \tag{1}$$

where c and h are the private consumption and hours worked respectively. $U(.)$ is increasing in consumption, decreasing in hours, strictly concave and twice continuously differentiable. The representative household trades in the international bond market and receives after-tax wage income from labour, rent from capital and spends that on consumption, investment and debt repayment. The household's budget constraint is given by:

$$d_{t+1} + (1-\tau_t)(w_t h_t + z_t k_t) = c_t + I_t + (1+r_t)d_t + \zeta(d_{t+1}) + \kappa_t \tag{2}$$

where w_t, z_t and τ_t denote the wage rate, rental rate and the income tax rate respectively. $\zeta(d_{t+1})$ is the loan adjustment cost faced by the household which is introduced to induce stationarity in the model following Schmitt-Grohe and Uribe (2003). κ_t denotes capital adjustment costs which are convex in investment and are defined in the following way:

$$\kappa_t = \kappa(I_t, k_t), k_I > 0, k_{II} > 0.$$

Lastly,

$$I_t = k_{t+1} - (1-\delta)k_t \tag{3}$$

In addition to the budget constraint, the household is also subject to the usual no-Ponzi game conditions. Households' problem can be described as maximization of (1) subject to (2) and (3) and the no-Ponzi game conditions. Note that households do not internalize the fact that they face an upward sloping supply curve for loan and they take interest rate as given. First order conditions with respect to consumption, labour supply, investment and foreign bonds imply:

$$-\frac{u'_{h_t}}{u'_{c_t}} = (1-\tau_t)w_t \tag{4}$$

$$u'_{c_t}(1-\zeta'_{d_{t+1}}) = E_t\beta\left[(1+r_{t+1})\,u'_{c_{t+1}}\right] \tag{5}$$

$$u'_{c_t}(1+\kappa'_{t_{k_{t+1}}}) = E_t\beta\left[\left((1-\tau_{t+1})z_{t+1}+1-\delta-\kappa'_{t+1_{k_{t+1}}}\right)u'_{c_{t+1}}\right] \tag{6}$$

First-order condition (4) implies that the tax rate introduces a wedge between the wage rate and the marginal rate of substitution between consumption and leisure. The higher the tax rate, the lower will be the labour supply for a given wage rate. The consumption Euler equation (5) indicates that the extra utility derived from investing one unit of consumption today in the foreign bond, to consume tomorrow, should be equal to the utility forgone by not consuming it today. This is another way of saying that, at the optimum, marginal benefit of an additional unit of debt must equal its marginal cost. Equation (5) is the Euler equation with respect to capital which shows that the marginal cost of investing one unit of consumption on physical capital today should equal the expected after tax marginal benefit the next period.

4.2 Firms

Firms are owned by the households.They produce the final good using a constant return to scale technology in labour and capital:

$$Y_t = A_t F(k_t, h_t) = A_t k_t^{\eta} h_t^{1-\eta} \tag{7}$$

where A_t is a productivity parameter. The law of motion of A_t is given by the following $AR(1)$ process:

$$\ln A_{t+1} = \rho \ln A_t + \epsilon_{t+1} \tag{8}$$

where $\rho \in (0, 1)$ and $\epsilon_{t+1} \sim NIID(0, \sigma_\epsilon^2)$. The static profit maximization problem of the representative firm can be expressed as follows:

$$\max_{h_t, k_t} \left(A_t k_t^{\eta} h_t^{1-\eta} - w_t h_t - z_t k_t \right)$$

This gives us the standard first order conditions which equate the marginal benefit of using labour and capital at any period t to their respective marginal costs:

$$w_t = (1-\eta)A_t k_t^{\eta} h_t^{-\eta} \tag{9}$$

$$z_t = \eta A_t k_t^{\eta-1} h_t^{1-\eta} \tag{10}$$

4.3 The Government

In the benchmark model, government expenditure is exogenously specified at $g_t = \bar{g}, \forall t$. This is just to illustrate the trade-off faced by the government in choosing distortionary taxation and/or costly public debt accumulation. Government finances its expenditure either by taxing wage and rental income of the households or by borrowing from the international credit market where it has access to a one period real non-contingent bond b_t. Unlike the household, government, however, internalizes the fact that the interest rate faced in the international capital market depends on the real net worth of the country. It is also assumed that a commitment technology exists and the government can bind itself to a particular sequence of fiscal policy variables. The budget constraint of the government is given by:

$$b_{t+1} + \tau_t(w_t h_t + z_t k_t) = g_t + (1+r_t)b_t \tag{11}$$

The government is also subject to a no-Ponzi-game condition of the following form:

$$\lim_{k\to\infty} E_t \left[\left(\prod_{j=0}^{t+k-1} \left(\frac{1}{1+r_j} \right) \right) b_{t+j} \right] \leq 0 \tag{12}$$

