Fiscal policy in an emerging market business cycle model

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ABSTRACT

Emerging market economy business cycles are typically characterized by high consumption and output volatility, strongly counter-cyclical current accounts, and counter-cyclical real interest rates. Evidence from the wider EME and less developed economy business cycle experience suggests however that real interest rates can also be pro-cyclical. We reconcile the pro-cyclicality of real interest rates with the above facts by embedding fiscal policy into a standard emerging market business cycle model. We show that fiscal policy makes real interest rates a-cyclical or pro-cyclical. We use the model to replicate some of the key features of the Indian business cycle.

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1. Introduction

Building dynamic stochastic general equilibrium (DSGE) models of emerging market economies (EMEs) has become an important area of research in macroeconomics. In this paper we build a small open economy (SOE) real business cycle (RBC) model with fiscal policy and interest rate shocks to understand the salient features of the Indian business cycle. While we calibrate the model to India, our model has broader implications for EME business cycles. In particular, the model allows us to understand how non-discretionary fiscal policy can offset the adverse effects of real interest rate shocks on labor market outcomes in emerging market economies. By incorporating fiscal policy in a small open economy, we also provide a more general and tractable theoretical framework to understand the wider EME evidence on business cycles.

The set-up of our model is similar to the seminal work by Neumeyer and Perri (2005) although we extend this framework to incorporate a distinctive role for fiscal policy. The government provides a public good to households and also lends a portion of the working capital to private firms facing working capital constraints at a subsidized interest rate. Firms however can only borrow a fraction of their working capital requirement from the government. The rest of the working capital needs to be financed in global markets through one period risk free bonds. The interest rate on these bonds is determined by the foreign interest rate plus a country specific risk premium that depends on expected future total factor productivity (TFP). Tax revenues are collected through invariant distortionary taxes on consumption, wages, and capital income. The government also receives interest income on the subsidized loans. The government follows a balanced budget,

Table 1
Real interest rates and government expenditures in EMEs from Male (2010).

Country	Sample	$\frac{\sigma(G)}{\sigma(Y)}$	$\frac{\sigma(R)}{\sigma(Y)}$	$\rho(G, Y)$	k_c
Brazil	1980:1–2004:4	18.4	3.6	0.51	−0.74
Chile	1980:1–2004:4	11.3	1.7	–	−0.22
Colombia	1980:1–2004:4	2.2	3.7	0.35	0.27
Hong Kong	1980:1–2004:4	2.5	3.1	−0.21	0.33
Hungary	1980:1–2004:4	1.7	2.6	−0.63	−0.01
Israel	1980:1–2004:4	20.7	8.7	–	−0.02
Jordan	1980:1–2004:4	2.0	3.6	−0.16	0.35
Korea	1980:1–2004:4	2.4	2.1	−0.04	−0.36
Malaysia	1980:1–2004:4	1.5	2.1	−0.21	0.75
Mexico	1980:1–2004:4	4.0	8.5	−0.11	−0.48
Nigeria	1980:1–2004:4	14.5	2.1	−0.55	0.38
Slovak Rep.	1980:1–2004:4	2.3	5.1	–	0.45
Slovenia	1980:1–2004:4	1.5	11.1	0.27	0.25
South Africa	1980:1–2004:4	1.9	3.9	0.04	0.13
Turkey	1980:1–2004:4	8.3	–	0.74	–
Uruguay	1980:1–2004:4	3.7	4.9	0.36	−0.36
India	1999:2–2010:2	5.53	1.77	−0.35	0.38

in which the tax and interest rate revenue is spent on new working capital loans and government consumption. Unlike Neumeyer and Perri (2005), we also assume that household preferences are Cobb-Douglas to allow for the possibility of income effects in household's labor supply from interest rate shocks. Private and public consumption are assumed to be perfect substitutes.

We calibrate the model to match the business cycle features of the quarterly macroeconomic data for India from 1999:2 to 2010:2.[1] The model succeeds in matching some salient features of the Indian business cycle, including (a) higher relative consumption volatility, (b) counter-cyclical net exports and government expenditures, and (c) pro-cyclical interest rates.[2] India also typifies the broader EME business cycle experience discussed later in Column 3 of Table 2. The counter-cyclicality of government expenditures has been coupled with pro-cyclical interest rates and counter-cyclical net exports, consistent with the evidence on other EMEs discussed in Table 1 and 2. We also believe that the specification of fiscal policy in our paper is particularly relevant for India (and generally some other EMEs). For instance, although there have been major financial sector reforms, public sector banks still own 70% of the banking sector's assets in India.[3] These banks extend priority sector lending to certain sectors such as agriculture, exports, infrastructure, and small and medium enterprises at a subsidized lending rate. Government expenditures, in recent years, is approximately 12–13% of GDP[4] suggesting its role as a plausible channel through which interest rate shocks are propagated in the model.[5]

Matching pro-cyclical interest rates is of particular interest in our context, as Neumeyer and Perri (2005) assume that the key transmission mechanism hinges on *counter-cyclical* interest rates. We later show that our description of fiscal policy creates a "fiscal policy wedge" which makes the effective real interest rate less counter-cyclical or even pro-cyclical. This amplification effect of the fiscal policy wedge increases when households value public consumption highly.

1.1. Literature review

A recent empirical literature has identified key stylized facts in EME business cycles to see how these differ from the main features of advanced economy (AE) business cycles (see Agénor, McDermott, and Prasad (2000), Rand and Tarp (2002), Neumeyer and Perri (2005), Loayza, Ranciére, Servén, and Ventura (2007), Male (2010), and Ghate et al. (2013)). The key stylized facts that these papers have identified are as follows. First, output in EMEs tends to be more volatile than output in advanced economies.[6] Second, EMEs have counter-cyclical real interest rates. In AEs, real interest rates are typically a-cyclical or at the most mildly pro-cyclical. Third, consumption is pro-cyclical and more volatile than output in EMEs, whereas in AEs it is pro-cyclical but is less volatile than output. Fourth, net exports are much more counter-cyclical with respect to

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[1] See Ghate Pandey, and Patnaik (2013) for a description of the quarterly data. The above time frame corresponds to quarterly data from 1999-Q2 to 2010-Q2.

[2] The key Indian stylized facts are as follows: higher relative consumption volatility, higher relative investment volatility, counter-cyclical net exports, counter-cyclical government expenditures, and a pro-cyclical interest rate (see Ghate et al. (2013), Table 5).

[3] Table no. 3.1, statistical tables relating to banks of India, Handbook of Statistics of the Indian Economy (2012) (http://www.rbi.org.in/scripts/Pub licationsView.aspx? id=14672).

[4] See the 2013 World Development Indicators: http://www.data.worldbank.org/indicator/NE.CON.GOVT.ZS

[5] There is no economy-wide estimate for labor hours on the Indian economy. However, as we will show later, because equilibrium output depends on labor market outcomes, analyzing changes in equilibrium output are sufficient from the standpoint of determining co-movements.

[6] Male also (2010) estimates output to be on average twice as volatile in EMEs in comparison to AEs. Rand and Tarp (2002) on the contrary state that output is no more than 20% more volatile in EMEs compared to AEs.

Table 2
Facts based on the wider literature on EME business cycles.

Variables	Evidence from NP and AG[a]	Wider evidence from Male[b]
$\frac{\sigma(C)}{\sigma(Y)}$	>1	>1
$\rho(\frac{NX}{Y}, Y)$	<0	<0
$\rho(R, Y)$	<0	$\gtrless 0$
$\rho(G, Y)$	No role	$\gtrless 0$

[a] NP stands for Neumeyer and Perri (2005) and AG stands for Aguiar and Gopinath (2007).
[b] See Male (2010).

output in EMEs in comparison to the AEs.

This research has motivated new theoretical models to understand the propagation and amplification of shocks in EME business cycles. One branch of the literature builds upon the seminal work of Neumeyer and Perri (2005).[7] These authors build a small open economy (SOE) real business cycle (RBC) model with interest rate shocks and working capital constraints.[8] A higher interest rate implies that a firm's borrowing costs to meet its working capital constraint increases. This leads to a decline in the labor demanded by firms, and since this is a full employment model, a reduction in labor demand leads to a reduction in output. This channel makes real interest rates counter-cyclical. A crucial feature of this model is that households have GHH preferences (see Greenwood, Hercowitz, and Huffman, (1988)). GHH preferences shut off the income effect, making labor supply invariant to the income effects associated with an interest rate shock (see Li (2011)). Consumption drops instantaneously and falls more than output due to the inter-temporal substitution effect from a rise in real interest rates. At the same time private investments also fall since the demand for private capital falls because of higher interest rates. As a result, net exports displays counter-cyclicality with respect to output.

Another branch of EME business cycles builds on the seminal work of Aguiar and Gopinath (2007). These authors explain the key stylized facts of EME business cycles discussed above by allowing for both permanent trend shocks and transitory changes in productivity. Trend shocks affect both current income and future income. They justify this assumption by noting that emerging markets are characterized by a large number of policy regime shifts, which can be viewed as shocks to the trend productivity growth rate. Using the permanent income hypothesis as the identification mechanism, a shock to trend productivity implies a boost to both current output and also future output. Since a shock to the trend productivity increases permanent income, consumption increases more than income. This reduces savings, and generates a counter-cyclical current account deficit.

One aspect that is missing in the above theoretical literature is that there is no explicit role for fiscal policy. This is puzzling since fiscal policy plays an important role in macroeconomic stabilization in many developing countries and EMEs.[9] For instance, Male (2010) finds that government expenditures tend to be significantly more volatile than output in EMEs. She also reports that there is no robust stylized observation on the correlation between real government expenditure and output.[10] In other evidence (see Talvi and Vegh (2005)), government expenditures have tended to be more pro-cyclical in EMEs than in AEs although there are countries where government expenditures are counter-cyclical.[11] A bigger challenge for emerging economies is that fiscal policy often contributes to worsening business cycle fluctuations (Lane, 2003b). On the contrary, for AEs particular categories of fiscal policy shocks (such as a deficit-financed tax cut), appear to stimulate the economy (Mountford and Uhlig (2009)). Our takeaway from this literature is that in some EMEs, government expenditures are counter-cyclical with respect to output yet in others it is pro-cyclical.

Another aspect that has typically not received sufficient attention is the role of fiscal policy for macroeconomic stabilization when an economy is hit with an interest rate shock. For instance, Male (2010) finds that a typical feature of these EMEs is that both government expenditures and real interest rates are more volatile than output. The contemporaneous correlation of the government expenditure and the real interest rate with respect to output however, is positive or

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[7] Recently, Tiryaki (2012) estimates Neumeyer and Perri's (2005) model to replicate Turkey's business cycle properties.

[8] More specifically, in their model, firms face a working capital constraint, i.e., firms have to pay a fraction of the wage bill before actual production takes place. In order to finance this working capital constraint, firms issue corporate bonds to agents in international capital markets at a market determined interest rate on bonds. The interest rate has two different components – an international interest rate component and a country spread component driven by a shock to the country spread risk with the latter varying according to an individual country's sovereign risk.

[9] Fiscal policy can serve as a stabilizing instrument if government expenditures are counter-cyclical along with pro-cyclicality of government revenues. One explanation for pro-cyclical government expenditure in EMEs is that governments often face political pressures or temptations to avoid budgetary surpluses during boom-time thereby constraining themselves from lowering expenditures or raising taxes. During recessions, governments in EMEs are forced to reduce spending because of lack of access to credit (see Talvi and Vegh (2005)). In the post great financial crisis period, there is also a renewed interest in fiscal policy in small open economies.

[10] Agénor et al. (2000) state that government expenditures tend to be more counter-cyclical in AEs as compared to EMEs.

[11] This is at odds with a voluminous literature that has found that fiscal policies are pre-dominantly pro-cyclical in EMEs (Talvi and Vegh (2005), Cuadra, Sanchez, and Sapriza (2010)). Over the last decade, however, several EMEs have "graduated" from having pro-cyclical fiscal policy to having counter-cyclical fiscal policy. This "graduation" has been attributed to improvements in institutional quality (see Frankel, Vegh, and Vuletin, (2013)).

negative.[12] This is in contrast to advanced economies where real interest rates are observed to be a-cyclical or mildly pro-cyclical (see Agénor et al. (2000), Neumeyer and Perri (2005), and Male (2010)). In Table 1, we summarize the estimates of the relative standard deviation and contemporaneous correlations of government expenditures (G) and real interest rates (R) for twelve EMEs from Male (2010).[13]

In countries for which data is available, seven countries have counter-cyclical real interest rates, while nine have pro-cyclical interest rates. While government expenditure is counter-cyclical in eight countries, it is pro-cyclical in six. Further, a few countries exhibit both counter-cyclical government expenditure *and* pro-cyclical real interest rates (Nigeria, Malaysia, India, Jordan, Hong Kong). Drawing on the evidence from Table 1, we summarize the stylized facts that are the focus of the theoretical literature on EME business cycles (Column 2), and the wider EME evidence in Column 3 in Table 2.

