Procyclical Government Spending in Developing Countries: The Role of Capital Market Imperfections

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Abstract

Whereas in the G-7 countries government consumption is essentially acyclical, in developing countries it appears to be highly procyclical (i.e., government consumption rises in good times and falls in bad times). Several explanations have been advanced to explain this puzzle, including political factors and borrowing constraints. This paper shows, however, that such differences in the procyclicality of government consumption are entirely consistent with a standard neoclassical model of fiscal policy in which policymakers optimally choose both the level of government consumption and taxes. We show that, with complete markets, the correlation of government consumption and output is zero (as in G-7 countries). With only risk-free debt, however, this correlation is typically above 0.7, suggesting that the lack of a sufficiently rich menu of financial assets might be a major determinant of the way fiscal policy is carried out in developing countries. Hence, the degree of market incompleteness is enough to explain the above "puzzle" in a standard neoclassical fiscal model. Incomplete markets are socially costly as they induce substantial volatility in both private and public consumption, which would not be present otherwise.

1 Introduction

A puzzling stylized fact related to the cyclical behavior of government consumption is that it appears to be much more procyclical in developing countries than in industrial countries. In fact, Talvi and Végh (2000) report that the average correlation between the cyclical components of government consumption and output for 36 developing countries over the period 1970-1994 is 0.53 compared to essentially zero for the G-7 countries. Remarkably, this correlation is positive in every developing country in their sample. Using more refined econometric techniques, Braun (2001) finds ample support for this phenomenon. Specifically, while in OECD countries a one percentage point increase in GDP is associated with a reduction of 0.37 percentage points in the ratio of government expenditures to GDP, in developing countries this ratio remains unchanged. In other words, government expenditures increases by the same proportion as output in expansions, while both fall by the same proportion in recessions.

The striking difference between government consumption being acyclical for G-7 countries and highly procyclical for developing countries has been viewed as inconsistent with the neoclassical paradigm of fiscal policy – à la Barro (1979) and Lucas and Stokey (1983) – and thus as a puzzle in search of an explanation. Explanations have thus far followed under two main strands: (i) political pressures – which are exacerbated in developing countries by larger political fragmentation and/or a more volatile tax base – may lead to higher spending in good times (Lane and Tornell (1999) and Talvi and Végh (2000)) and (ii) loss of access to international credit in difficult times that forces developing countries to contract government spending and raise tax rates in bad times (Gavin and Perotti (1997), Aizenman, Gavin, and Hausmann (1996)).

This paper starts from the idea that, whatever the merits of these existing explanations, one should not be too quick in dismissing the neoclassical fiscal paradigm as being inconsistent with the stylized facts. In fact, we will argue in this paper that the cyclical behavior of government consumption is entirely consistent with the neoclassical fiscal model. We will show that all that is needed to explain the different behavior in developing and industrial countries is to recognize that the international credit markets faced by industrial countries are more "complete" (in the Arrow-Debreu sense) than those facing developing countries. With complete markets, the optimal fiscal policy (in a Ramsey sense) consists in completely smoothing out government consumption. We take the complete markets case as roughly capturing the case of the G-7 countries. With incomplete markets (i.e., access to only risk-free debt), the optimal fiscal policy implies that government consumption is procyclical. More importantly, from a quantitative point of view, the correlations between government consumption and output coming out of the model are in a range which is fully consistent with the observed figures. We view the incomplete markets case as capturing the environment faced by developing countries. In other words, even though developing countries may have perfect access to capital markets (in terms of non-contingent claims), the inability to borrow contingent on the state of nature will make it optimal to let government spending covary positively with the business cycle. We will thus conclude that there is really no puzzle to be explained when the neoclassical fiscal model is suitably modified to account for incomplete asset markets.

While the procyclical behavior of government spending may be optimal *given* the presence of incomplete markets, the volatility of public consumption is costly relative to the case of complete markets. While we do not yet provide quantitative estimates of this welfare costs in terms of our specific model, recent research by Pallage and Robe (2003) suggests that the welfare costs of macroeconomic volatility in developing countries are substantial. Hence, we conjecture that the welfare costs of engaging in procyclical government consumption are likely to be important. Hence, from a policy point of view, the paper stresses the importance of efforts aimed at providing a richer menu of financial assets for developing countries – and hence removing the incentives for procyclical government spending.

In terms of the existing literature (i.e., Lucas and Stokey (1983) and most of the ensuing literature), our paper differs in two key respects. First, we endogeneize the behavior of government consumption by assuming that it provides direct utility to households. Clearly, this modification is critical to enable us to provide a theory of the cyclical behavior of government spending. Second, we solve the optimal fiscal policy problem for a small open economy in the presence of only risk-free debt. As is well-known in this literature, this is a technically complex enterprise. The technical difficulties arise from the fact that the absence of complete markets imposes additional and complicated constraints on the set of competitive equilibrium allocations that the Ramsey planner can choose from (see Chari, Christiano and Kehoe (1996)). While Aiyagari, Marcet, Sargent, and Seppala (2001) have solved for the optimal fiscal policy without state-contingent debt in a closed economy, we know of no such efforts in an open economy context (which introduces complications of its own).