4.4 Characterizing Equilibrium

A competitive equilibrium is defined in the usual way:

Definition 1 Given the household's and the government's initial real debt d_0 and b_0, the initial capital stock k_0 and the exogenous stochastic processes

$\{A_t\}_{t=0}^{\infty}$ and exogenous government expenditure $\bar{g}$, an equilibrium is an allocation $\{c_t, k_{t+1}, h_t, d_{t+1}\}_{t=0}^{\infty}$, price system $\{w_t, r_t\}_{t=0}^{\infty}$ and government policy $\{b_{t+1}, \tau_t\}_{t=0}^{\infty}$ such that:

1. $\{c_t, k_{t+1}, h_t, d_{t+1}\}_{t=0}^{\infty}$ solve the household maximization problem subject to the sequence of household's budget constraints and the no-Ponzi game constraint.

2. $\{k_t, h_t, w_t, z_t\}_{t=0}^{\infty}$ solve the firm's problem.

3. $\{b_{t+1}, \tau_t\}_{t=0}^{\infty}$ satisfy the sequence of government budget constraints and the government's no-Ponzi game constraint.

4. The factor and the goods markets are cleared

Competitive equilibrium is obtained subject to the condition that (2)-(6), (9)-(11) and the no-Ponzi-game conditions are satisfied. To simplify the analysis of Ramsey optimal policy, we characterize the equilibrium in primal form. This involves restating the equilibrium conditions in terms of real allocations alone. Given those allocations, it is possible to recover the equilibrium values for the price and the policy variables. The following proposition presents the primal form of the competitive equilibrium:

Proposition 1 Given the household's and the government's initial real debt d_0 and b_0, initial capital stock k_0 and the exogenous stochastic processes $\{A_t, g_t\}_{t=0}^{\infty}$, the allocation $\{c_t, k_t, h_t, d_t, b_t\}_{t=0}^{\infty}$ satisfy (5), and

$$u'_{c_t}(1+\kappa'_{t_{k_{t+1}}}) = E_t\beta\left[\left(-\frac{u'_{h_{t+1}}}{u'_{c_{t+1}}}\frac{\eta}{1-\eta}\frac{h_{t+1}}{k_{t+1}} + 1 - \delta - \kappa'_{t+1_{k_{t+1}}}\right)u'_{c_{t+1}}\right] \quad (13)$$

$$d_{t+1} - \frac{1}{1-\eta}\frac{u'_{h_t}}{u'_{c_t}}h_t = c_t + k_{t+1} - (1-\delta)k_t + (1+r_t)d_t + \zeta(d_{t+1}) + \kappa_t \quad (14)$$

$$b_{t+1}+d_{t+1}+A_tF(k_t,h_t)=c_t+g_t+(1+r_t)(b_t+d_t)+k_{t+1}-(1-\delta)k_t+\zeta(d_{t+1})+\kappa_t \tag{15}$$

if and only if they satisfy (2)-(6), (9)-(11).

Proof. See Appendix. ■

This implies once we have $\{c_t, k_{t+1}, h_t, d_{t+1}, b_{t+1}\}_{t=0}^{\infty}$ satisfying (5), (13), (14) and (15), the wage rate w_t, the rental rate z_t and the policy variable τ_t can be recovered from (9) and (4) respectively. (5) and (13) are the constraints imposed on the planner by the household's intertemporal consumption-saving decisions about the choice of d_{t+1} and b_{t+1}. (14) is the sequential budget constraint of the household and (15) is the aggregate resource and borrowing constraint at time t. In a small open economy with incomplete markets, it is not possible to derive a date-zero implementability constraint - as in Lucas and Stokey (1983) and Chari et al. (1991) - by combining (5), (13) and the government budget constraint. This is because at date zero there is no market for all the states in the future. Incomplete markets, therefore, complicate the Ramsey optimization problem considerably as we need to work with the sequential constraints at every time period.