1.2. Description and main results

Given Tables 1 and 2, we build a small open economy RBC model which allows us to understand the causal link between the nature of counter-cyclical or a-cyclical fiscal policy, pro-cyclical or counter-cyclical real interest rates, counter-cyclical net exports, and higher relative consumption volatility. We obtain higher relative consumption volatility without having to assume the presence of trend shocks to productivity, as in Aguiar and Gopinath (2007). Our model is different from Neumeyer and Perri (2005) in two respects.

First, we extend their framework by incorporating fiscal policy. We incorporate two different roles for fiscal policy: the government provides public consumption with the private and public components of consumption substitutable; and, the government lends a portion of the working capital constraint faced by the firm at a subsidized interest rate. We assume that the government imposes time invariant distortionary taxes on consumption, labor income and capital income, and maintains a balanced budget at every time period.

Second, unlike Neumeyer and Perri (2005), where agents have GHH preferences, in our framework, agents are assumed to have Cobb-Douglas (CD) utility functions. The assumption of CD preferences *permits* a shock to the real interest rate to have income effects on labor supply through consumption.[14]

We show that these added features make the real interest rate less counter-cyclical or even pro-cyclical at times. Fiscal policy affects the transmission of interest rate shocks onto the real economy through a standard inter-temporal substitution effect, and a time varying wedge which we denote as the *fiscal policy wedge*. We show that the fiscal policy wedge is a more general version of the simple intra-temporal tax wedge that distorts labor hours in the standard stochastic growth model. Our theoretical contribution is two-fold: first, we characterize the fiscal policy wedge in closed-form under a variety of assumptions on fiscal policy, and show how this affects movements in labor supply adversely; and second, we show that because the fiscal policy wedge is time varying and increases with a positive interest rate shock, the impact of an increase of the wedge on labor supply is higher when there is a higher weight on government consumption in the utility function. This happens because of two effects. First, when an economy is hit with an interest rate shock labor supply falls due to an increase in the fiscal policy wedge. The fiscal policy wedge increases more when households value public consumption highly. Second, a higher weight on public consumption in utility induces a strong standard inter-temporal substitution effect which reduces private consumption and increases labor supply.[15] The net effect on labor market outcomes of a positive interest rate shock therefore depends on the relative strength of these two individual effects. In general, the net effect will be positive (i.e., equilibrium employment and output increase).[16]

We also show that fiscal policy's second role in our model – to subsidize working capital – dampens the reduction in labor demand due to a positive interest rate shock in the standard Neumeyer and Perri (2005) setup. Thus, both labor supply and labor demand channels make the real interest rate a-cyclical, and under certain cases, pro-cyclical, matching the qualitative features of the EME data in Table 2.[17]

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[12] While Neumeyer and Perri (2005) and Uribe and Yue (2006) state that interest rates are generally counter-cyclical in EMEs, Male (2010) finds this observation not to be universally true particularly among EMEs in Africa, Asia, and Eastern Europe.

[13] $\sigma(Z)$ denotes the standard deviation of variable Z and $\rho(Z, Y)$ is the contemporaneous correlation of variable Z with output, Y. For India, we obtain the moments from Ghate et al. (2013).

[14] Our approach is consistent with other papers in the literature where government expenditure influences effective consumption (public+private consumption) of an agent, and thereby the agent's labor-leisure choice (see Barro (1981), Ni (1995), and Christiano and Eichenbaum (1992)). Non-separability of public consumption in utility implies that there exists Edgeworth substitutability between private and public consumption.

[15] As a result, a higher weight on public consumption also makes private consumption more volatile in our model. Ljungqvist and Uhlig (2000) however show that using a "catching up with the Joneses" type utility function, counter-cyclical fiscal policy with pro-cyclical tax adjustments makes private consumption smoother.

[16] The counter-cyclicality of government spending is also consistent with the theoretical prediction of government spending in the neo-classical framework where we would expect to see government consumption move counter-cyclically, if public and private components are substitutes. See Lane (2003a).

[17] Our results are consistent with many papers in the literature which argue that the final effect of the simple inter-temporal tax wedge on hours worked depends crucially on whether public consumption is perceived as highly substitutable by agents (see Prescott, 2002).

2. The model

2.1. The firm's problem

The economy consists of firms, a government, and households. At any given time t a representative firm produces final output using labor employed at time t and capital carried forward from time period $t - 1$. However, prior to actual production, the firm needs to pay a portion $\theta \in [0, 1]$ of its total wage bill in advance. To meet this working capital constraint, the firm borrows from the government and from households by issuing debt.[18] The firm issues corporate bonds to households to whom they promise a return of R_{t-1}^P which is a mark-up over the existing international interest rate R_{t-1}^*. Firms can also borrow from the government at a subsidized interest rate $R_{t-1}^P(1 - s)$ where $0 \leq s < 1$ is the subsidy. We assume however that only a fixed portion, θ_G, of the total firm's working capital constraint, θ, such that $\theta_G \leq \theta$ can be borrowed from the government at the subsidized rate. The rest of the working capital constraint ($\theta - \theta_G \geq 0$) has to be covered by issuing bonds in international capital markets at R_{t-1}^P.

The firm hires labor (l_t) and uses capital (k_{t-1}) accumulated in time period $t - 1$ to produce the final output y_t such that

$$
\begin{aligned}
y_t &= A_t k_{t-1}^\alpha l_t^{1-\alpha} \left(1 + \gamma\right)^{t(1-\alpha)} \\
&= A_t k_{t-1}^\alpha \left[\left(1 + \gamma\right)^t l_t \right]^{1-\alpha}, \quad 0 < \alpha < 1
\end{aligned}
\tag{1}
$$

where $(1 + \gamma)^t$ is labor augmenting technical progress in time period t. We assume that the production technology, y_t, exhibits constant returns to scale (CRS). The firm's profits are given by:

$$
\pi_t = y_t - w_t l_t - r_t k_{t-1} - \left(R_{t-1}^G - 1 \right) \theta_G w_t l_t - \left(R_{t-1}^P - 1 \right) \left(\theta - \theta_G \right) w_t l_t,
\tag{2}
$$

The last two terms in (2) denote the interest costs for working capital loans from the government and households, respectively, where R_{t-1}^P is the country specific gross interest rate at which firms borrow from international capital markets, and R_{t-1}^G is the subsidized gross interest rate offered by the government to lend 'θ_G' portion of the firm's total working capital constraint. No-arbitrage implies:

$$
R_{t-1}^G = R_{t-1}^P (1 - s).
\tag{3}
$$

We assume that $\overline{R}^P (1 - s) \geq 1$ in the steady state. This ensures that the government earns a non-negative net interest earning in its lending to firms.[19] We can therefore re-write Eq. (2) as

$$
\pi_t = y_t - r_t k_{t-1} - \left(1 - \theta\right) w_t l_t - w_t l_t R_{t-1}^P \left[\theta - s\theta_G \right].
\tag{4}
$$

The partially subsidized loan provided by the government to cover the firm's working capital constraint therefore effectively creates a wedge $[\theta - s\theta_G]$ on the interest payment. If subsidy s is zero, we go back to the standard Neumeyer and Perri (2005) model.[20]

Timing of Events. The timing of events and decisions is given in Fig. 1. In the beginning of period t, which we denote as t^-, firms borrow, $\theta w_t l_t$, to make advance payments to labor prior to actual production (which occurs at t). Firms then produce output and repay the loan borrowed at the end of time period (t^+), with workers receiving the rest of their wage bill, $(1 - \theta) w_t l_t$, at time t^+ also. Since the time gap between t^- and t, and between t and t^+ is very small, we drop these superscripts and consider the entire period as time period t.

We transform output y_t to it's stationary value $\widetilde{y}_t$, as follows[21]

$$
\widetilde{y}_t = \frac{y_t}{\left(1 + \gamma\right)^t} = \frac{A_t k_{t-1}^\alpha l_t^{1-\alpha} \left(1 + \gamma\right)^{t(1-\alpha)}}{\left(1 + \gamma\right)^t} = A_t \frac{k_{t-1}^\alpha}{\left[\left(1 + \gamma\right)^t \right]^\alpha} l_t^{1-\alpha} = \frac{A_t}{\left(1 + \gamma\right)^\alpha} \widetilde{k}_{t-1}^\alpha l_t^{1-\alpha}.
$$

Hence, Eq. (4) can be re-written as

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[18] In Neumeyer and Perri (2005), firms cannot borrow from the government.

[19] Relaxing this assumption implies that the government makes negative net interest earnings in the steady state. Allowing for the government to be a net negative interest earner does not change our main calibrated results as long as s and θ_G are chosen such that the subsidy on the firm's working capital constraint remains the same.

[20] As in Neumeyer and Perri (2005), country specific interest rates depend on the international interest rate and the country specific spread component which measures the economy's riskiness.

[21] For any variable m_t, we define it's stationary transformation as $\tilde{m}_t$ such that,

$$
\tilde{m}_t = \frac{m_t}{(1 + \gamma)^t}.
$$

All variables in our model grow at the same exogenous rate $(1 + \gamma)$. All variables are therefore transformed to their corresponding stationary values except l_t, which is assumed to be stationary.
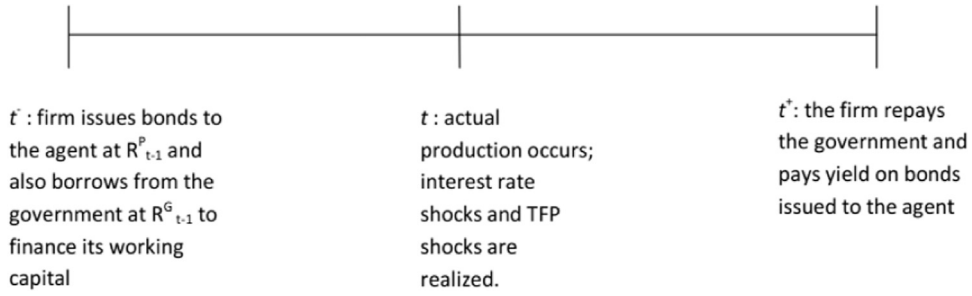
Fig. 1. Timing of events and decisions.

$$\tilde{\pi}_t = \tilde{y}_t - \frac{r_t \tilde{k}_{t-1}}{(1+\gamma)} - (1-\theta)\tilde{w}_t l_t - \tilde{w}_t l_t R^P_{t-1}[\theta - s\theta_G].$$

2.1.1. Firms profit maximizing conditions

The firm's profit maximization yields the following first order conditions $\forall\, t$, for labor, l_t, and capital, $\tilde{k}_{t-1}$, respectively.

$$\{l_t\}: \frac{(1-\alpha)\tilde{y}_t}{l_t} = \tilde{w}_t\Big[(1-\theta) + R^P_{t-1}(\theta - s\theta_G)\Big]$$

$$\Big\{\tilde{k}_{t-1}\Big\}: \frac{\alpha\tilde{y}_t}{\tilde{k}_{t-1}} = \frac{r_t}{(1+\gamma)}. \tag{5}$$

Without any working capital constraints, $\theta = \theta_G = 0$, and the standard first order condition for labor demand, $\frac{(1-\alpha)\tilde{y}_t}{l_t} = \tilde{w}_t$, obtains. The presence of the working capital constraint therefore modifies this condition by changing the effective wage payment to, $\tilde{w}_t\Big[\big(1-\theta\big) + R^P_{t-1}\big(\theta - s\theta_G\big)\Big]$. For given values of θ and θ_G, interest rate shocks affect wage payments with a lag since effective wage payments depend on R^P_{t-1}.

2.2. Government

Fiscal policy is entirely non-discretionary in the model. The government collects tax revenue by imposing time invariant distortionary taxes on consumption $\tau_c \in [0, 1]$, wage income $\tau_w \in [0, 1]$, and capital income $\tau_k \in [0, 1]$. It also receives interest income from financing the 'θ_G' component of a firm's working capital constraint.[22] The interest income is given by, $R^G_{t-1}\theta_G w_t l_t$. The government allocates G_t of it's total revenue towards government consumption. We assume that net of G_t, the government lends S_t to firms at time period t at a subsidized interest rate given by (3). The government is assumed to balance it's budget at every time period t such that[23]

$$TR_t + R^G_{t-1}\theta_G w_t l_t = G_t + S_t.$$

TR_t denotes the total tax revenue collected by the government at every time period such that

$$TR_t = \tau_c c_t + \tau_w w_t l_t + \tau_k r_t k_{t-1}. \tag{6}$$

As discussed above, due to the timing of the firm's problem, we have

$$S_t = \theta_G w_t l_t.$$

Clearly, this implies[24]

$$G_t = \tau_c c_t + \left\{\Big[R^P_{t-1}(1-s) - 1 \Big]\theta_G + \tau_w \right\} w_t l_t + \tau_k r_t k_{t-1}. \tag{7}$$

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[22] The share of public goods in the households' utility function is fixed and the fraction of government financed working capital loans is fixed, too.

[23] We assume that there is no public debt in the model, although analyzing fiscal policy in conjunction with the sovereign default literature would be a natural extension. See Eaton and Gersovitz (1981).