The paper proceeds as follows. Section 2 presents some empirical evidence on the stylized facts that we are trying to explain. Section 3 solves the Lucas-Stokey-Ramsey problem for a small open economy with endogenous government spending and complete markets. In other words, the government optimally chooses the level of government spending and the level of taxes. Output is assumed to be an arbitrary, exogenously-given, finite-valued, stochastic process. In this case, and under fairly simple assumptions, one can show analytically that the optimal levels of both government spending and the tax rate are constant across states of nature. Government spending is thus acyclical (i.e., the correlation of government spending and output is zero). We take this complete-markets case as capturing the case of industrial countries.

Section 4 abandons the complete markets assumption and assumes that this small open economy has access to only risk-free debt. We use the recursive contracts approach of Marcet and Marimon (1998) to set up the Ramsey problem as a recursive problem and then use standard linearization techniques to solve numerically for the optimal choice of government spending and taxes. The effects of allowing only risk-free debt are quite dramatic: the correlation between government spending and output is in the range 0.7-1.0 depending on output persistence. This clearly shows that having access to only risk-free debt increases the procyclicality of government spending to the levels observed for many developing countries. Intuitively, the absence of state-contingent debt substantially reduces the economy's ability to diversify its idiosyncratic risk. The model thus predicts (assuming "continuity" across degrees of market incompleteness) that the more incomplete markets are, the more procyclical government consumption will be.

2 Stylized facts

Using Talvi and Vegh's (2000) data set, we calculated the business cycle properties of a few key macroeconomic variables using two types of filters: log differences and Hodrick-Prescott (with $\lambda = 100$). Our sample covers annual data between 1970 and 1994.

Tables 1 and 2 reports the volatility of output, private consumption, the share of government consumption, the share of private consumption, government consumption and total revenues. All data are taken from IFS and GFS of the IMF, except for Argentina, Bolivia, Dominican Republic and Peru which are from the IDB's internal database.

Country Group	#	Standard Deviation %		Standard Deviation Relative to Y				
		Y	PC	G Share	PC Share	G	TREV	
G-7	6	2.11	1.94	0.27	0.91	1.26	3.29	
Industrial Countries	22	2.24	2.47	0.30	1.10	1.64	2.94	
Developing Countries	16	4.12	5.71	0.37	1.41	4.71	3.14	

Table 1: Log Difference Filter. All data is in real terms.

Country Group	#	Standard Deviation %		Standard Deviation Relative to Y				
		Y	PC	G Share	PC Share	G	TREV	
G-7	6	2.05	1.84	0.27	0.87	1.20	2.82	
Industrial Countries	22	2.17	2.29	0.29	1.06	1.54	2.54	
Developing Countries	16	4.32	5.04	0.27	1.15	3.22	2.67	

Table 2: HP Filter ($\lambda = 100$). All data is in real terms except for the inflation tax.

It is clear from these tables that developing countries are at least twice as volatile as industrial countries. This is true in terms of output, private consumption, and government consumption and does not depend on the type of filter used to measure the cyclical component of macroeconomic series.

Tables 3 and 4 report the correlations of output with private consumption, government consumption, total revenues, and share of government consumption.

Country Group	Contemporaneous Correlations with Y				
	PC	G	TREV		G Share
G-7	0.76	0.00	0.19		-0.62
Industrial Countries	0.60	0.13	0.24		-0.46
Developing Countries	0.58	0.38	0.44		-0.01

Table 3: Log Differences Filter.

Country Group	Contemporaneous Correlations with Y				
	PC	G	TREV		G Share
G-7	0.82	-0.02	0.22		-0.64
Industrial Countries	0.67	0.11	0.30		-0.48
Developing Countries	0.64	0.46	0.56		-0.01

Table 4: HP Filter ($\lambda = 100$).

For our purposes, the most notable facts from Tables and 3 and 4 are the following:

1. The high positive correlation of output with government consumption for developing countries, as opposed to industrial countries or the Group of Seven.

2. The high negative correlation of output with the share of government consumption (in output) for the group of seven or industrial countries as opposed to the almost null correlation for developing countries.

   These facts do not depend on the type of filter that we use.

3 The complete markets case

Consider a small open economy inhabited by a large number of identically and infinitively-lived agents with Von Neumann-Morgenstern utility functions. The economy is endowed with an exogenously-given and stochastic output stream. There is a finite number of states of nature. Both the government and private agents have access to a complete set of Arrow-Debreu securities traded in world capital markets. Denote by $s^t = (s_0, ..., s_t)$ the history of events up to and including period t. The probability as of time 0 of any particular history s^t is denoted by $\pi(s^t)$. The initial realization, s_0, is given. Let $p(s^{t+1})$ be the time t price in terms of consumption in period t (conditional on s^t) of an asset that promises to pay one unit in the event that s^{t+1} is realized.