4.5 Ramsey Problem

Ramsey optimal policy problem can be defined as the one that maximizes the lifetime expected utility of the household (1) with respect to the real allocations subject to (5), (13), (14) and (15) and the no-Ponzi-game conditions. Note that the constraints (5) and (13), i.e. the consumption Euler equations of the households, involve expectations of future variables. This makes the Ramsey planner's problem non-recursive. The government needs to take account of the future expectations of the private households, therefore, the optimal choice at time t is not a time invariant function of the state variables $\{k_t, d_t, b_t, A_t\}$ at time t.

To solve the Ramsey problem, we need to reconstruct the government's problem in a recursive framework. Marcet and Marimon (1998) show that in such cases an equivalent recursive saddle point maximization problem can be constructed from the original non-recursive problem by expanding the state space to induce a new state variable that summarizes the influence of the past events on the choice of current allocations. Following their methodology, as a first step, the original problem is rewritten as:

$$\min_{\{\gamma_t,\nu_t\}_{t=0}^{\infty}} \max_{\{c_t,k_{t+1},h_t,d_{t+1},b_{t+1}\}_{t=0}^{\infty}} E\sum_{t=0}^{\infty}\beta^t[U(c_t,h_t)$$

$$+\nu_t\left\{u'_{c_t}(1-\zeta'_{d_{t+1}}) - E_t\beta\left[(1+r_{t+1})\,u'_{c_{t+1}}\right]\right\}+$$

$$\gamma_t\left\{u'_{c_t}(1+\kappa'_{t_{k_{t+1}}}) - E_t\beta\left[\left(-\frac{u'_{h_{t+1}}}{u'_{c_{t+1}}}\frac{\eta}{1-\eta}\frac{h_{t+1}}{k_{t+1}}+1-\delta-\kappa'_{t+1_{k_{t+1}}}\right)u'_{c_{t+1}}\right]\right\}$$

subject to (14) and (15) and taking as given d_0, b_0 and k_0. ν_t, γ_t are co-state variables which are the same as the Lagrange multipliers associated with the constraint (5) and (13) of the original problem. This problem is still non-recursive. However, using the law of iterated expectations, it can be easily shown that the above problem is equivalent to the following recursive problem:

$$\min_{\{\nu_t,\gamma_t\}_{t=0}^{\infty}} \max_{\{c_t,k_{t+1},h_t,d_{t+1},b_{t+1}\}_{t=0}^{\infty}} E\sum_{t=0}^{\infty}\beta^t[U(c_t,h_t)$$

$$+\nu_t u'_{c_t}(1-\zeta'_{d_{t+1}}) - Z_t^{\nu}(1+r_t)u'_{c_t}$$

$$+\gamma_t u'_{c_t}(1+\kappa'_{t_{k_{t+1}}}) - Z_t^{\gamma}\left[\left(-\frac{u'_{h_t}}{u'_{c_t}}\frac{\eta}{1-\eta}\frac{h_t}{k_t}+1-\delta-\kappa'_{t_{k_t}}\right)u'_{c_t}\right]$$

where $Z_t^{\nu}=\nu_{t-1}$ and $Z_t^{\gamma}=\gamma_{t-1}$. The enlarged state space of the problem is now composed by the vectors $A_t, k_t, Z_t^{\nu}, Z_t^{\gamma}$. Z_t^{ν} and Z_t^{γ} track the value to the planner of committing to the pre-announced policy plan. The Lagrangian for this problem is given by:

$$L = \min_{\{\nu_t,\gamma_t,\lambda_t,\phi_t\}_{t=0}^{\infty}} \max_{\{c_t,k_{t+1},h_t,d_{t+1},b_{t+1}\}_{t=0}^{\infty}} E\sum_{t=0}^{\infty}\beta^t[U(c_t,h_t)$$

$$+\nu_t u_{c_t}^{'}(1-\zeta_{d_{t+1}}^{'}) - \nu_{t-1}(1+r_t)u_{c_t}^{'}$$

$$+\gamma_t u_{c_t}^{'}(1+\kappa_{t_{k_{t+1}}}^{'}) - \gamma_{t-1}\left[\left(-\frac{u_{h_t}^{'}}{u_{c_t}^{'}}\frac{\eta}{1-\eta}\frac{h_t}{k_t} + 1 - \delta - \kappa_{t_{k_t}}^{'}\right)u_{c_t}^{'}\right]$$