[24] The stationary transformation of Eq. (7) is:

$$\tilde{G}_t = \tau_c \tilde{c}_t + \left\{\Big[R^P_{t-1}(1-s) - 1 \Big]\theta_G + \tau_w \right\}\tilde{w}_t l_t + \frac{\tau_k r_t \tilde{k}_{t-1}}{1+\gamma}.$$

2.3. The household problem

The economy is populated by infinitely lived households with a mass normalized to 1. Each representative household consumes and invests a homogenous good and supplies labor and capital to firms. The representative household has the following expected discounted lifetime utility

$$E_0 \sum_{t=0}^{\infty} \beta^t U(c_t^*, l_t),$$
(8)

where $\beta \in (0, 1)$ denotes the households subjective discount factor. We assume that

$$c_t^* = c_t + \Theta G_t,$$
(9)

where household consumption, c_t is augmented by government consumption, G_t. Following Barro (1981), Ni (1995), Roche (1996), Ambler and Paquet (1996), and Christiano and Eichenbaum (1992) the parameter Θ captures the weight of public consumption in household utility, where $\Theta > 0$. Given our specification in Eq. (9), c_t and G_t are assumed to be perfect substitutes.[25] We assume that agents treat G_t as given. l_t denotes hours worked.

Following Aguiar and Gopinath (2007) and Tiryaki (2012), we parametrize the utility function, U, in (8) by assuming a Cobb-Douglas (CD) specification, i.e.,

$$U(c_t^*, l_t) = \frac{\left[\left(c_t^* \right)^{\mu} \left(1 - l_t \right)^{(1-\mu)} \right]^{(1-\sigma)}}{(1 - \sigma)}, \quad 0 < \mu < 1, \sigma > 0.$$

This is an important point of departure from Neumeyer and Perri (2005), who assume GHH preferences. Assuming GHH preferences ensures that labor supply is independent of consumption and therefore interest rates. A positive shock to the interest rates does not cause any shift in the labor supply while it reduces demand for labor thereby reducing equilibrium labor. This leads to a reduction in output which makes real interest rates counter-cyclical with respect to output. We focus on the Cobb-Douglas (CD) utility function to allow equilibrium labor to increase due to a single period interest rate shock for some parametric restrictions. The parameter σ is the coefficient of risk aversion and μ is the intra-temporal elasticity of substitution of labor supply.

The household maximizes expected lifetime discounted utility (8) subject to

$$(1 + \tau_c)c_t + x_t + b_t + \kappa(b_t) \le (1 - \tau_w)w_t l_t + (1 - \tau_k)r_t k_{t-1} + R_{t-1}^P b_{t-1}.$$
(10)

where b_t denotes bond holdings of the household, x_t denotes investment, and $\tau_c \in [0, 1]$ is the tax on consumption, $\tau_w \in [0, 1]$ is the tax on labor income, and $\tau_k \in [0, 1]$ is the tax on capital income. Agents take the competitive factor awards, w_t, the wage rate, and r_t, the return to capital as given in deciding optimal choices. For bond holdings, b_t, the term $\kappa(b_t)$ in (10) is the bond holding cost such that

$$\kappa(b_t) = \frac{\kappa}{2} y_t \left[\left(\frac{b_t}{y_t} \right) - \left(\frac{b}{y} \right) \right]^2,$$
(11)

where $\frac{b}{y}$ is the steady state bond holding to output ratio.[26] The term x_t in (10) is the level of private investment such that

$$x_t = k_t - (1 - \delta)k_{t-1} + \Phi(k_t, k_{t-1}),$$
(12)

where $\Phi(k_t, k_{t-1})$ is the investment adjustment costs such that[27]

$$\Phi(k_t, k_{t-1}) = \frac{\phi}{2} k_{t-1} \left[\left(\frac{k_t}{k_{t-1}} \right) - (1 + \gamma) \right]^2.$$
(13)

Household First Order Conditions. We obtain the following first order conditions with respect to all stationary transformed variables, $\forall \, t$, by maximizing (8) subject to consumer budget constraint (10), where Eqs. (11), (12) and (13) have

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[25] In an emerging market context, an example of G_t can be public health or public transportation services whose quality is typically seen as being superior to private alternatives. Higher provision of services elicits a strong reduction in the private consumption of these services (see Kuehlwein (1998)). Further, since government expenditure is a public good that agents treat as given, the value of Θ can also be greater than 1, as in Ambler and Paquet (1996).

[26] Introducing adjustment costs on international bonds is one of the many ways of guaranteeing stationarity in the model (see Schmitt-Grohe and Uribe (2003) and Uribe and Yue (2006)). This ensures in steady state, $\frac{b_t}{y_t} = \frac{b}{y}$, i.e., the bond-to-output ratio is constant and depends only on the deep parameters of the model. As in Neumeyer and Perri (2005), in our framework, a bond adjustment cost is analogous to an operational mark-up caused by financial intermediaries. However, the adjustment cost parameter, κ, will be calibrated to be small thereby preserving the business cycle properties of our model.

[27] An investment adjustment cost is required to make the volatility of private investments relative to output match empirically observed values. This is also a standard practice in RBC models.

been substituted into the consumer budget constraint. This yields the first order conditions (14), (15), (16) and (17), with respect to consumption, labor, bond holdings , and the capital stock, respectively. The first order condition for consumption is given by

$$\{\tilde{c}_t\}: \lambda_t(1 + \tau_c) = \left[\left(\tilde{c}_t^*\right)^\mu\left(1 - l_t\right)^{(1-\mu)}\right]^{-\sigma}\mu\left(\tilde{c}_t^*\right)^{\mu-1}\left(1 - l_t\right)^{(1-\mu)},$$

(14)

where $\tilde{\beta} = \beta(1 + \gamma)^{\mu(1-\sigma)}$ and λ_t is the Lagrangian multiplier. The first order condition for labor supply is given by

$$\{l_t\}: \lambda_t(1 - \tau_w)\widetilde{w}_t = \left[\left(\tilde{c}_t^*\right)^\mu\left(1 - l_t\right)^{(1-\mu)}\right]^{-\sigma}(1 - \mu)\left(\tilde{c}_t^*\right)^\mu\left(1 - l_t\right)^{-\mu}.$$

(15)

The first order condition with respect to $\tilde{b}_t$ is given by

$$\{\tilde{b}_t\}: 1 + \kappa\left[\frac{\tilde{b}_t}{\tilde{y}_t} - \frac{b}{y}\right] = E_t\left[\frac{\tilde{\beta}}{(1 + \gamma)}\frac{\lambda_{t+1}}{\lambda_t}R_t^P\right].$$

(16)

Finally the first order condition with respect to $\tilde{k}_t$ (the Euler equation) is given by

$$\{\tilde{k}_t\}: 1 + \phi(1 + \gamma)[\left(\frac{\tilde{k}_t}{\tilde{k}_{t-1}}\right) - 1] = E_t\left[\tilde{\beta}\frac{\lambda_{t+1}}{\lambda_t}\left\{\begin{array}{c}\dfrac{(1 - \delta) + (1 - \tau_k)r_{t+1}}{(1 + \gamma)} \\ +\dfrac{\phi}{2}(1 + \gamma)\left\{\left(\dfrac{\tilde{k}_{t+1}}{\tilde{k}_t}\right)^2 - 1\right\}\end{array}\right\}\right].$$

(17)

From (14) and (15) we get the standard expression for the labor supply (18), i.e.,

$$(1 - l_t) = \left(\frac{1 - \mu}{\mu}\right)\left(\frac{1 + \tau_c}{1 - \tau_w}\right)\left(\frac{\tilde{c}_t^*}{\widetilde{w}_t}\right).$$

(18)

Competitive Equilibrium. A competitive equilibrium of our model is defined as follows.

Definition 1: Given $\{A_t$ and $R_t^P\}_{t=0}^\infty$, a vector of fiscal policy parameters $\{\tau_c, \tau_k, \tau_w, \theta_G, s, \Theta\}$, and initial conditions $\tilde{k}_{-1}, \tilde{b}_{-1}, R_{-1}^P$, a competitive equilibrium is a vector of allocations of $\{\tilde{c}_t, \tilde{k}_t, \tilde{b}_t, l_t$ and $\tilde{G}_t\}_{t=0}^\infty$ and factor prices $\{\widetilde{w}_t$ and $r_t\}_{t=0}^\infty$ such that, for the given sequence of factor prices, (i) $\{\tilde{k}_t$ and $l_t\}_{t=0}^\infty$ solves the firm's profit maximization problem (4) and (5), (ii) $\{\tilde{c}_t, \tilde{k}_t, \tilde{b}_t, l_t\}_{t=0}^\infty$ maximizes the utility of the representative agent (8) subject to (1), (10), (9), (11), (12) and (13), together with $\tilde{c}_t, \tilde{k}_t \geq 0$, (iii) $\tilde{G}_t$ satisfies (7), (iv) a no-Ponzi associated with the initial conditions k_{-1} and b_{-1} holds for the representative agent, and finally, (v) all markets clear $\forall t$.

2.4. The steady state

From the firm's first order conditions (5), at the steady state we obtain

$$\frac{\overline{y}}{\overline{r}\overline{k}} = \frac{1}{(1 + \gamma)\alpha}$$

(19)

and

$$(1 - \alpha)\overline{y} = \overline{w}\overline{l}\left[\left(1 - \theta\right) + \overline{R}^P\left(\theta - s\theta_G\right)\right].$$

(20)

From Eq. (18), at the steady state, labor supply is given as

$$(1 - \overline{l}) = \left(\frac{1 - \mu}{\mu}\right)\left(\frac{1 + \tau_c}{1 - \tau_w}\right)\left(\frac{\overline{c} + \Theta\overline{G}}{\overline{w}}\right)$$

which implies

$$\overline{l} = 1 - \left(\frac{1 - \mu}{\mu}\right)\left(\frac{1 + \tau_c}{1 - \tau_w}\right)\left(\frac{\overline{c} + \Theta\overline{G}}{\overline{w}}\right)$$

(21)

where $\overline{c}, \overline{G}, \overline{y}$ and $\overline{w}$ are steady levels of consumption, government consumption, output and the wage rate respectively.[28] From the first order conditions for the representative agent with respect to bonds (16), at the steady state, we obtain

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[28] See the Appendix for a characterization of the steady state.

$$\overline{R}^P = \frac{(1 + \gamma)}{\widetilde{\beta}} > \left(1 + \gamma\right),$$

(22)

since $\widetilde{\beta} \in (0, 1)$.

From the first order conditions for the representative agent with respect to capital (17), at the steady state, we obtain the following arbitrage condition between $\overline{r}$ and $\overline{R}^P$

$$\overline{r} = \frac{\overline{R}^P - (1 - \delta)}{(1 - \tau_k)}.$$

(23)

In sum, the steady state of this economy is summarized by Eqs. (19)–(23).

2.5. The fiscal policy wedge

This section derives the fiscal policy wedge for the model, and shows how the impact of interest rate shocks on labor market outcomes is mitigated by the presence of the wedge.

2.5.1. The effect of interest rate shocks on labor supply

Note that from Eq. (18), and unlike the case with GHH preferences, labor supply depends on current levels of effective consumption, $\widetilde{c}_t^*$ because of the income effect, and $\widetilde{w}_t$. The following Proposition shows that l_t^S can be expressed as a function of consumption, wages and a time varying *fiscal policy wedge*, which we denote by, $\Gamma_t > 1$.

Proposition 1: *Labor supply, l_t^S, is given by*:

$$l_t^S = 1 - \frac{\widetilde{c}_t}{\widetilde{w}_t}\left(\frac{1 - \mu}{\mu}\right)\Gamma_t$$

(24)

where

$$\Gamma_t = \left(\frac{1 + \tau_c}{1 - \tau_w}\right)\frac{\Psi_t}{D_{t-1}}$$

(25)

and

$$D_{t-1} = 1 + \Theta\left(\frac{1 - \mu}{\mu}\right)\left(\frac{1 + \tau_c}{1 - \tau_w}\right)\left\{\left[R_{t-1}^P(1 - s) - 1\right]\theta_G + \tau_w\right\}$$

$$\Psi_t = \left[1 + \Theta\tau_c + \frac{\Theta\tau_k r_t \widetilde{k}_{t-1}}{(1 + \gamma)\widetilde{c}_t} + \frac{\Theta\left\{\left[R_{t-1}^P(1 - s) - 1\right]\theta_G + \tau_w\right\}\widetilde{w}_t}{\widetilde{c}_t}\right].$$

Further, suppose $\tau_c > \tau_w$, $\tau_c > \left[R_{t-1}^P(1 - s) - 1\right]\theta_G$, and $\mu > 0.5$. This implies that $\Gamma_t > 1$.

Proof. See Appendix. ∎

The above proposition derives sufficient conditions under which $\Gamma_t > 1$. From Eq. (25), the presence of the fiscal policy wedge reduces labor supply relative to the case $\Gamma_t = 1$. Note also that from Eq. (25), Γ_t depends upon the fiscal policy parameters τ_k, τ_w, τ_c, s, θ_G, and Θ. This implies that the fiscal policy wedge is not just sensitive to the tax rates but also to the subsidy given to the firms.