3.1 Households

Since markets are complete, we can set up the agents' decision problem as if all trade occurred in the first period ($t = 0$). The representative agent's lifetime utility is given by:

$$\sum_{t,s^t} \beta^t \pi(s^t) U(c(s^t), g(s^t)), \tag{1}$$

where $\beta(< 1)$ is the discount factor, $c(s^t)$ and $g(s^t)$ denote private and government consumption (conditional on the history of events s^t), and $U(.)$ is a strictly increasing and convex function. The intertemporal budget constraint is given by:

$$\sum_{t,s^t} R(s^t)p(s^t)[1 + \tau(s^t)]c(s^t) = f(s^{-1}) + \sum_{t,s^t} R(s^t)p(s^t)y(s^t),$$

where τ denotes a consumption tax imposed by the government; $f(s^{-1})$ is the initial endowment of Arrow-Debreu securities held by the representative agent; $R(s^t) = \prod_{k=0}^{t-1} p(s^k)$, and each s^k is embedded in s^t.[1] By definition, $R(s^0) = 1$ and $p(s^0) = 1$.

The first order conditions for this problem imply the following Euler equation:

$$\beta^t \pi(s^t) \frac{U_1(c(s^t), g(s^t))}{U_1(c(s^0), g(s^0))} = R(s^t)p(s^t) \frac{1 + \tau(s^t)}{1 + \tau(s^0)}, \quad \text{for all } t \text{ and } s^t.$$

It follows that, for any two realizations s^t and $s^{t'}$,

$$\frac{\pi(s^t)}{\pi(s^{t'})} \frac{U_1(c(s^t), g(s^t))}{U_1(c(s^{t'}), g(s^{t'}))} = \frac{p(s^t)}{p(s^{t'})} \frac{1 + \tau(s^t)}{1 + \tau(s^{t'})}. \tag{2}$$

3.2 Ramsey problem

Under complete markets and assuming no restrictions on date 0 taxes, the Ramsey's problem is the same as the central planer's problem (with access to all securities) as long as the set of allocations can be implemented by appropriately setting fiscal policy in the decentralized version of the economy. We implicitly assume that output and international prices do not force taxes to be negative or grater than one. Therefore, the government maximizes (1) subject to:

[1] Notice $R(s^t)$ is known at time $t - 1$. It is the risk free discount factor between 0 and $t - 1$.

$$\sum_{t,s^t} R(s^t)p(s^t)(c(s^t)+g(s^t)) = f(s^{-1}) + b(s^{-1}) + \sum_{t,s^t} R(s^t)p(s^t)y(s^t),$$

where $b(s^{-1})$ is the initial endowment of Arrow-Debreu securities held by the government. The resulting allocations from the above planer's problem can be supported in the decentralized version of the economy by setting taxes in the following way:

$$\tau(s^t) = \beta^t \pi(s^t) \frac{U_1(c(s^t), g(s^t))}{U_1(c(s^0), g(s^0))} \frac{1+\tau(s^0)}{R(s^t)p(s^t)} - 1. \tag{3}$$

Finally, notice that $\tau(s^0)$ can always be set so that the representative agent's intertemporal budget constraint is satisfied.

The first order conditions for this problem are given by:

$$\begin{aligned} \beta^t \pi(s^t) \frac{U_1(c(s^t), g(s^t))}{U_1(c(s^0), g(s^0))} &= R(s^t)p(s^t), & (4) \\ \beta^t \pi(s^t) \frac{U_2(c(s^t), g(s^t))}{U_2(c(s^0), g(s^0))} &= R(s^t)p(s^t). & (5) \end{aligned}$$

Combining these two equations, we obtain:

$$U_1(c(s^t), g(s^t)) = U_2(c(s^t), g(s^t)),$$

which says that, at an optimum, the marginal utility of private and public consumption should be the same.

We assume that prices are actuarially fair. Hence, by definition,

$$\frac{p(s^{t\prime})}{p(s^t)} = \frac{\pi(s^{t\prime})}{\pi(s^t)}. \tag{6}$$

Given (6), conditions (4) and (5) imply that:

$$\begin{aligned} U_1(c(s^t), g(s^t)) &= U_1(c(s^{t'}), g(s^{t'})), \\ U_2(c(s^t), g(s^t)) &= U_2(c(s^{t'}), g(s^{t'})). \end{aligned}$$

At an optimum, the marginal utility of both private and public consumption is equalized across states of nature.

3.3 Parametrization

Let the instantaneous utility function be a CES function between private and government consumption. More precisely, assume

$$U(c_t, g_t) = f((\theta c_t^{-\sigma} + (1-\theta) g_t^{-\sigma})^{-\frac{1}{\sigma}}), \tag{7}$$

where $\sigma \geq -1$, $\sigma \neq 0$, and

$$U(c_t, g_t) = f(c_t^{\theta} g_t^{1-\theta}) \tag{8}$$

when $\sigma = 0$. In both cases $f(x) = \frac{x^{1-\gamma}-1}{1-\gamma}$, where $\gamma > 1$, and $f(x) = \log(x)$, when $\gamma = 1$.The elasticity of substitution between private and public consumption is $\frac{1}{1+\sigma}$.