$$+\lambda_t(d_{t+1} - \frac{1}{1-\eta}\frac{u_{h_t}^{'}}{u_{c_t}^{'}}h_t - c_t - k_{t+1} + (1-\delta)k_t - (1+r_t)d_t - \zeta(d_{t+1}) - \kappa_t)$$

$$+\phi_t(b_{t+1} + d_{t+1} + A_tF(k_t,h_t) - c_t - g_t - (1+r_t)(b_t+d_t)$$

$$-k_{t+1} + (1-\delta)k_t - \zeta(d_{t+1}) - \kappa_t)]$$

with d_0, b_0 and k_0 given. Following Khan, King and Wolman (2003), Schmitt-Grohe and Uribe (2004) and Faia and Monacelli (2007), ν_{-1}, γ_{-1} are set at the steady state values implicit in the system of Ramsey first order conditions. This way, we ignore the optimal policy problem at time zero and take a *timeless perspective* on optimal policy. Implicit assumption is that the policy has been optimal in the past.

Ramsey first order conditions are given by:

$$u_{c_t}^{'} + \nu_t u_{c_t}^{''}(1-\zeta_{d_{t+1}}^{'}) - \nu_{t-1}u_{c_t}^{''}(1+r_t) + \gamma_t u_{c_t}^{''}(1+\kappa_{t_{k_{t+1}}}^{'}) + \frac{\eta}{1-\eta}\gamma_{t-1}\frac{u_{c_t h_t}^{''}h_t}{k_t}$$

$$-\gamma_{t-1}u_{c_t}^{''}(1-\delta-\kappa_{t_{k_t}}^{'}) - \lambda_t\left[1 + \frac{h_t}{1-\eta}\left(\frac{u_{c_t}^{'}u_{c_t h_t}^{''} - u_{h_t}^{'}u_{c_t}^{''}}{(u_{c_t}^{'})^2}\right)\right] - \phi_t = 0 \quad (16)$$

$$u'_{h_t} + \nu_t u''_{c_t h_t}(1 - \zeta'_{d_{t+1}}) - \nu_{t-1}(u''_{c_t h_t}(1 + r_t) + u'_{c_t} r'_{t_{h_t}}) + \gamma_t u''_{c_t h_t}(1 + \kappa'_{t_{k_{t+1}}})$$

$$+\gamma_{t-1}\frac{\eta}{(1-\eta)k_t}(u'_{h_t} + h_t u''_{h_t}) - \gamma_{t-1}(u''_{c_t h_t}(1 - \delta - \kappa'_{t_{k_t}}) + u'_{c_t} A_t F_{k_t, h_t})$$

$$+\lambda_t\left[-\frac{1}{1-\eta}\frac{u'_{c_t}(u'_{h_t} + h_t u''_{h_t}) - h_t u'_{h_t} u''_{c_t h_t}}{(u'_{c_t})^2} - d_t r'_{t_{h_t}}\right] + \phi_t(A_t F_{h_t} - (d_t + b_t) r'_{t_{h_t}}) = 0 \quad (17)$$

$$\gamma_t u'_{c_t} \kappa''_{t_{k_{t+1}}} + \gamma_{t-1} u'_{c_t} \kappa''_{t_{k_t k_{t+1}}} - (1 + \kappa'_{t_{k_{t+1}}})(\lambda_t + \phi_t)$$

$$+\beta E_t[-\nu_t u'_{c_{t+1}} r'_{t+1_{k_{t+1}}} + \gamma_{t+1} u'_{c_{t+1}} \kappa''_{t+1_{k_{t+1} k_{t+2}}} + \gamma_t u'_{c_{t+1}} \kappa''_{t+1_{k_{t+1}}}$$

$$-\gamma_t \frac{\eta h_{t+1} u'_{h_{t+1}}}{(1-\eta)k_{t+1}^2} + \lambda_{t+1}(1 - \delta - \kappa'_{t+1_{k_{t+1}}} - r'_{t+1_{k_{t+1}}} d_{t+1})$$

$$+\phi_{t+1}(A_{t+1} F_{k_{t+1}} + 1 - \delta - \kappa'_{t+1_{k_{t+1}}} - r'_{t+1_{k_{t+1}}}(d_{t+1} + b_{t+1}))] = 0 \quad (18)$$