The above proposition formalizes the mechanism through which interest rate shocks affect labor market outcomes. From Eq. (24), interest rate shocks affect labor supply through two channels in time period, t. First, a positive interest rate shock causes consumption, $\widetilde{c}_t$, to instantaneously fall due to the standard inter-temporal substitution effect (Eq. (16)). Fig. 2 illustrates the effect of a single period shock to R_t^P on labor supply.

The second channel occurs through the fiscal policy wedge, Γ_t. As can be seen in Proposition 1, Γ_t, consists of two time varying variables D_{t-1} and Ψ_t. The variable D_{t-1} does not change on impact because it depends on R_{t-1}^P, that is, the interest rate that prevailed in time period $t - 1$. The variable Ψ_t however increases in time period t due to a reduction in $\widetilde{c}_t$ and an increase in r_t (through the no arbitrage condition). As a result, the fiscal policy wedge, Γ_t, increases on impact due to a positive interest rate shock. Also, for a higher value of Θ, the increase in the fiscal policy wedge *is higher* for a given interest rate shock, as can be seen in Fig. 6.[29] We therefore obtain the following Proposition

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[29] In Fig. 6, we assume $\tau_w = \tau_k = 0.01$, as will be discussed in the section on calibration. We can also show that the magnitudes of the increase in the fiscal policy wedge increases for lower τ_c for given $\tau_w = \tau_k$. Also for a given τ_c a higher $\tau_w = \tau_k = \tau$ dampens the instantaneous increase in the fiscal policy wedge, but falls by more in the next time period before it converges to the steady state levels. This is also true for lower values of s or θ_G. These results are available on request.

Proposition 2: *For a positive shock to* R_t^P

$$\frac{\partial \tilde{c}_t}{\partial R_t^P} < 0 \Longrightarrow \frac{\partial l_t^S}{\partial R_t^P} > 0$$

Further, a positive interest rate shock always increases the fiscal policy wedge, i. e., $\frac{\partial \Gamma_t}{\partial R_t^P} > 0$, *with the effect stronger for a higher* Θ. *An increase in* Γ_t *therefore dampens the outward shift of the labor supply:*

$$\left| \frac{\partial l_t^S}{\partial R_t^P} \right|_{\Gamma_t = 1} > \left| \frac{\partial l_t^S}{\partial R_t^P} \right|_{\Gamma_t > 1} > 0.$$

Fig. 3 illustrates how Γ_t dampens the effect of a single period shock to R_t^P on labor supply.

Labor supply moves out to $L^{S''}$ instead of $L^{S'}$ due to an increase in Γ_t. With Cobb-Douglas preferences, the labor supply moves outward as a result of an interest rate shock because consumption drops instantaneously. This is the standard inter-temporal substitution effect, and it is strengthened with a higher value of Θ. This happens because a higher value of Θ implies a higher weight on government consumption in utility which allows households to reduce their private con-sumption more and push current consumption to the future. However, because of the simultaneous increase in Γ_t, labor supply reduces since an increase in Γ_t makes consumption more expensive in terms of leisure. The net increase in labor supply is therefore determined by the inter-temporal substitution effect and the fiscal policy wedge, Γ_t. When Θ is high, the inter-temporal substitution effect has a stronger effect on labor supply than the fiscal policy wedge. This causes a larger net increase in labor supply in time period, t. When Θ is small (1), the inter-temporal substitution effect has a smaller effect on labor supply than the fiscal policy wedge. This causes a smaller net increase in labor supply in time period, t. Importantly, in time period, t, equilibrium labor always increases.

Note that the fiscal policy wedge, Γ_t, is time varying because government consumption directly affects the household's effective consumption $\tilde{c}_t^*$. Under certain conditions however, the fiscal policy wedge will be constant and greater than 1. This constancy of the wedge implies interest rate shocks will affect labor supply only through consumption, $\tilde{c}_t$, and not the fiscal policy wedge. Remark 1 summarizes these conditions.
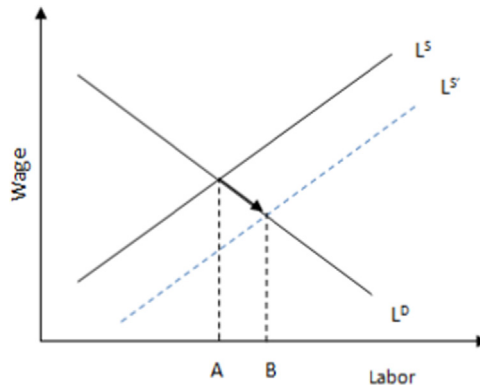

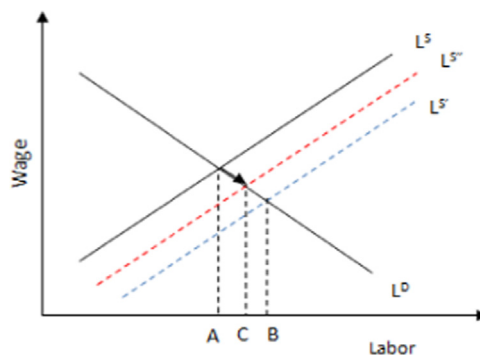**Fig. 2.** The effect of an increase in R_t^P on l_t^S.

Fig. 3. The effect of the wedge Γ_t on l_t^S.

Remark 1: Γ_t will be a constant under different specifications of fiscal policy. When there is no fiscal policy, i.e.,

$$\tau_k = \tau_w = \tau_c = 0, \ and \ s = \theta_G = \Theta = 0, \ implying \ \Gamma_t = \bar{\Gamma} = 1, \quad \forall \ t.$$

When $\tilde{G}_t$ does not affect $\tilde{c}_t^*$ or if the government provided a lump-sum income transfer instead to the representative agent, in which case, the fiscal policy wedge is the standard intra-temporal tax wedge, i.e.,

$$\Theta = 0, \Rightarrow \Gamma_t = \bar{\Gamma} = \left(\frac{1 + \tau_c}{1 - \tau_w} \right), \quad \forall \ t$$

Under GHH preferences, Γ_t, is given by[30]

$$\Gamma_t = \bar{\Gamma} = \left(\frac{1 - \tau_w}{1 + \tau_c} \right)^{\frac{1}{\nu - 1}} \quad \forall \ t.$$

2.5.2. The effect of interest rate shocks on labor demand

From Eq. (4), we can show that the demand for labor is given by

$$l_t^D = \frac{(1 - \alpha)\tilde{y}_t}{\overline{w}_t \left[\left(1 - \theta \right) + R_{t-1}^P \left(\theta - s\theta_G \right) \right]},$$

which can be re-written as

$$l_t^D = \left[\frac{(1 - \alpha)A_t}{\overline{w}_t \left[\left(1 - \theta \right) + R_{t-1}^P \left(\theta - s\theta_G \right) \right]} \right]^{\frac{1}{\alpha}} \frac{\tilde{k}_{t-1}}{(1 + \gamma)}. \tag{26}$$

An increase in R_t^P causes the labor demand curve l^D to shift inwards only in time period $t + 1$, that is,

$$\frac{\partial l_{t+1}^D}{\partial R_t^P} = - \frac{l_{t+1}^D \left(\theta - s\theta_G \right)}{\alpha \left[\left(1 - \theta \right) + R_t^P \left(\theta - s\theta_G \right) \right]}. \tag{27}$$

This is shown in Fig. 4.

The presence of the subsidy parameters θ_G and s however dampens the inward shift of l_{t+1}^D. As shown in Fig. 5, if the government increases θ_G or s, the reduction in l_{t+1}^D is less, and the new labor demand curve is $L^{D''}$ and not $L^{D'}$.

Proposition 3 summarizes the effect of a single period shock R_t^P on labor demand.

Proposition 3: *A positive single period shock to interest rate R_t^P lowers labor demand only in time period $t + 1$. However, the presence of θ_G and s, dampens the reduction in l_{t+1}^D. That is*

$$\left| \frac{\partial l_{t+1}^D}{\partial R_t^P} \right|_{s \neq 0, \theta_G \neq 0} < \left| \frac{\partial l_{t+1}^D}{\partial R_t^P} \right|_{s=0, \theta_G=0}.$$

Proof. See Appendix. ∎

Therefore from Proposition 2 and 3 we obtain the impact of a single period positive interest rate shock on equilibrium labor and output in time period t. This is shown in Proposition 4.

Proposition 4: *Equilibrium labor l_t increases on impact due to a positive single period shock to R_t^P. This causes output y_t to increase on impact, that is,*

$$\frac{\partial \tilde{y}_t}{\partial R_t^P} > 0.$$

Fiscal policy dampens the movements in equilibrium labor. This is because an increase in the fiscal policy wedge Γ_t dampens the outward movement of l_t^S and the subsidy parameters, θ_G and s, dampens the inward movement of l_{t+1}^D.

Proof. Follows from Proposition 2 and 3, and because private capital in time period $t - 1$, $\tilde{k}_{t-1}$, remains unchanged. ∎

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[30] In this case, $U(\tilde{c}_t^*, l_t) = \frac{\left[\tilde{c}_t^* - \psi l_t^\nu \right]^{(1 - \sigma)}}{(1 - \sigma)}$, and the first order conditions yields:

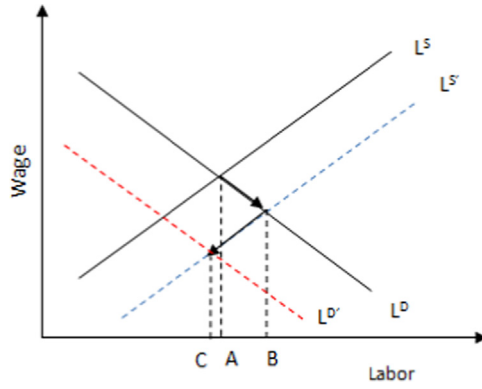$$\left(\frac{1 - \tau_w}{1 + \tau_c} \right) \overline{w}_t = \psi \nu \left(l_t^s \right)^{\nu - 1}.$$

Fig. 4. The effect of an increase in R_t^P on l_{t+1}^D.
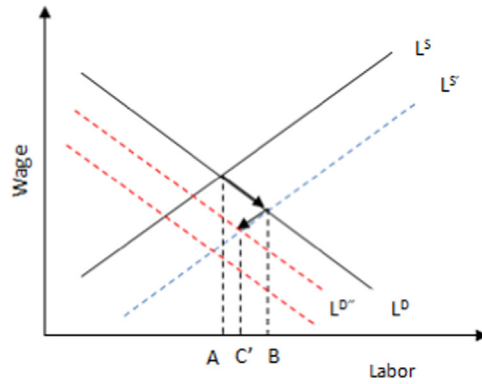
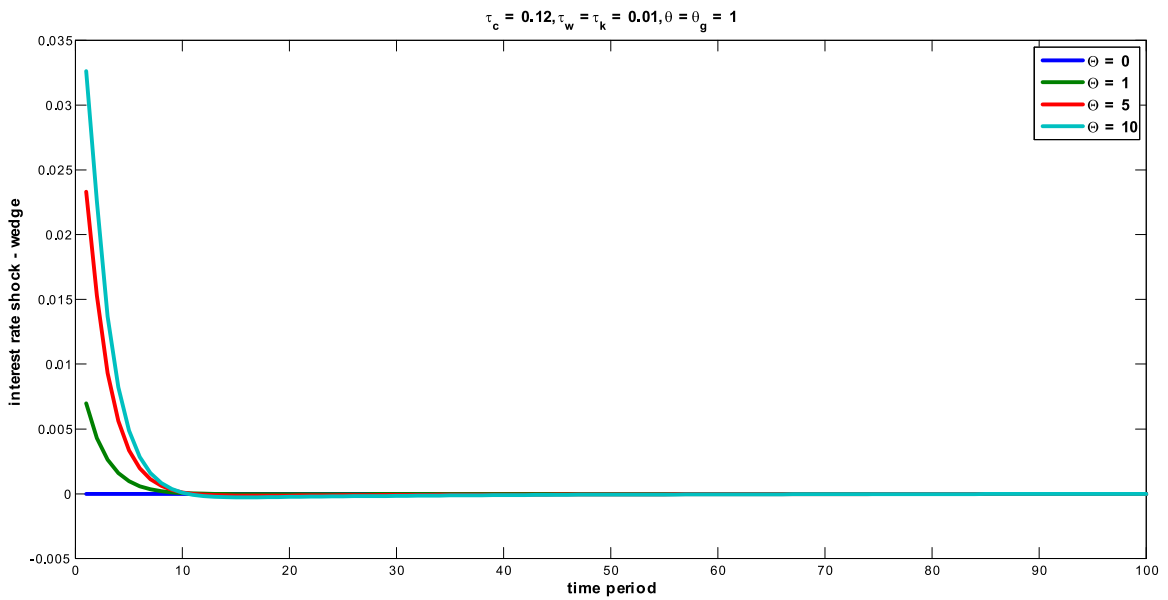**Fig. 5.** The effect of a subsidy θ_G and s on l_{t+1}^D.

Fig. 6. The effect of a single period interest rate shock on Γ_t.