3.4 Results

If prices are actuarially fair and preferences are as above, then one can easily prove that consumption is constant across states. It follows that both private consumption, taxes and government expenditures are acyclical. The result depends on the absence of labor supply. When labor supply is present, the marginal utility of consumption is still constant across states, though consumption itself is not (except in the obvious case in which the instantaneous utility is separable between consumption and leisure).

In sum, we have shown that under complete markets, the optimal path of public consumption and tax rates is constant across states of nature. Hence, the correlation between (i) government consumption and output and (ii) tax rates and output will be zero. This case thus broadly replicates the case of G-7 countries illustrated in Tables 1 and 2, in which all these correlations are basically zero.

4 Incomplete markets

Suppose now that markets are incomplete in the sense that this small open economy has access only to risk-free debt (i.e., a non-state contingent bond). In other words, this economy can borrow/lend at a given and constant real interest rate, r. Otherwise the economy is the same as that described above for the complete markets case (and, unless otherwise noticed, the same notation is used).

4.1 Households

The preferences of the representative household are given by:

$$E\left[\sum_{t=0}^{\infty}\beta^t U(c_t, g_t)\right]. \tag{9}$$

Households face the following flow constraint:

$$f_t = (1+r_t)f_{t-1} + y_t - (1+\tau_t)c_t - \Phi(f_t - \overline{f}), \tag{10}$$

for a given f_{-1}, where f_t denotes the households' net holdings of the risk free bond at the end of period t and y_t is the exogenously-given and stochastic level of output. The function $\Phi(.)$ captures a quadratic cost of adjusting the asset portfolio, where $\overline{f}$ is the non-stochastic steady-state level of f_t.[2] As a particular case, when $\Phi(.) \equiv 0$, we obtain the standard small open economy model with a unit root. While the $\Phi(.) \equiv 0$ case is conceptually the simplest and more elegant version of our model, the numerical results for this particular case should be taken with caution since, as is well-known, the numerical solution for unit-root models is, in principle, subject to technical problems (as the model is linearized around a steady-state to which it does not return). For any other case with positive adjustment costs, the numerical algorithm is free of problems since the model becomes stationary.

Let the logarithm of output, $\log(y_t)$, follow the following autoregressive process:[3]

$$\log(y_{t+1}) = (1-\rho)y + \rho\log(y_t) + \varepsilon_{t+1}, \quad \varepsilon_{t+1} \sim N(0, \sigma_\epsilon^2),$$

where$E[y_t] = y$ and ε_t are independent.

Households maximize (9) subject to (10). The first order conditions imply

$$\frac{U_c(c_t, g_t)}{1+\tau_t} = E_t\left[\beta\frac{U_c(c_{t+1}, g_{t+1})}{1+\tau_{t+1}}(1+\widetilde{r}_{t+1})\right], \tag{11}$$

[2] This is a technical device that guarantees taht the model has a stationary steady-state and thus that standard numerical algorithms can be used to solve the model numerically. There are, of course, other ways of "closing the economy" that yield qualitatively similar results (see Schmitt-Grohe and Uribe (2002)).

[3] The notation here is the same as in our previous model. Just notice that any variable with subindex t, x_t (i.e f_t, c_t, etc) stands for $x(s^t)$.

$$\lim_{t \to \infty} \frac{f_t}{\prod_{i=0}^{t} (1 + \widetilde{r}_i)} = 0, \tag{12}$$

where

$$1 + \widetilde{r}_{t+1} \equiv \frac{1 + r_{t+1}}{1 + \Phi'(f_t - \overline{f})}.$$

Condition (11) is the standard stochastic Euler equation.

Notice that, from a computational point of view, the household's problem has a non-recursive structure since agents' decisions rules for consumption will depend not only on the current state of the economy but also on all future taxes.

4.2 Ramsey problem

The government faces the following flow constraint:

$$b_t = (1 + r_t) b_{t-1} + \tau_t c_t - g_t - \Phi(b_t - \overline{b}), \tag{13}$$

for a given b_{-1}, where b_t denotes the government's stock of net foreign assets. Notice that, like the household, the government faces adjustment costs of changing its portfolio.

The government chooses an allocation of public and private consumption subject to the condition that this allocation be implementable as a competitive equilibrium. Formally, this Ramsey problem consists in maximizing (9) subject to the household's flow constraint, given by (10), the government's flow constraint, given by (13), the implementability condition given by (11), the transversality condition given by (12), and taking as given f_{-1} and b_{-1}.