$$\nu_t u'_{c_t} \zeta''_{d_{t+1}} + (1 - \zeta'_{d_{t+1}})(\lambda_t + \phi_t) - \beta E_t \nu_t u'_{c_{t+1}} r'_{t+1_{d_{t+1}}}$$

$$-\beta E_t[\lambda_{t+1}(1 + r_{t+1} + d_{t+1} r'_{t+1_{d_{t+1}}}) + \phi_{t+1}(1 + r_{t+1} + (d_{t+1} + b_{t+1}) r'_{t+1_{d_{t+1}}})] = 0 \quad (19)$$

$$\phi_t - \beta E_t \nu_t u'_{c_{t+1}} r'_{t+1_{b_{t+1}}}$$

$$-\beta E_t[\lambda_{t+1} d_{t+1} r'_{t+1_{b_{t+1}}} + \phi_{t+1}(1 + r_{t+1} + (d_{t+1} + b_{t+1}) r'_{t+1_{b_{t+1}}})] = 0 \quad (20)$$

The Ramsey equilibrium is defined by the system of equations (5), and (13) to (20). We have nine equations in nine unknowns $c_t, h_t, k_{t+1}, d_{t+1}, b_{t+1}$, γ_t, ν_t, ϕ_t and λ_t. Since it is not possible to solve this system analytically, we present quantitative results based on log-linear approximation of the first order conditions. We calibrate the model to Mexico, a representative emerging country. The choice of Mexico allows us to compare the model's predictions with the business cycle properties of the data presented for Mexico in Aguiar and Gopinath (2007) and Cuadra, Sanchez and Sapriza (2009).

4.6 Parameterization

The utility function is assumed to follow the following specification:

$$U(c_t, h_t) = \frac{\left(c_t^{\alpha}(1-h_t)^{1-\alpha}\right)^{1-\sigma}}{1-\sigma}$$

The parameter σ is the coefficient of relative risk aversion and we set it equal to 5 following Mendoza and Uribe (2000) and Reinhart and Végh (1994) for the Mexican economy. Note that $\sigma = 5$ is the lower-bound of estimates obtained for Mexico by Reinhart and Végh (1994). This approximates the median of existing estimates for developing economies that range between 1.25 and 10 in their paper[7]. The value for α is set so that one third of the time endowment is spent on working in the steady state. The β is chosen so that the steady state risk-free rate of interest is 0.01 per quarter. η is the share of capital in production which equals 0.33.

We choose values of $\bar{b}$ and $\bar{d}$ such that the average public and private debt to GDP ratios are 17 % and 13 % respectively. These are the average values for Mexico for the period between 1994.1 and 2001.4. $\bar{g}$ is chosen so that the average share of the government expenditure to GDP is 19 % which again reflects the average value for the Mexican economy during the same period.

[7]However, Aguiar and Gopinath (2007) and Cuadra, Sanchez and Sapriza (2009) use $\sigma = 2$ for the Mexican economy. We do a robustness check of our model for $\sigma = 2$ when we discuss our results.

The debt adjustment cost function for the household debt is given by: $\zeta(d_t) = \frac{\zeta}{2}(d_t - \bar{d})^2$. The parameter ζ equals 0.0007 as in Schmitt-Grohe and Uribe (2004). The capital adjustment cost κ takes the following functional form: $\kappa_t = \frac{\phi_k}{2} k_t \left(\frac{I_t - \delta k_t}{k_t}\right)^2$. We choose a value of ϕ_k to match the average quarterly volatility of investment to output in the Mexican data. The depreciation rate δ equals 0.05 which is chosen following the values used for the Mexican economy in Mendoza and Uribe (2000) and Reinhart and Végh (1994).

The most crucial parameter for this model is the risk-premium elasticity parameter ψ. Unfortunately, estimates of this parameter that can be used in the context of this model are not available in the literature. We set a value of ψ so that the correlation of real interest rate with output generated by the model is equal to -0.49 which is the value for Mexico reported in Neumeyer and Perri (2005). The persistence parameter ρ in the productivity shock is 0.95 as reported in Aguiar and Gopinath (2007). We choose the standard deviation of the error term in the shock process to match the average volatility of output in the Mexican data.