An impact of a single period interest rate shock on the fiscal policy wedge Γ_t can be shown in Fig. 6. In Fig. 6, we assume $\tau_w = \tau_k = 0.01$.[31]

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[31] See the following section on calibration for details.

As can be seen in Fig. 6 a single period interest rate shock causes an instantaneous increase in the fiscal policy wedge Γ_t. The import of Proposition 4 is that in time period t, on impact, equilibrium output increases. However, in $t + 1$, the labor demand schedule moves downwards which implies that output will rise/fall depending on the magnitude of the fiscal policy wedge, and the policy parameters in the labor demand curve. If the fiscal policy wedge is strong and the subsidy parameters, (s, θ_G) are small, then a downward movement in labor demand will unambiguously decrease full employment output.

3. Calibration

In this section, we calibrate the model to Indian data. Based on the quarterly data available on the Indian macroeconomy documented in Ghate et al. (2013), the stylized facts relevant for India economy are,[32] (a) higher relative consumption volatility, (b) counter-cyclical net exports, (c) counter-cyclical government expenditures, and (d) a pro-cyclical real interest rate. In this paper, we seek to replicate these facts qualitatively.

As noted in the introduction, while the first two facts are common to a wide variety of EMEs, there is no robust stylized observation on the correlation between real government expenditure and output. In some EMEs, government expenditures are counter-cyclical with respect to output and in others it is pro-cyclical. Also, while Neumeyer and Perri (2005) and Uribe and Yue (2006) state that interest rates are generally counter-cyclical in EMEs, Male (2010) finds this observation not to be universally true particularly among EMEs in Africa, Asia and Eastern Europe. In the small sample of EMEs in Neumeyer and Perri (2005), however, the interest rate is counter-cyclical, and there is no role for fiscal policy. Our theoretical model therefore provides a more general framework that produces a range of business cycle outcomes that are consistent with the broader EME experience.

3.1. Parameter values

We set the exogenous labor augmenting technological progress for India at $\gamma = 0.004275$. This is approximately equal to one-fourth of the average annual growth rate of TFP of 1.7% for the period 1992–2010 from the Penn World Tables Version 8.1 (2015).[33] We fix the depreciation rate at $\delta = 0.0375$, to match the annual rate of depreciation of 15% for plants and machinery in India.[34] We choose $\alpha = 0.4$ from Ghate, Glomm, and Liu (2012). We choose the value of $\overline{R}^P = 1.0623$ so as to match the average gross real lending rate for India during the period 1992–2010, as estimated by World Bank.[35] The capital adjustment cost parameter, ϕ is fixed at 200.[36] We assume the bond holding cost parameter $\kappa = 0.01$.[37] We calculate the steady state bond holdings to output ratio, $\frac{b}{y}$ as in Neumeyer and Perri (2005), using the estimates for the net foreign assets to output ratio $\left(\frac{NFA}{Y}\right)$ for India from Lane and Ferretti (2007).[38] We arbitrarily fix the share of consumption in the utility function, i.e., $\mu = 0.75$, and the value of coefficient of risk aversion parameter at $\sigma = 3.5$, so as to obtain the discount rate $\beta = 0.95$, as in the literature. We fix the value of $\theta = 1$ as in Neumeyer and Perri (2005). We choose $\theta_G \leq \theta$ according to our choice of θ. In our baseline calibrations, we arbitrarily set $\theta_G = 1$,[39] which means that the entire working capital constraint is subsidized. We arbitrarily choose a value of $\Theta \geq 1$.[40] We choose s such that

$$\overline{R}^G = \overline{R}^P (1 - s) \geq 1.$$

Given that India has a very narrow income tax base and depends more on generating revenue from indirect taxation, we allow for a high tax on consumption and a low income tax (see Poirson (2006)). In particular, the value of τ_c is fixed at 0.12 to match the VAT rate applicable in India. We fix the factor income tax rates low at $\tau_k = \tau_w = 0.01$ which follows the estimated average effective tax rates in Poirson (2006). Table 3 summarizes our choice of deep parameters in our model.[41]

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[32] The sample period is 1999:2 to 2010:2.

[33] We use the variable "rtfpna", a TFP index with a base year of 2005.

[34] The annual rate of depreciation of 15% matches the depreciation allowance as a percentage of written down value, as permitted by the Income Tax Department, Government of India, on machineries and plants since 2006–07. For details, see http://www.incometaxindia.gov.in/charts%20%20tables/depreciation%20rates.htm

[35] The real interest rate is calculated as the annual lending rate adjusted for inflation using the GDP deflator. See http://data.worldbank.org/indicator/FR.INR.RINR These lending rates are rates at which short and medium term financing needs of the private sector are met. These lending rates are differentiated according to the credit-worthiness of borrowers.

[36] The value of ϕ is higher than what is typically assumed in the literature. Neumeyer and Perri (2005) assume $\phi = 25$ and $\phi = 40$ in their numerical experiments. We choose a higher value of ϕ to capture the large adjustment costs of capital in low income EMEs. The value of ϕ is therefore chosen so as to match the relative investment volatility in the Indian data.

[37] While this is larger than what is used in the literature (see Neumeyer & Perri, 2005 and Tiryaki, 2012) we require this to make private investments positively correlated with output in our model. Our model requires "more" financial frictions in the bond markets in order to make private investments more pro-cyclical.

[38] See Appendix for details.

[39] Though we choose $\theta_G = 1$, the subsidy s is very small, which implies the effective amount of subsidized loan from the government is not very large.

[40] In our calibrations, we arbitrarily fix $\Theta = \{1, 1.5, 5\}$. Since the representative agent takes G as given in every time period, $\Theta > 1$ is feasible (see Ambler and Paquet (1996)). A high value of Θ implies that government consumption is highly efficient and the agent attaches high weight to it. As we will show, this assumption is crucial for making consumption more volatile than output in our model.

[41] The rest of our endogenous and exogenous variables are derived at the steady state based on these parameter values.

Table 3
Summary of parameter values.

Parameter name	Symbol	Value
Coefficient of risk aversion (calibrated)	σ	3.5
Share of consumption in utility function (calibrated)	μ	0.75
Depreciation rate	δ	0.0375
Rate of technical progress (Quarterly) (Penn World Tables)	γ	0.004275
Ratio of wage bill to be paid in advance	θ	1
Real Interest Rate (World Bank Lending Rates)	$\bar{R}^P$	1.0623
Effective discount rate (calibrated)	$\widetilde{\beta}$	$\frac{(1+\gamma)}{\bar{R}^P}$
Discount rate (calibrated)	β	$\frac{\widetilde{\beta}}{(1+\gamma)^{\mu(1-\sigma)}}$
Share of capital in production (Ghate et al., 2012)	α	0.4
Bond holding costs (Tiryaki, 2012)	κ	0.01
Capital adjustment costs	ϕ	200
Subsidized portion of the advance wage bill ratio	θ_G	$\leq \theta$
Subsidy on working capital loans	s	$1 - \frac{1}{\bar{R}^P}$
Tax on consumption (VAT rate in India)	τ_c	0.12
Tax on labor income (Poirson, 2006)	τ_w	0.01
Tax on capital income	τ_k	$=\tau_w$
Weight of government consumption in c_t^*	Θ	≥ 1
Steady state TFP	$\bar{A}$	1

3.2. Estimation of the data generating processes

We calibrate the model using total factor productivity (TFP) shocks and interest rate shocks. We use annual logged data for total factor productivity for the period 1992–2010 from the Penn World Tables version 8.1 (2015).[42] We use the variable "rtfpna", a TFP index with base year 2005, as reported in the Tables.[43] The aggregate logged TFP data is then de-trended using a HP-Filter using a standard annual smoothing parameter equal to 100 This yields an estimate of the persistence parameter

$$\widehat{A}_t = \rho_A \widehat{A}_{t-1} + \varepsilon_{tA}, \tag{28}$$

where $\rho_A = 0.405856$

with a standard error of regression $\sigma_A = 0.013027$. $\widehat{A}_t$ is the de-trended logged – TFP data.

To estimate the data generating process for real interest rates, we use the annual real interest rates data published by the World Bank for the period 1992–2010. We choose annual data to maintain consistency in the frequency across all data generating processes.[44] The domestic interest rate on bonds is modeled as a mark-up on the world interest rate, i.e.,

$$R_t^P = R_t^* D_t \tag{29}$$

where R_t^P is the gross domestic real lending rate in India and R_t^* is the world interest rate which is assumed to be the US gross real lending rate. D_t is the country spread over R_t^*.[45] We de-trend the log of the gross real interest rate data using a standard annual smoothing parameter (100) such that

$$\widehat{R}_t^P = \widehat{R}_t^* + \widehat{D}_t \tag{30}$$

where a variable $\hat{m}_t$ is the de-trended value of m_t from its steady state $\bar{m}$. We then estimate an AR(1) process on $\widehat{R}_t^*$ is an AR(1)

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[42] We do not have robust quarterly estimates for TFP in India. We therefore use the annual data for the period 1992–2010 in the Penn World Tables for estimating the data generating process for TFP. See http://www.rug.nl/research/ggdc/data/pwt/pwt-8.1.

[43] For 2005, rtfpna=1.

[44] The real interest rate is calculated as the lending rate adjusted for inflation using the GDP deflator. See http://data.worldbank.org/indicator/FR.INR.RINR. These lending rates are rates at which short and medium term financing needs of the private sector are met. These lending rates are differentiated according to the credit-worthiness of borrowers.

[45] Neumeyer and Perri (2005) and Tiryaki (2012) assume 91-day US Treasury bill rates. Ghate et al. (2013) also report the second order moments for India using a 91-day Treasury bill rate.

process to be

$$\widehat{R}_t^* = \rho_R \widehat{R}_{t-1}^* + \varepsilon_{tR} \tag{31}$$

where $\rho_R = 0.613784$

with standard error $\sigma_{R^*} = 0.009739.$[46]

As in Neumeyer and Perri (2005), we assume that the de-trended country spread component $\widehat{D}_t$ depends on future expected total factor productivity. In other words, with a higher future expected total factor productivity, the repayment capacity of borrowers increases, which causes a reduction in the country spread risk. Therefore $\widehat{D}_t$ contains two components – an idiosyncratic risk component (u_t) and second a term that depends upon the expected future total factor productivity, i.e.,

$$\widehat{D}_t = -\eta E_t \widehat{A}_{t+1} + u_t \tag{32}$$

u_t is a random shock

$\eta = 1.4917$

with a standard error of regression $\sigma_U = 0.017676$. We find that the above relation between country spreads and expected TFP is statistically significant.[47] This means, a higher expected total factor productivity in time period $t + 1$ indeed lowers the country spread in time period t. We assume that all shocks are uncorrelated.

3.3. Single period shocks

There are three shocks in our model – TFP shocks $\left(\widehat{A}_t\right)$, world interest rate shocks $\left(\widehat{R}_t^*\right)$, and shocks to the country spread risk (u_t). Since from Eq. (30)

$$\widehat{R}_t^P = \widehat{R}_t^* + \widehat{D}_t,$$

a TFP shock will lower $\widehat{R}_t^P$ through a reduction in D.

We will analyze the effect of single period shocks on $\widetilde{y}_t, \widetilde{c}_t, \widetilde{x}_t, \widetilde{G}_t, \widetilde{l}_t$, and net exports, $\widetilde{nx}_t$.[48] We will see how a single period 10% shock affects the deviations of these variables from their corresponding steady state values. In particular, for any variable z, we define variable lz as the deviation of the variable z from it's steady state value of $\overline{z}$ i.e.,

$$lz = z_t - \overline{z}.$$

3.3.1. TFP shock

Fig. 7 plots the impulse response functions due to a single period shock in total factor productivity (A).

A one period positive total factor productivity shock, instantaneously causes output to increase. As a result, the deviation of output from its corresponding steady state value (ly) increases. This is because an increase in the firm's productivity causes an increase in labor demand and demand for private capital. An increase in the demand for private capital causes an increase in private investments (lx). While an increase in the firm's demand for labor causes an increase in equilibrium labor (ll) on impact and raises output, the positive income effect causes consumption (lc) to also increase in comparison to it's steady state value. Government consumption lg also increases on impact first due to a positive TFP shock. This is because an increase in output raises total tax revenue. R_t^P (shown as R in Fig. 7) falls due to a reduction in the country spread risk. This causes a drop in lg in period $t + 1$, and thereafter, converges gradually to the steady state from above. The savings-investment (s-I) gap (shown as si_gp) falls on impact because savings decrease and investment (lx) increases. The government revenue-expenditure gap (shown as tr_gp) increases in time period $t + 1$ because

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[46] While the AR (1) TFP and real interest rate processes are estimated with annual data, this would lead to less persistent shocks compared to quarterly data. Raising the persistence parameters proportionally in the neighborhood of the reported values to mimic persistence in quarterly data, does not alter our results qualitatively.