As in the household's case, this Ramsey problem has a non-recursive structure since decision rules will depend not only on the current state but also on future information based on agents' decision rules. To numerically solve this Ramsey problem , we need to write the government's problem in a recursive framework. To this end, notice that any solution to the government's problem is also a solution to maximizing:[4]

[4]This is Marcet and Marimon's (1998) recursive contracts approach.

$$\max E\left\{\sum_{t=0}^{\infty}\beta^t\left[U(c_t,g_t)+\mu_t[\frac{U_c(c_t,g_t)}{1+\tau_t}-E_t(\beta\frac{U_c(c_{t+1},g_{t+1})}{1+\tau_{t+1}}(1+\widetilde{r}_{t+1}))]\right]\right\},$$

subject to (10), (13), (11), and (12), and taking as given f_{-1} and b_{-1}.

Using the law of iterated expectations, one can easily show that the government's objective function is equivalent to the following two equations:

$$E\left[\sum_{t=0}^{\infty}\beta^t\left[U(c_t,g_t)+\phi_t\frac{U_c(c_t,g_t)}{1+\tau_t}\right]\right] \tag{14}$$

$$\mu_t = (1+\widetilde{r}_t)\mu_{t-1}+\phi_t, \qquad \mu_{-1}=0 \tag{15}$$

Hence, any solution to the original Ramsey problem must also be a solution to the problem of maximizing (14) subject to (15), (10), (13), and (12), taking as given f_{-1} and b_{-1}. This problem is recursive. The Lagrangian for this problem is given by:

$$\begin{aligned} L \;=\; & E\sum_{t=0}^{\infty}\beta^t\{U(c_t,g_t)+\phi_t\frac{U_c(c_t,g_t)}{1+\tau_t} \\ & +\lambda_t\left[f_t-(1+r_t)f_{t-1}-y_t+(1+\tau_t)c_t+\Phi(f_t-\overline{f})\right] \\ & +\chi_t\left[(b_t-(1+r_t)b_{t-1}-\tau_tc_t+g_t+\Phi(b_t-\overline{b})\right] \\ & +\Omega_t(\left[\mu_t-\phi_t-\mu_{t-1}(1+\widetilde{r}_t)\right]\} \end{aligned}$$

In addition to (15), (10), and (13), the first order conditions are given by:

$$
\begin{array}{rcl}
\lambda_t\left[1+\Phi'(f_t-\overline{f})\right] & = & E_t\left[\beta\lambda_{t+1}(1+r_{t+1})+\beta\Omega_{t+1}\mu_t\dfrac{\partial\widetilde{r}_{t+1}}{\partial f_t}\right] \\
\chi_t\left[1+\Phi'(b_t-\overline{b})\right] & = & E_t[\beta\chi_{t+1}(1+r_{t+1})] \\
\Omega_t & = & E_t\left[\beta\Omega_{t+1}(1+\widetilde{r}_{t+1})\right] \\
\phi_t\dfrac{U_c(c_t,g_t)}{(1+\tau_t)^2}+c_t\chi_t & = & \lambda_t c_t \\
U_g(c_t,g_t)+\phi_t\dfrac{U_{cg}(c_t,g_t)}{(1+\tau_t)}+\chi_t & = & 0 \\
U_c(c_t,g_t)+\phi_t\dfrac{U_{cc}(c_t,g_t)}{(1+\tau_t)}+\lambda_t(1+\tau_t)-\chi_t\tau_t & = & 0 \\
\dfrac{U_c(c_t,g_t)}{(1+\tau_t)}-\Omega_t & = & 0
\end{array}
$$

The following additional conditions are sufficient for an optimum:

$$
\begin{array}{rcl}
\lim\limits_{t\to\infty}\dfrac{f_t}{\prod\limits_{i=0}^{t}(1+\widetilde{r}_i)} & = & 0 \\
\lim\limits_{t\to\infty}\dfrac{b_t}{\prod\limits_{i=0}^{t}(1+\widetilde{r}_i)} & = & 0 \\
\lim\limits_{t\to\infty}\dfrac{\mu_t}{\prod\limits_{i=0}^{t}(1+\widetilde{r}_i)} & = & 0 \\
f_{-1}, b_{-1}\text{ given and }\mu_{-1} & = & 0
\end{array}
$$

We will solve this system of equations using the linearization method of King Plosser and Rebelo.

4.3 Parametrization

We keep the same parametrization for preferences given in (7) and (8). For the cost of adjusting the portfolio of foreign assets, we use the following functions for the representative agent and the government, respectively:

$$
\begin{array}{rcl}
\Phi(f_t-\overline{f}) & = & \kappa(f_t-\overline{f})^2, \\
\Phi(b_t-\overline{b}) & = & \kappa(b_t-\overline{b})^2.
\end{array}
$$

Our benchmark calibration uses the following parameters:

Benchmark Calibration									
β	r	γ	σ	θ	$\overline{f}$	$\overline{b}$	μ	y	κ
$\frac{1}{1.03}$	0.03	1.25	0.75	0.8	0.1	0.1	0	1	0

The values of $y, \overline{f}, \overline{b}$ are arbitrary, y is a scale parameter, and by construction, the model is consistent with any predetermined steady-state values of $\overline{f}$ and $\overline{b}$. The value of μ is consistent with the optimal and time-consistent policy that we are computing in this paper. In our benchmark calibration the elasticity of substitution between private and public consumption is $\frac{1}{1+\sigma} = 0.8$, the intertemporal elasticity of substitution is $\frac{1}{\gamma} = 0.8$ and the weights of private and public consumption in the representative agent's utility function are: $\theta = 0.8$ and $1 - \theta = 0.2$, respectively. Finally, notice that since $\kappa = 0$, the benchmark calibration corresponds to the unit root case.