4.7 Results

Figure 1 depicts the impulse responses of the key variables in response to a one percent negative productivity shock in the economy. Since the tax-base declines and income taxation introduces distortion and thereby further reduces labour supply and investment during a period of recession, the optimal response of the government should be to increase debt to meet the given expenditure target. Incurring more debt is, however, costly given that the interest rate is higher during the bad time due to low net worth. If government borrows more, it will increase the interest rate further and thereby make it more difficult for the private household to smooth consumption. From the loan supply function, we know that the term $r'_{t+1_{b_{t+1}}}$ in the Ramsey first-order condition (20) is positive and, therefore, borrowing by the government increases the expected loss of marginal utility next period relative to the gain at the margin this period. Government needs to trade-off this intertemporal distortion with the distortion from income taxation. To see this trade-off clearly, we deduct the constraint (14) from the aggregate resource constraint (15) and write the government budget constraint in terms of real allocations only:

$$b_{t+1} + A_t k_t^{\eta} h_t^{1-\eta} \left(1 + \frac{u'_{h_t}}{u'_{c_t}(1-\eta) A_t k_t^{\eta} h_t^{-\eta}} \right) = g_t + (1 + r_t) b_t$$

The term in the parenthesis in the left hand side of the above equation expresses the tax rate in terms of real allocation. From the government budget constraint it follows that, to meet the expenditure traget g_t net of the loan repayment target $(1+r_t)b_t$, the government either has to increase borrowing or raise taxes. Given that u_{h_t} is negative, the tax rate is higher, the lower is the ratio between the marginal rate of substitution of labour for consumption and the marginal productivity of labour. With no tax distortion, the value of this ratio is one and then it approaches zero as the tax rate increases.

In the numerical solution of our model, this trade-off leads to an increase in the tax rate while the government debt goes down. Fall in public debt increases the net worth and offsets some of the increase in interest rate. Private households, in contrast, have two motives to borrow. Following a bad shock in the economy, their income goes down and they would like to borrow more during that time to smooth consumption. However, following a bad shock, investment falls sharply and that reduces the borrowing needs of the private household for investment purposes. In equilibrium, the investment effect dominates, at least in a few periods after a shock. This allows households to reduce their debt burden. In sum, we get a procyclical fiscal policy and capital flow as a welfare maximizing outcome. Note that a standard international real business cycle model with persistent productivity shock will give us procyclical private debt flow due to investment demand but the flow of public debt will not be procyclical since the government has no investment demand and, therefore, will borrow only for the purpose of consumption smoothing.

5 A Model with Endogenous Government Expenditure

In the preceding section, we have seen that the optimal tax rate can be procyclical in the presence of a loan supply function that relates interest rate to the level of net-worth of the economy. However, in that model government expenditure is exogenously specified at a constant level. In contrast, in the data, we know that the government expenditure is strongly pro-cyclical. This calls for endogenous government expenditure. As we have mentioned before, the standard ways of introducing endogenous public expenditure in a real business cycle model are either as a consumption good in the utility function or as an input in the production function. We take the simple approach of introducing it as a flow of government provided consumption goods which are exogenous to households but are optimally chosen by the government.

This specification allows us to compare our results with Cuadra, Sanchez and Sapriza (2009) who endogenize public expenditure in the same way.

We keep the basic set up of the benchmark model intact. However, the Ramsey planner now optimizes the following utility function of the households:

$$U(c_t, h_t, g_t) = \frac{\left(c_t^{\alpha}(1-h_t)^{1-\alpha}\right)^{1-\sigma}}{1-\sigma} + \theta \frac{g_t^{1-\sigma}}{1-\sigma}$$

In this specification, utility is increasing in government consumption g_t. A competitive equilibrium under endogenous public expenditure is defined in the following way:

Definition 2 Given the household's and the government's initial real debt d_0 and b_0, the initial capital stock k_0 and the exogenous stochastic processes $\{A_t\}_{t=0}^{\infty}$, an equilibrium is an allocation $\{c_t, k_{t+1}, h_t, d_{t+1}\}_{t=0}^{\infty}$, price system $\{w_t, r_t\}_{t=0}^{\infty}$ and government policy $\{g_t, b_{t+1}, \tau_t\}_{t=0}^{\infty}$ such that:

1. $\{c_t, k_{t+1}, h_t, d_{t+1}\}_{t=0}^{\infty}$ solve the household maximization problem subject to the sequence of household budget constraints and the no-Ponzi-game constraint.