[47] In Neumeyer and Perri (2005), this model is called *the induced country risk case*. They also estimate another case, *the independent country risk case*, where $\widehat{D}_t$ is assumed to evolve according to an exogenous process. This exogenous process is assumed to follow an AR(1) process. However, an AR(1) fit for $\widehat{D}_t$ in our model was not statistically significant given our choice of the interest rate series. We therefore report all our calibration results only for the induced country risk case. As an alternative exogenous process, we assume

$$\widehat{D}_t = \varepsilon_{tD}$$

results for which are available on request.

[48] We have chosen the value of $\tau_k = \tau_w = \tau = 0.01$ for generating the impulse responses in this section. While the impulse responses are on net exports, our calibrated second order moments are on net export to output ratio. This is similar to Ghate et al. (2013); Neumeyer and Perri (2005), and Tiryaki (2012).
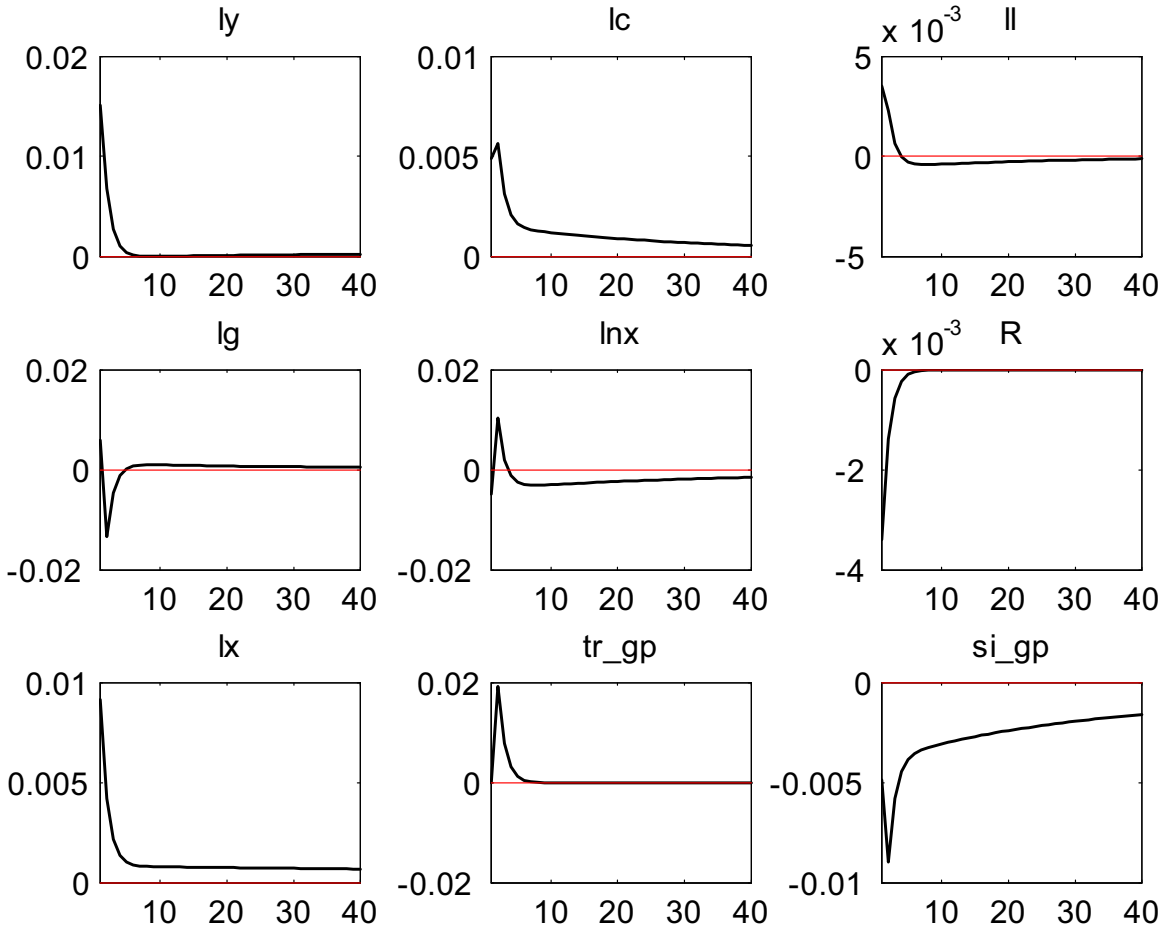
Fig. 7. Impact of a single period TFP ($\widehat{A}$) shock.

$$TR_t - G_t = - \left\{ \left[R_{t-1}^G - 1 \right] \theta_G \right\} w_t l_t. \tag{33}$$

This is because tr_gp in time period t depends on the interest rates of time period $t - 1$ which falls because of a TFP shock. An instantaneous drop in net exports (lnx) therefore occurs due to a fall in the savings-investment gap. Net exports thereafter quickly converges to the corresponding steady state value because the public revenue-expenditure gap increases in period $t + 1$.

3.3.2. Interest rate shock

Fig. 8 shows the impact of a single period shock to the world interest rate R^*. The domestic interest rate (R) increases which causes an instantaneous drop in private consumption (lc) due to the inter-temporal substitution effect.

Therefore, equilibrium labor (ll) increases on impact due to a reduction in (lc). Output in time period t depends on l_t and k_{t-1}. Since k_{t-1} in time period t is given from time period $t - 1$, ly increases on impact due to an increase in ll. Government consumption (lg) drops in time period t before it increases above the steady state level in $t + 1$. This is because an initial reduction in tax revenue from lower consumption levels dominates the increase in tax revenue from the wage and rental income taxation.[49] A positive interest rate shock causes government consumption (lg) to then jump above the steady state in time period $t + 1$ before it starts converging to the steady state from levels below zero. A combination of opposite movements in lc and lg causes ll to finally converge to zero. Investments (lx) falls because the private rate of return (lr) increases through the no arbitrage condition. An increase in savings due to postponement of consumption and reduction in investments causes the savings-investment gap (shown as si_gp) to increase on impact. The government revenue to expenditure gap denoted by tr_gp (see (33)) falls because labor (ll) increases. An increase in the savings-investment gap and a reduction in tr_gp therefore makes lnx increase on impact as shown in Fig. 8.

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[49] Clearly, the initial rise or fall in lg depends on the choice of fiscal policy parameters. As we discussed above, our choice of $\tau_c > \tau_w = \tau_k$ also puts higher weightage on the tax on consumption in comparison to tax on wage and capital income.
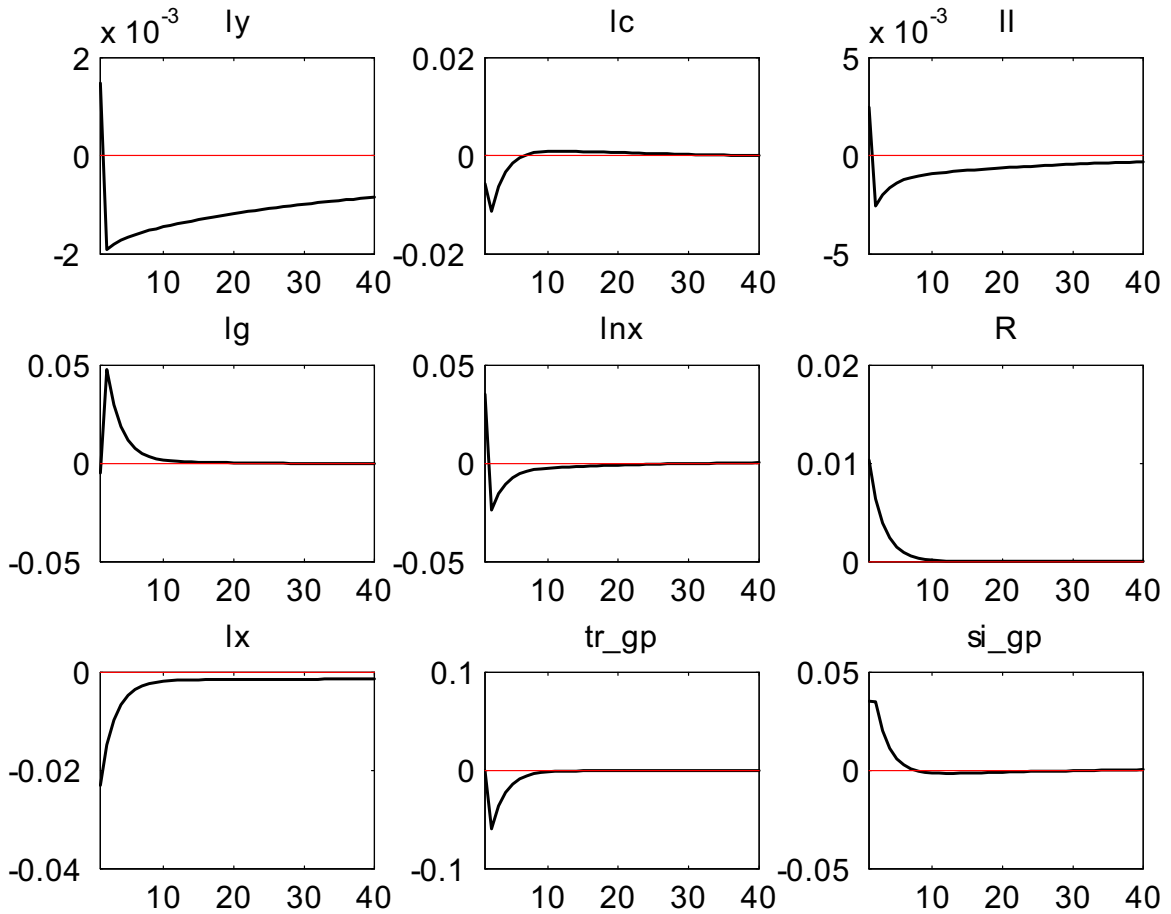
Fig. 8. Impact of a single period interest rate $\left(\hat{R}^{*}\right)$ shock.

The impact of a single period shock to idiosyncratic risk (u) is shown in Fig. 9.

The intuition for a single period shock to u is identical to a single period shock to the world interest rate R^* at time period t. The impulse responses however seem to be converging to the steady state very quickly since u is not persistent.

3.4. Multi-period shocks

Next, we calibrate our model, with multi-period uncorrelated shocks to TFP $\left(\hat{A}_t\right)$, world interest rates $\left(\hat{R}_t^{*}\right)$ and idiosyncratic shocks to the country spread ($\hat{u}_t$), and compare the second order moments of our simulated data with the Indian quarterly data from 1999 Q2 to 2010 Q2.[50] Table 4 summarizes our calibration results. We calibrate the model in stages to assess goodness of fit. First, we estimate the second order moments of our model when there is no fiscal policy in the baseline model. The results from estimating this model are reported in the column "No Fiscal Policy". In this case, the fiscal policy wedge, $\Gamma_t = \bar{\Gamma} = 1$. Second, we include only government consumption $\widetilde{G}_t$ financed by factor income taxes, and with $\Theta = 1$. The results from estimating this model are reported in the column "Only G". Third, we assume that in addition to $\widetilde{G}_t$ the government also subsidizes working capital loans, where $R_t^G = R_t^P(1-s)$, to firms on the fraction, $\theta_G w_t l_t$, of their wage payments. Results for these are reported in Column 4. We then report results obtained by estimating this model in the column "G and S" in Column 5 by marginally increasing Θ to $\Theta = 1.5$. Column 6 reports results with both G and S for a higher value of $\Theta = 5$. Finally, the column "Actual Data" reports the actual second order moments of the quarterly Indian data from Ghate et al. (2013), Table 5. Broadly, the model is able to capture the pro-cyclicality of private consumption and private investments, the counter-cyclicality of the net exports to output ratio, and the pro-cyclicality of the real interest rate, as observed in India. We also observe that adding both G and S in the model yields private consumption to be more volatile than output. We find that our results are robust to values of θ close to 1.[51]

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[50] See Table 5 in Ghate et al. (2013) for the Indian data. The simulated series estimated by the model was generated for 500 time periods and was then hp-filtered with the value of the multiplier chosen to be 1600, a standard value used to hp-filter quarterly data.