With this calibration, the non-stochastic steady-state of the model is given by:

Steady State (Benchmark Calibration)					
y	c	g	τ	f	b
1.0	0.76	0.25	0.33	0.1	0.1

The steady state is independent of the cost of adjustment. We still need to calibrate the output process. We provide sensibility analysis of our results with respect to γ, σ and ρ. Finally, σ_ϵ is calibrated so that the implied volatility of the rate of growth of output is the same as the one calculated for developing countries. We also discuss the quantitative role of the adjustment cost parameter κ.

4.4 Results

4.4.1 Unit root case ($\kappa = 0$)

All variables are first differences of the logs of each variable. The solution is started from the steady state. The tables below report volatility and correlations (with output) calculated using 10000 simulated data points for the unit root case (i.e., $.\kappa = 0$). All parameters are the ones of the benchmark calibration unless otherwise stated.

Several remarks are in order. First, even though the model exhibits a unit root, the statistics below for the first (log) differences are "tightly" estimated. (We also computed the cases of $\gamma = 1$ and $\gamma = 10$ and the results do not change up to the first two decimal places.) Second, the correlation between government spending and output is consistently high (varying from 0.71 to 1.00). This is, of course, in sharp contrast to the complete markets case where this correlation is zero. Third, even though they co-vary positively with output, tax rates are essentially flat (as captured by an extremely low standard deviation) indicating the presence of substantial tax smoothing.

The intuition behind these results is as follows. In the absence of state contingent claims, the economy is unable to borrow more in the worse state of natures (i.e., lowest output states of nature) as it would do under complete markets. This will force the economy to consume less in bad times (and more in good times), which introduces a positive correlation between private consumption and output. Put differently, the high correlation between private consumption and output illustrates the weak insurance role played by non-contingent debt, which is consistent with the results of Correia, Neves, and Rebelo (1995). A similar intuition applies to public consumption: the government would prefer to smooth public consumption across states of nature but is not able to do so, which forces it to provide more public consumption in good times and less in bad times. The government is able, however, to keep tax rates essentially flat over the business cycle which suggests that, on the financing side, incomplete markets still allow considerable flexibility to the government.

Volatility and Correlations Model Economy					
	γ	y	c	g	τ
Volatility $std(\%)$	1.25	4.12	0.08	0.08	0.00
	5	4.12	0.08	0.08	0.00
Correlations with Output	1.25	1.00	0.71	0.71	0.71
	5	1.00	0.71	0.71	0.71
$\rho = 0$					

Volatility and Correlations Model Economy					
	γ	y	c	g	τ
Volatility $std(\%)$	1.25	4.12	0.20	0.20	0.00
	5	4.12	0.20	0.20	0.00
Correlations with Output	1.25	1.00	0.86	0.86	0.86
	5	1.00	0.87	0.87	0.87
$\rho = 0.5$					

Volatility and Correlations Model Economy					
	γ	y	c	g	τ
Volatility $std(\%)$	1.25	4.12	3.03	3.03	0.04
	5	4.12	3.07	3.07	0.04
Correlations with Output	1.25	1.00	1.00	1.00	1.00
	5	1.00	1.00	1.00	1.00
$\rho = 0.99$					

4.4.2 Stationary case ($\kappa > 0$)

We now show the results for the case in which the adjustment cost parameter is positive, which implies that the model is stationary. As a benchmark, the unit root case ($\kappa = 0$) is also included. There are several notable features. First, the correlation between government consumption and output is even higher than in the unit root case. This is intuitive as the presence of adjustment costs makes it more costly to borrow, which reduces the ability of risk-free debt to smooth private and public consumption across states of nature. Second, the variability of the tax rate increases dramatically as the adjustment cost parameter, κ, increases. Clearly, the fact that government borrowing is also subject to adjustment costs makes it too costly for the government to smooth taxes across states of nature.