2. $\{k_t, h_t, w_t, z_t\}_{t=0}^{\infty}$ solve the firm's problem.

3. $\{g_t, b_{t+1}, \tau_t\}_{t=0}^{\infty}$ satisfy the sequence of government budget constraints and the government's no-Ponzi-game constraint.

4. The factor and the goods markets are cleared.

The primal form representation of the competitive equilibrium is exactly the same as in the benchmark model except that g_t in equation (15) is now an endogenous variable. First order conditions of the recursive transformation of the Ramsey problem with respect to $c_t, h_t, k_{t+1}, d_{t+1}$ and b_{t+1} are the same as before since g_t is additively separable in the utility function. They are denoted by equations (16) to (20) respectively. However, the Ramsey planner has a new choice variable g_t which gives an additional first order condition:

$$\theta g_t^{-\sigma} = \phi_t \tag{21}$$

The Ramsey equilibrium is defined by the system of equations (5) and (13) to (21). Note again that g_t in equation (15) and (21) is now an endogenous variable. We have ten equations in ten unknowns $c_t, h_t, k_{t+1}, d_{t+1}, b_{t+1}, g_t, \gamma_t, \nu_t, \phi_t$ and λ_t. We solve the model as before using the log-linear approximation of the optimality conditions around a non-stochastic steady state. The new parameter θ is calibrated to give steady state public expenditure to GDP ratio of 19% which is the average value for Mexico for the period between 1994.1 and 2001.4. This is the time period used in Neymeyer and Perri (2005) to calculate the correlation between the interest rate and output.

5.1 Results

Table 5: **Data and the Implied Moments**

Moments	Data	Benchmark model	Model with Endogenous Expenditure
$\sigma(y)$	2.37	2.37	2.37
$\sigma(\frac{c}{y})$	1.22	0.98	0.76
$\sigma(\frac{i}{y})$	4.15	4.15	4.15
$\rho(y,g)$	0.55		0.74
$\rho(y,\tau)$	-0.14	-0.54	-0.13
$\rho(y,r)$	-0.49	-0.49	-0.34

Figure 2 depicts the impulse responses to a one percent negative productivity shock in this economy. Public expenditure now declines following a bad shock. This is expected given the incompleteness of the credit market. Tax base declines as output falls and the government faces the trade-off of increasing taxes or raising debt. However, now the planner can reduce public expenditure and thereby lower the distortion from increasing income tax rate during bad times. As the impulse response functions show, the optimal choice is a combination of reduction in public expenditure, increase in tax rate and reduction in borrowing. However, as we can see from the table below, the negative co-movement between the output and the tax rate is now much weaker and is very close to what we observe in the data. Thus the optimal policy in the model with endogenous public expenditure matches all three aspects of the procyclicality of the fiscal variables in emerging countries: i) government expenditure is positively correlated with GDP, ii) the average tax rate in the economy is negatively correlated with the output and iii) the net capital flow from abroad is positively correlated with output.

5.1.1 Sensitivity Analysis

We do some sensitivity analysis of our results by using lower values for the risk premium elasticity ψ and by using the value $\sigma = 2$ for the degree of risk premium parameter as in Aguiar and Gopinath (2007) and Cuadra, Sanchez and Sapriza (2009) for the Mexican economy. The model with endogenous public expenditure is used for sensitivity analysis. The lower value of ψ leads to a low correlation between interest rate and output. As the countercyclicality of the interest rate declines it weakens the negative correlation between tax rate and output. And as we can see from Table 6 below, this decline is monotonic. As the market is incomplete, the public expenditure continues to co-move with output but the degree of its procyclicality gradually declines. These results strengthen our claim that the presence of the risk premium and the counter-cyclical interest rate play an important role in making the optimal fiscal policy procyclical.

Table 6: **Robustness Analysis**

Cyclicality of Fiscal Policy	Benchmark Calibration $\sigma = 5$	Change in $\rho(y,r)$			$\sigma = 2$
		$\rho(y,r)$ $= -0.2$	$\rho(y,r)$ $= -0.1$	$\rho(y,r)$ $= -0.05$	
$\rho(y,g)$	0.74	0.65	0.61	0.58	0.78
$\rho(y,\tau)$	-0.13	-0.07	-0.02	0.04	-0.15

Note: Different levels of $\rho(y,r)$ are chosen by changing ψ accordingly.
In the benchmark calibration, $\rho(y,r) = -0.49$.