[51] Our results remain unchanged even for higher values of s, which would allow for the government to be a negative net interest rate earner both on
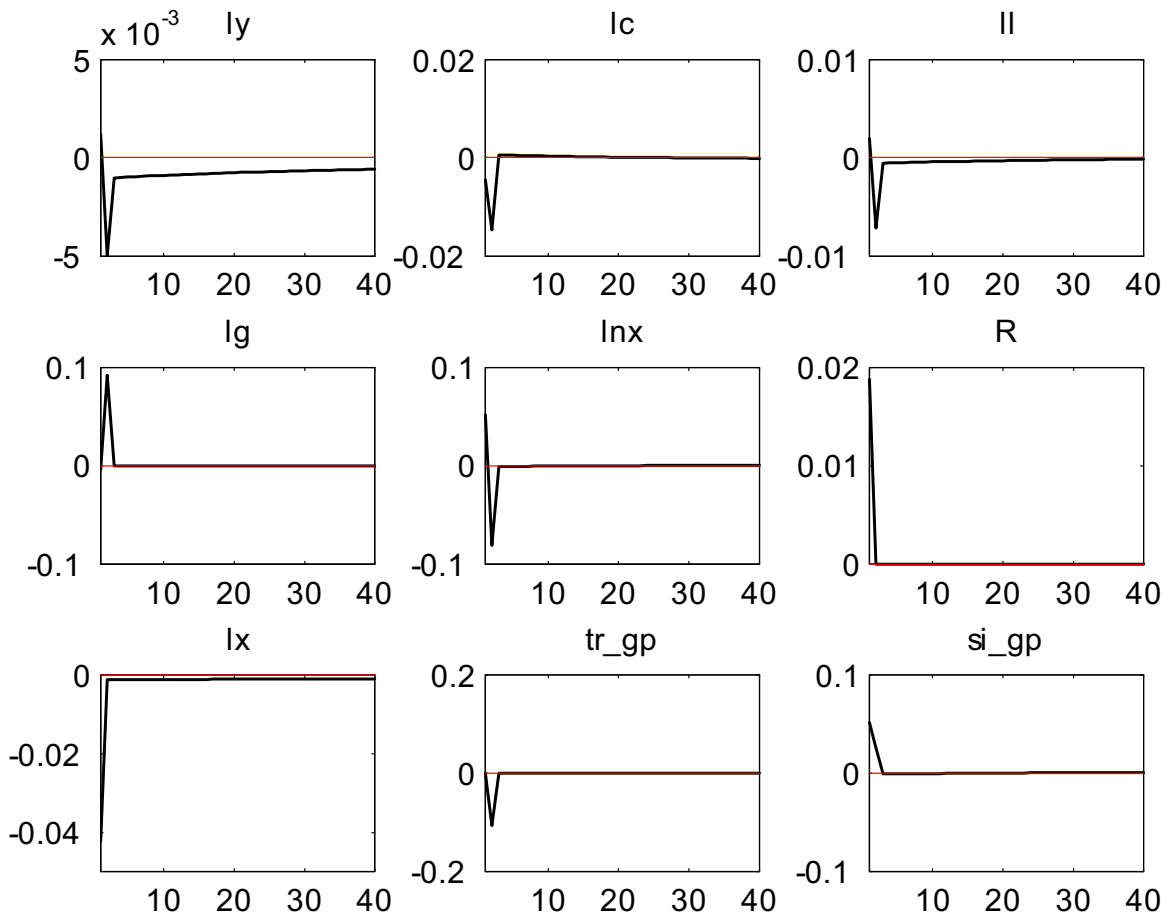
Fig. 9. Impact of a single period spread $\left(\hat{D}\right)$ shock.

Table 4
Comparison between the model and the data[a].

Moments	No Fiscal Policy	Only G ($\Theta = 1$)	G and S ($\Theta = 1$)	G and S ($\Theta = 1.5$)	G and S ($\Theta = 5$)	Actual Data 1999:2 to 2010:2
(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\rho(C, Y)$	0.4192	0.3885	0.3986	0.3952	0.4179	0.51
$\rho(X, Y)$	0.0240	0.0108	0.0121	0.0173	0.0211	0.69
$\rho(R, Y)$	0.0060	0.0197	0.0222	0.017	0.0143	0.38
$\rho(\frac{NX}{Y}, Y)$	−0. 6655	−0.6809	−0.6609	−0.5967	−0.1404	−0.15
$\rho(G, Y)$	–	0.5388	−0.2499	−0.2660	−0.3367	−0.35
$\sigma(C)/\sigma(Y)$	0.5898	0.5763	1.2237	1.4983	2.8476	1.31
$\sigma(X)/\sigma(Y)$	2.8176	2.7562	2.8512	2.7768	2.5920	3.43
$\sigma(R)/\sigma(Y)$	1.2776	1.2475	1.2847	1.2482	1.1492	1.77
$\sigma(NX)/\sigma(Y)$	3.3515	3.6881	6.4172	5.7259	3.5835	1.04
$\sigma(G)/\sigma(Y)$	–	0.5942	6.2367	5.7657	3.9456	5.53

[a] $\rho(Z, Y)$ is the correlation coefficient of variable Z with output Y. $\sigma(Z)/\sigma(Y)$ is the relative standard deviation of variable Z with output Y. Also, refer to Table 2 for second order moments of the Indian data.

3.4.1. No fiscal policy

In this case, the fiscal policy wedge, $\Gamma_t = \overline{\Gamma} = 1$. This is because: $\tau_k = \tau_w = \tau_c = 0$, $s = 0$, and $\theta_G = \Theta = 0$. The labor demand Eq. (26) becomes

$$l_t^D = \left[\frac{(1-\alpha)A_t}{\widetilde{w}_t\left[\left(1-\theta\right) + \theta R_{t-1}^P\right]} \right]^{\frac{1}{\alpha}} \frac{\tilde{k}_{t-1}}{(1+\gamma)}. \tag{34}$$

Unlike in Eq. (26), in Eq. (34) the effect of a positive shock to R_t^P on labor demand is fully transmitted through the labor market by lowering labor demand. The labor supply Eq. (24), becomes the standard labor supply equation in the absence of fiscal policy:

$$l_t^S = 1 - \frac{\tilde{c}_t}{\widetilde{w}_t}\left(\frac{1-\mu}{\mu}\right). \tag{35}$$

As shown in column 2 in Table 4, we observe that consumption and investment are pro-cyclical, the net-export to output ratio is strongly counter-cyclical, and real interest rates are weakly pro-cyclical. While this model under-estimates the relative volatility of consumption, investment, and the real interest rate, it over-estimates the relative volatility of net-exports.

3.4.2. Government consumption

Suppose the government imposes factor income taxes and spends revenues only on government consumption that affects utility. The government does not subsidize working capital loans. Under this specification,

$$\tau_k = \tau_w = \tau > 0, \tau_c > 0$$
$$s = \theta_G = 0$$
$$\Theta > 0.$$

Labor supply in (24) is now given by

$$l_t^S = 1 - \frac{\tilde{c}_t}{\widetilde{w}_t}\left(\frac{1-\mu}{\mu}\right)\Gamma_t'. \tag{36}$$

The fiscal policy wedge, in this case, Γ_t', is given by

$$\Gamma_t' = \left(\frac{1+\tau_c}{1-\tau_w}\right)\frac{\Psi_t'}{D_{t-1}'}$$

such that

$$D_{t-1}' = 1 + \Theta\tau_w\left(\frac{1-\mu}{\mu}\right)\left(\frac{1+\tau_c}{1-\tau_w}\right) > 1 \text{ and } \Psi_t' = \left[1 + \Theta\tau_c + \frac{\Theta\tau_k r_t \tilde{k}_{t-1}}{(1+\gamma)\tilde{c}_t} + \frac{\Theta\tau_w \widetilde{w}_t}{\tilde{c}_t}\right] > 1.$$

As shown in column 3 government consumption is quite strongly pro-cyclical. This is expected because government expenditure given by

$$\widetilde{G}_t = \tau_c \tilde{c}_t + \tau_w \widetilde{w}_t l_t + \tau_k r_t \frac{\tilde{k}_{t-1}}{(1+\gamma)}.$$

Therefore any change in consumption and factor income directly affects government consumption. It is however estimated to be less volatile than output which is at odds with the actual data.

In this model real interest rates become marginally more pro-cyclical, compared to the "No Fiscal Policy" case in column 2, and investment is less pro-cyclical. A positive interest rate shock does not have a direct effect on the fiscal policy wedge, although it does affect the wedge, and therefore l_t^S, indirectly through other endogenous variable such as $\tilde{c}_t$, r_t, $\tilde{k}_t$, and $\widetilde{w}_t$. In particular, a positive interest rate shock always increases the fiscal policy wedge (see Fig. 6), which tends to offset the outward movements in labor supply due to a reduction in consumption. Since consumption falls (even more with higher values of Θ) and this induces a larger instantaneous increase in the labor supply, the combined magnitude – from $\tilde{c}_t$ and Γ_t – on labor supply is still higher compared to the case where fiscal policy is absent.

The important difference however, is that the relative volatility of consumption and investments have fallen marginally compared to the model with no fiscal policy. This may suggest, $\widetilde{G}_t$ has a stabilizing effect. However, these relative magnitudes could be marginally lower even if the actual magnitudes of all endogenous variables are higher. Consumption for instance becomes relatively less volatile because on the one hand households have to pay factor income taxes while on the other, a reduction in consumption due to taxes are returned to agents through $\widetilde{G}_t$ which is more volatile than consumption.

3.4.3. Government consumption and subsidy

Now suppose

$$\tau_k = \tau_w = \tau > 0, \, \tau_c > 0$$

$$s > 0, \, \theta_G > 0$$

$$\Theta > 0.$$

This is our model as discussed in Section 2 in which labor supply is now given by Eq. (24) and labor demand is given by Eq. (26). The moments are summarized in Column 4 of Table 4 for $\Theta = 1$. In contrast to the model with only government consumption, we now get counter-cyclical government consumption, marginally less counter-cyclical net-exports to output ratio, more pro-cyclical consumption and investments, and more pro-cyclical real interest rates. Our model qualitatively replicates the standard stylized facts that motivate the theoretical framework of Neumeyer and Perri (2005) through an alternate but compatible mechanism, and in addition helps explain the pro-cyclicality of the real interest rate and counter-cyclicality of government expenditures.

We find that contemporaneous correlation of consumption and government expenditure with respect to output are also closer to the Indian data and further increase with increases in Θ. Private investments and the real interest rate are less pro-cyclical as compared to the data. Relative volatility of consumption, investments, net exports, and government expenditures are all closer to the Indian data and higher in the presence of subsidies to working capital loans to firms. This is because, the subsidy lowers the volatility of output which then increases the relative magnitudes.

Government expenditures are now significantly counter-cyclical due to high subsidies given to firms. The net-exports to output ratio, given by

$$nx_t = \frac{(s_t - x_t) + (TR_t - G_t)}{y_t},$$

are more counter-cyclical because of a falling savings-investment gap and a negative public revenue-expenditures gap. Finally, strong income effects from TFP on consumption and the dampening effect of subsidies on the labor, and therefore output, increases the relative volatility of consumption with respect to output.

While the model with all three shocks and both roles for fiscal policy qualitatively match the stylized facts of EMEs, we find so far that the calibrated moments of this variant of the model (full fiscal policy) are also closer to the Indian data than columns 2 and 3. However, while predicted relative consumption volatility is approximately close to the Indian data, relative volatility of government consumption is under estimated and that of investment and net exports are over estimated. We also find that contemporaneous correlations of investment and real interest rates are much less as compared to the actual Indian data.

3.4.4. Government consumption and subsidy (under higher Θ)

In our model, fiscal policy affects the economy by distorting the labor market equilibrium. On the one hand, a subsidy from the government affects labor demand, whereas on the other, utility enhancing government consumption, which imposes a time-varying fiscal policy wedge, affects labor supply by influencing not just its inward-outward movements, but also its slope. As a result, fiscal policy affects the transmission of the interest rate shocks on the labor market, and therefore affects the fluctuations in other endogenous variables such as output, consumption, and net exports. In this section, we therefore analyze the effect of changes in Θ on some of our calibration results.

In our simulations for arbitrary values of $\Theta = \{1, 1.5, 5\}$, we obtain the following observations. While government expenditures are relatively unimportant in comparison to private consumption for $\Theta < 1$, an increase in Θ to $\Theta \geq 1$ makes government consumption more significant compared to private consumption. Hence, an increase in Θ makes consumption more volatile, as can be seen in Columns 5 and 6 of Table 4. The higher volatility causes a reduction in the contemporaneous correlation between private consumption and output. In particular, when $\Theta < 1$, and when there are no subsidies available to firms, private consumption is less volatile compared to output, which is not true for our sample of EMEs. Our model suggests that a higher Θ generates this higher consumption volatility.

As can be seen from Column 5, for higher values of Θ, $\rho(R, Y) > 0$, i.e., real interest rates become marginally less pro-cyclical. As Θ increases, private consumption becomes more volatile. As a result, a positive interest rate shock causes a bigger reduction in current consumption. A big reduction in current consumption dominates the dampening effect of an increase in Γ on labor supply. The real interest rate is however only mildly pro-cyclical because the productivity shock has also exerted a simultaneous contemporaneous positive income effect.

Government expenditures also tend to become more counter-cyclical with Θ increasing - as in Columns 5 and 6 - because of a larger fall in private consumption due to an interest rate shock. From Eq. (7), we know that government expenditure is financed by taxing consumption, household wage and rental income, and a net interest income from lending to firms. As Θ increases, the revenue from taxing consumption falls whereas the revenue from taxing wage income, capital income, and interest income from subsidized lending rises. In the net, the former outweighs the latter, with the net effect increasing in Θ. This makes government expenditures more counter-cyclical.