Volatility and Correlations Model Economy					
	κ	y	c	g	τ
Volatility $std(\%)$	1	4.12	1.76	1.86	4.07
	0.5	4.12	1.29	1.39	3.97
	0	4.12	0.08	0.08	0.00
Correlations with Output	1	1.00	0.87	0.92	0.96
	0.5	1.00	0.80	0.87	0.99
	0	1.00	0.71	0.71	0.71
* $\rho = 0, \sigma_\varepsilon = 0.029.$					

Volatility and Correlations Model Economy					
	κ	y	c	g	τ
Volatility $std(\%)$	1	4.12	2.76	2.80	2.66
	0.5	4.12	2.29	2.35	3.09
	0	4.12	0.20	0.20	0.00
Correlations with Output	1	1.00	0.96	0.97	0.92
	0.5	1.00	0.95	0.96	0.96
	0	1.00	0.86	0.86	0.86
* $\rho = 0.5, \sigma_\varepsilon = 0.0356.$					

Volatility and Correlations Model Economy					
γ	κ	y	c	g	τ
Volatility $std(\%)$	1	4.12	4.07	4.07	0.11
	0.5	4.12	4.05	4.05	0.14
	0	4.12	3.03	3.03	0.04
Correlations with Output	1	1.00	1.00	1.00	0.93
	0.5	1.00	1.00	1.00	0.95
	0	1.00	1.00	1.00	1.00
* $\rho = 0.99, \sigma_\varepsilon = 0.041.$					

The appendix provides sensitive analysis with respect to the intertemporal elasticity of substitution and the intratemporal elasticity of substitution between private and public consumption. The basic message – high correlations between government spending and output – remains unchanged.

Impulse response functions To further illustrate the workings of the model, Figure 1 depicts the impulse response functions after a i.i.d. one percent increase in output. The full line represents the benchmark case (with $\gamma = 1.25$) and the dashed line indicates the $\gamma = 5$ case. All variables are expressed in percentage deviations from the steady state. This impulse response function corresponds to the case of $\kappa = 1$ and the benchmark calibration. Notice how in response to the temporarily higher level of output, both private and public consumption increase, as well as private and government's assets, indicating that part of the windfall is saved.

5 Conclusions

Our analysis suggests that the observed differences in the procyclicality of government consumption between developing and industrialized countries are entirely consistent with a standard neoclassical model of fiscal policy in which policymakers optimally choose both the level of government consumption and taxes. We show that, with complete markets, the correlation of government consumption and output is zero (as in G-7 countries). With only risk-free debt, however, this correlation is in the range 0.7-1.0. Hence, differences in the menu of financial assets available to developed and developing countries can explain the quantitative differences in the procyclical behavior of government spending.

While we view the results of this paper as an important first step within a neoclassical framework towards an understanding of fiscal policy in developing countries, there are three key areas that clearly deserve further attention. The first is the role of government spending. In the current model government consumption provides direct utility to consumers. Alternatively, one could model government spending as serving as an input into productive activities (i.e., infrastructure). In fact, it is commonly argued that public investment is the most volatile (and procyclical) component of public spending. It would thus be important to build a model with endogenous production and with public spending playing a productive role and, in that context, solve for the optimal fiscal policy. In this connection, it would also be useful to gather data on public investment in developing countries and check its business cycles properties.

A second area of further research is the behavior of tax rates. It has been argued – based on casual evidence – that tax rates are also procyclical in developing countries (i.e., tax rates are raised in bad times and reduced in good times). This indeed, is how the inflation tax behaves. However, data on actual tax rates is very difficult to come by. Moreover, our model would predict that tax rates should be set countercyclically which would run