Next we consider a lower value of σ while keeping all other parameters, including ψ, at the benchmark level. $\sigma = 2$ implies a decrease in the willingness to smooth consumption over time. As the last column of the table 6 shows, a lower σ leads to a slightly higher level of procyclicality for the policy variables. Since the preference for consumption smoothing declines, it is optimal to let public expenditure fluctuate more with output.

6 Conclusion

This paper provides a formal optimal-policy-based argument for the view that it is possible to explain the observed procyclicalities in fiscal policy variables with a standard neoclassical model provided frictions in the credit market are taken into account. We calculate the Ramsey optimal policy for a standard small open economy facing an interest rate function that depends negatively on the net worth of the economy. Countercyclical interest rate, generated by this function, makes it optimal for an emerging country government to follow a procyclical fiscal pattern. It is not argued, however, that the alternative explanations of procyclical fiscal policies - based on political-economic frictions - have no merit of their own. At the policy level, dealing with these two types of frictions requires building up two different types of institutions as discussed in Talvi and Végh (2005). Our result stresses that the lack of access to the international credit market for the developing countries during bad times can have the potentially de-stabilizing consequence as it is associated with procyclical fiscal responses by the developing country policy makers.

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A Proof of proposition 1

Proof. First I show that $\{c_t, k_t, h_t, d_t, b_t\}_{t=0}^{\infty}$ satisfying (2)-(6) and (9)-(11) also satisfy (5), (13), (14) and (15). To derive (14), substitute (3)and (4) in (2). (15) is obtained by adding (2) and (11) and substituting for w_t and z_t from (9) and (10).

Now we need to check that if the allocations $\{c_t, k_t, h_t, d_t, b_t\}_{t=0}^{\infty}$ satisfy (5), (13), (14) and (15), then they also satisfy (2)-(6),(9)-(11). Set w_t and τ_t such that (9) and (4) hold so that they are satisfied by construction. Use the definition of w_t and τ_t in (14) to get back (2). Again use the definition of w_t and τ_t and subtract (2) from (15) to recover (11). ■

Figure 1: Benchmark Model: Impulse Responses to 1% negative Productivity Shock

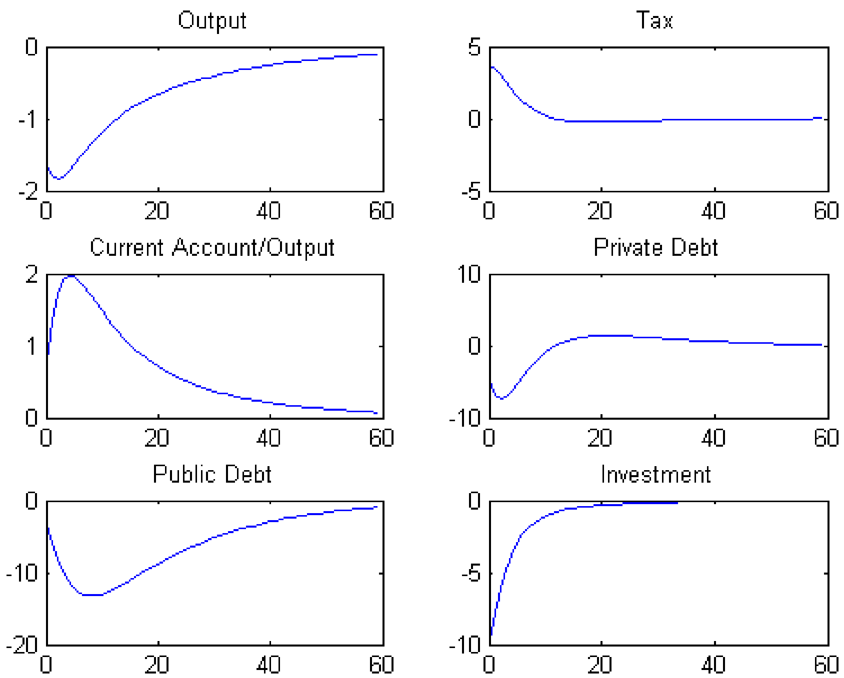

Figure 2: Model with Endogenous Public Expenditure: Impulse Responses to 1% negative Productivity Shock