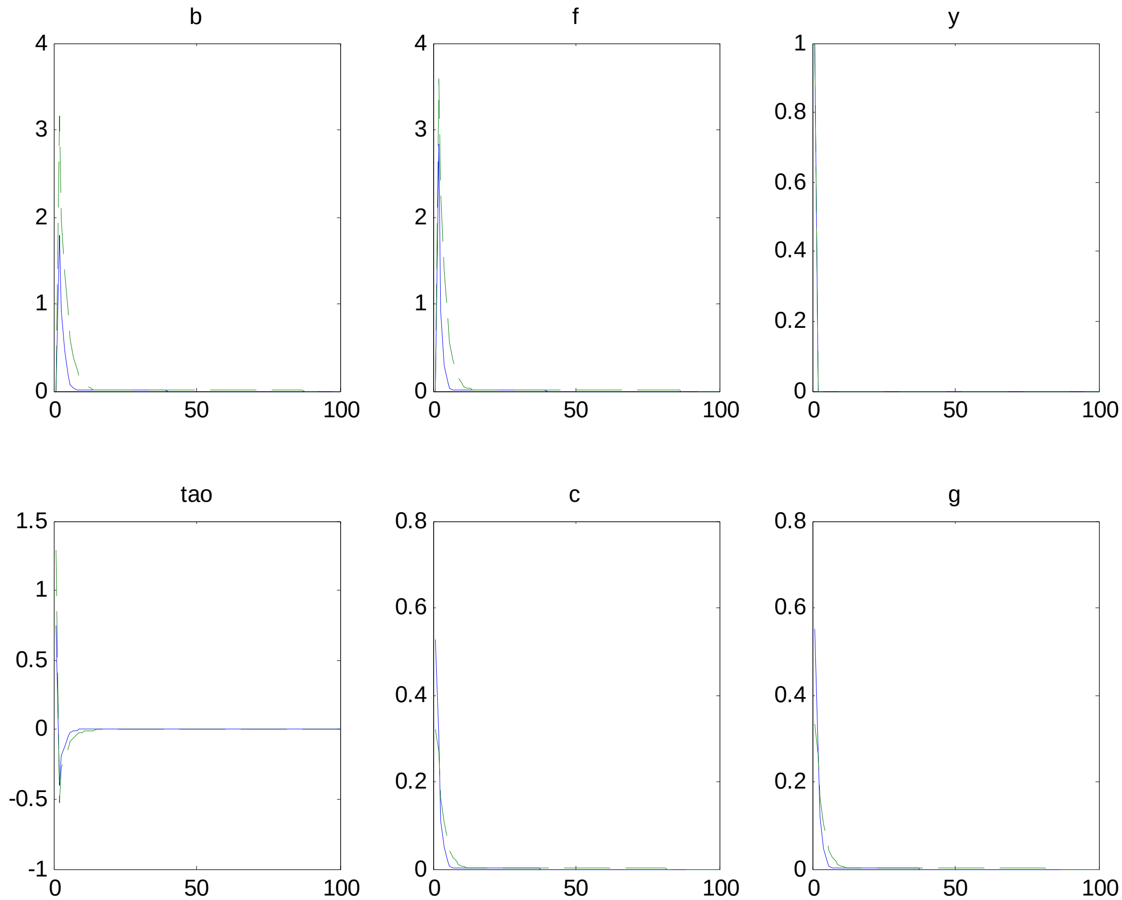

Figure 1: Impulse responses

counter to the conventional wisdom. We thus need to understand better what are the stylized facts in this area and whether this is consistent or not with the predictions of a neoclassical model.

A third area would be to investigate an intermediate case of market incompleteness and check that the procyclicality of government spending would fall in between the two extremes that we have analyzed. A potential candidate would be to have a non-state contingent bond whose rate of return is state contingent.

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A Sensitivity analysis: intertemporal elasticity of substitution $\left(\frac{1}{1+\gamma}\right)$

All variables are first differences of the logs of each variable. The solution is started from the steady state. The following tables report some statistics calculated using 10000 simulated data points. All parameters are the ones of the benchmark calibration unless otherwise stated. We set $\kappa = 1$.

Volatility and Correlations Model Economy					
	γ	y	c	g	τ
Volatility $std(\%)$	1.25	4.12	1.76	1.86	4.07
	5	4.12	1.02	1.05	6.5
Correlations with Output	1.25	1.00	0.87	0.92	0.96
	5	1.00	0.75	0.80	0.98
* $\rho = 0, \sigma_\varepsilon = 0.029, \kappa = 1.$					

Volatility and Correlations Model Economy					
	γ	y	c	g	τ
Volatility $std(\%)$	1.25	4.12	2.76	2.80	2.66
	5	4.12	1.93	1.96	4.7
Correlations with Output	1.25	1.00	0.96	0.97	0.92
	5	1.00	0.93	0.94	0.95
* $\rho = 0.5, \sigma_\varepsilon = 0.0356, \kappa = 1.$					

Volatility and Correlations Model Economy					
γ		y	c	g	τ
Volatility $std(\%)$	1.25	4.12	4.07	4.07	0.11
	5	4.12	4.02	4.02	0.2
Correlations with Output	1.25	1.00	1.00	1.00	0.93
	5	1.00	1.00	1.00	1.00
* $\rho = 0.99, \sigma_\varepsilon = 0.041, \kappa = 1.$					

B Sensitivity analysis: elasticity of substitution $(\frac{1}{1+\sigma})$

All variables are first differences of the logs of each variable. The solution is started from steady state. The following tables report some statistics calculated using 10000 simulated data points. All parameters are the ones of the benchmark calibration unless otherwise stated. We set $\kappa = 1$.

Volatility and Correlations Model Economy					
	σ	y	c	g	τ
Volatility $std(\%)$	0.25	4.12	1.76	1.86	4.07
	1	4.12	1.75	2.01	3.50
Correlations with Output	0.25	1.00	0.87	0.92	0.96
	1	1.00	0.86	0.95	0.95
* $\rho = 0, \sigma_\varepsilon = 0.029, \kappa = 1.$					

Volatility and Correlations Model Economy					
	σ	y	c	g	τ
Volatility $std(\%)$	0.25	4.12	2.76	2.80	2.66
	1	4.12	2.73	2.86	2.19
Correlations with Output	0.25	1.00	0.96	0.97	0.92
	1	1.00	0.96	0.98	0.90
* $\rho = 0.5, \sigma_{\varepsilon} = 0.0356, \kappa = 1.$					

Volatility and Correlations Model Economy					
γ	σ	y	c	g	τ
Volatility $std(\%)$	0.25	4.12	4.07	4.07	0.11
	1	4.12	4.06	4.06	0.09
Correlations with Output	0.25	1.00	1.00	1.00	0.93
	1	1.00	1.00	1.00	0.94
* $\rho = 0.99, \sigma_{\varepsilon} = 0.041, \kappa = 1.$					

Notice that the lower the elasticity of substitution (i.e., the higher is σ) the higher is the volatility of government consumption and the lower is the volatility of taxes.