4. The role of fiscal policy as an automatic stabilizer

Our model outlines how fiscal policy can play the role of an automatic stabilizer when an economy is hit with an interest rate shock which adversely affects labor market outcomes and also real output. Since government expenditure in our model is non-discretionary, it adjusts automatically with other endogenous variables. Table 4 shows how fiscal policy dampens overall volatility in the economy, but leads to a trade-off. A rise in Θ results in pro-cyclical interest rates *and* lesser relative volatility for X, R, NX, and G, even though these outcomes obtain at the expense of higher consumption volatility (see Columns 5 and 6).[52] Higher consumption volatility happens because of a strong inter-temporal substitution effect driven by the private and public components of consumption beings perfect substitutes and Θ is high. This makes private consumption's response to a positive interest rate shock high. A higher τ_c would also make private consumption's response to a positive interest rate shock high making interest rates more pro-cyclical.

Table 4 also identifies the intuition behind why government spending volatility goes down. This happens because as long as τ_c is sufficiently large, a positive interest rate shock reduces $\tau_c \tilde{c}_t$, which also reduces $\widetilde{G}_t$. A reduction in $\tilde{c}_t$ leads to an increase in labor supply and output. Thus $\tilde{y}_t$ increases and $\widetilde{G}_t$ falls. A rise in Θ causes a bigger increase in $\tilde{l}_t$ but an even bigger instantaneous increase in the fiscal policy wedge which makes $\tilde{y}_t$ more volatile. This causes a reduction in the relative volatility of $\widetilde{G}_t$.

As discussed in the previous section and shown in Fig. 6, since the impact of the fiscal policy wedge is increasing in Θ, a higher value of Θ reduces labor supply more when Θ is higher. However, a higher Θ also leads to a larger reduction in private consumption, $\tilde{c}_t$, and this inter-temporal substitution effect leads to an increase in labor supply which off-sets the reduction in labor supply from the fiscal policy wedge. The net effect on labor supply is therefore positive. Therefore the strength of substitutability between $\tilde{c}_t$, and $\widetilde{G}_t$ captured by Θ is crucial for fiscal policy's role as an automatic stabilizer.

5. Conclusion

We build a tractable small open economy RBC model in which fiscal policy has a role in making *pro-cyclical* real interest rates consistent with counter-cyclical net exports and higher consumption volatility. Our theoretical model contributes to the growing literature on fiscal policy in small open economies. In particular, we show that by adding a role for fiscal policy in the Neumeyer and Perri (2005) setup, we are able to establish a causal link between the nature of fiscal policy (counter-cyclical or a-cyclical), real interest rates (pro-cyclical or counter-cyclical), counter-cyclical net exports, and higher relative consumption volatility. Our framework therefore can be seen as a more general framework to understand the effect of interest rate shocks on the real economy discussed in the empirical business cycle literature. We then calibrate the model to India to qualitatively match its business cycle properties. We also discuss the role of fiscal policy as an automatic stabilizer in the context of our model.

From a policy standpoint, our model suggests how the adverse effects of interest rate shocks on labor market outcomes can be mitigated by fiscal policy. For future work, we want to introduce sovereign debt and endogenize country spreads with sovereign default risks. We also want to undertake a welfare analysis of various types of fiscal policy in our model.

Acknowledgments

Appendix A. Technical Appendix

Steady state calculations

The following are the set of steady state conditions that will be used in the model

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[52] While we do not assess welfare in the model, Gali (1994) shows that large taxes and large government expenditures – while stabilizing in nature – have welfare reducing effects.

$$\overline{R}^P = \frac{(1 + \gamma)}{\widetilde{\beta}}$$

(37)

$$\overline{r} = \frac{\overline{R} - (1 - \delta)}{(1 - \tau_k)}$$

(38)

From the firm's FOC,

$$\overline{y} = \frac{\overline{r}\overline{k}}{(1 + \gamma)\alpha}$$

(39)

and

$$(1 - \alpha)\overline{y} = \overline{w}\overline{l}\left[\left(1 - \theta \right) + \overline{R}^P\left(\theta - s\theta_G \right) \right].$$

(40)

Rearranging Eq. (21) we get

$$\overline{l} = \frac{1}{\left[1 + \dfrac{(1 - \mu)}{\mu} \dfrac{(1 + \tau_c)}{(1 - \tau_w)} \dfrac{\dfrac{\overline{c}}{\overline{y}} + \Theta\dfrac{\overline{G}}{\overline{y}}}{\dfrac{\overline{w}\overline{l}}{\overline{y}}} \right]}.$$

(41)

From the output technology we know

$$\widetilde{y}_t = \frac{A_t}{\left(1 + \gamma \right)^\alpha}\left[\widetilde{k}_{t-1} \right]^\alpha l_t^{1-\alpha}.$$

This implies, at steady state,

$$\overline{y} = \frac{\overline{A}}{\left(1 + \gamma \right)^\alpha}\overline{k}^\alpha \overline{l}^{1-\alpha}.$$

Substituting from Eq. (39)

$$\frac{\overline{r}\overline{k}}{(1 + \gamma)\alpha} = \frac{\overline{A}}{\left(1 + \gamma \right)^\alpha}\overline{k}^\alpha \overline{l}^{1-\alpha},$$

which on rearranging we get

$$\overline{k} = \left[\frac{\overline{A}\alpha}{\overline{r}} \right]^{\frac{1}{1-\alpha}}(1 + \gamma)\overline{l}.$$

(42)

From (40),

$$\overline{w} = \frac{(1 - \alpha)\overline{y}}{\left[\left(1 - \theta \right) + \overline{R}^P\left(\theta - s\theta_G \right) \right]\overline{l}}.$$

(43)

To calculate $\overline{k}$, $\overline{y}$, $\overline{w}$, and $\overline{r}$, we need $\overline{l}$. To obtain this, we proceed as follows. From the budget constraint

$$\frac{\overline{c}}{\overline{y}} = \frac{(1 - \tau_w)\dfrac{\overline{w}\overline{l}}{\overline{y}}}{(1 + \tau_c)} + \frac{(1 - \tau_k)\dfrac{\overline{r}\overline{k}}{\overline{y}}}{(1 + \tau_c)(1 + \gamma)} + \frac{\dfrac{\overline{R}^P\overline{b}}{\overline{y}}}{(1 + \tau_c)(1 + \gamma)} - \frac{\dfrac{\overline{k}}{\overline{y}}}{(1 + \tau_c)} + \frac{(1 - \delta)\dfrac{\overline{k}}{\overline{y}}}{(1 + \gamma)(1 + \tau_c)} - \frac{\dfrac{\overline{b}}{\overline{y}}}{(1 + \tau_c)}.$$

(44)

where, $\left(\frac{b}{y} \right)$ is known. From the government budget constraint

$$\frac{\overline{G}}{\overline{y}} = \left[\tau_c\frac{\overline{c}}{\overline{y}} + \left\{ \left[\overline{R}^P(1 - s) - 1 \right]\theta_G + \tau_w \right\}\frac{\overline{w}\overline{l}}{\overline{y}} + \frac{\tau_k}{(1 + \gamma)}\frac{\overline{r}\overline{k}}{\overline{y}} \right].$$

(45)

The above two expressions imply

$$\frac{\bar{c}}{\bar{y}} + \Theta\frac{\bar{G}}{\bar{y}} = \frac{\bar{w}\bar{l}}{\bar{y}}\left[\frac{(1 - \tau_w)(1 + \Theta\tau_c)}{(1 + \tau_c)} + \Theta\left\{\left[\bar{R}^P(1 - s) - 1\right]\theta_G + \tau_w\right\}\right]$$

$$+ \frac{\bar{r}\bar{k}}{\bar{y}(1 + \gamma)}\left[\frac{(1 - \tau_k)(1 + \Theta\tau_c)}{(1 + \tau_c)} + \Theta\tau_k\right] + \frac{\bar{b}(1 + \Theta\tau_c)}{\bar{y}(1 + \tau_c)}\left[\frac{\bar{R}^P}{(1 + \gamma)} - 1\right] - \frac{\bar{k}(1 + \Theta\tau_c)}{\bar{y}(1 + \tau_c)}\left[\frac{\gamma + \delta}{(1 + \gamma)}\right]$$

Simplifying, we get,

$$\frac{\bar{c}}{\bar{y}} + \Theta\frac{\bar{G}}{\bar{y}} = \frac{(1 - \alpha)}{\left[(1 - \theta) + \bar{R}^P(\theta - s\theta_G)\right]}\left[\frac{(1 - \tau_w)(1 + \Theta\tau_c)}{(1 + \tau_c)} + \Theta\left\{\left[\bar{R}^P(1 - s) - 1\right]\theta_G + \tau_w\right\}\right] + \alpha\left[\frac{(1 - \tau_k)(1 + \Theta\tau_c) + (1 + \tau_c)\Theta\tau_k}{(1 + \tau_c)}\right]$$

$$+ \frac{(1 + \Theta\tau_c)\left[\bar{R}^P - (1 + \gamma)\right]}{(1 + \tau_c)(1 + \gamma)}\left[\frac{(1 - \alpha)\theta}{\left[(1 - \theta) + \bar{R}^P(\theta - s\theta_G)\right]} + \frac{\overline{NFA}}{\bar{y}}\right] - \frac{(1 - \tau_k)(1 + \gamma)(1 + \Theta\tau_c)\alpha(\gamma + \delta)}{\left[\bar{R}^P - (1 - \delta)\right](1 + \tau_c)(1 + \gamma)} = \mathfrak{Y}, \text{ say.}$$

Recall, $\frac{NFA}{Y}$ is a parameter, calculated using the Lane and Ferretti (2007) data. Therefore, substituting for $\frac{\bar{c}}{\bar{y}} + \Theta\frac{\bar{G}}{\bar{y}}$ in Eq. (41), we get,

$$\bar{l} = \frac{1}{\left[1 + \frac{(1 - \mu)}{\mu}\frac{(1 + \tau_c)}{(1 - \tau_w)}\frac{\mathfrak{Y}\left[(1 - \theta) + \bar{R}^P(\theta - s\theta_G)\right]}{(1 - \alpha)}\right]}.$$

We obtain all other parameters as follows

$$\frac{\bar{k}}{\bar{y}} = \frac{(1 - \tau_k)(1 + \gamma)\alpha}{\bar{R}^P - (1 - \delta)}$$

$$\frac{\bar{w}\bar{l}}{\bar{y}} = \frac{(1 - \alpha)}{\left[(1 - \theta) + \bar{R}^P(\theta - s\theta_G)\right]}$$

$$\frac{\bar{r}\bar{k}}{\bar{y}} = (1 + \gamma)\alpha\bar{r} = \frac{\bar{R}^P - (1 - \delta)}{(1 - \tau_k)}$$

$$\frac{\bar{b}}{\bar{y}} = (\theta - \theta_G)\frac{(1 - \alpha)}{\left[(1 - \theta) + \bar{R}^P(\theta - s\theta_G)\right]} + \frac{\overline{NFA}}{\bar{y}}$$

$$\frac{\bar{c}}{\bar{y}} = \frac{(1 - \alpha)}{\left[(1 - \theta) + \bar{R}^P(\theta - s\theta_G)\right]}\frac{(1 - \tau_w)}{(1 + \tau_c)} + \frac{\alpha(1 - \tau_k)}{(1 + \tau_c)} - \frac{(1 - \tau_k)(\gamma + \delta)\alpha}{\left[\bar{R}^P - (1 - \delta)\right](1 + \tau_c)}$$

$$+ \frac{1}{(1 + \tau_c)}\left[\frac{\bar{R}^P}{(1 + \gamma)} - 1\right]\left[\frac{(1 - \alpha)\theta}{\left[(1 - \theta) + \bar{R}^P(\theta - s\theta_G)\right]} + \frac{\overline{NFA}}{\bar{y}}\right]$$

$$\frac{\bar{G}}{\bar{y}} = \left[\tau_c\frac{\bar{c}}{\bar{y}} + \left\{\left[\bar{R}^P(1 - s) - 1\right]\theta_G + \tau_w\right\}\frac{\bar{w}\bar{l}}{\bar{y}} + \frac{\tau_k}{(1 + \gamma)}\frac{\bar{r}\bar{k}}{\bar{y}}\right].$$

Finally for net exports,

$$\widetilde{NX}_t = \tilde{y}_t - \tilde{c}_t - \tilde{x}_t - \widetilde{G}_t$$

$$\Rightarrow \frac{\widetilde{NX}_t}{\tilde{y}_t} = 1 - \frac{\tilde{c}_t}{\tilde{y}_t} - \frac{\tilde{x}_t}{\tilde{y}_t} - \frac{\widetilde{G}_t}{\tilde{y}_t}$$

$$\Rightarrow \widetilde{nx}_t = 1 - \frac{\tilde{c}_t}{\tilde{y}_t} - \frac{\tilde{x}_t}{\tilde{y}_t} - \frac{\widetilde{G}_t}{\tilde{y}_t}$$

$$\Rightarrow \overline{nx} = 1 - \frac{\bar{c}}{\bar{y}} - \frac{\bar{x}}{\bar{y}} - \frac{\bar{G}}{\bar{y}}, \text{ clearly follows from above.}$$

Proof of Proposition 1

We know from the agents problem, labor supply is given by

$$l_t^S = 1 - \left(\frac{1-\mu}{\mu}\right)\left(\frac{1+\tau_c}{1-\tau_w}\right)\left(\frac{\tilde{c}_t^*}{\widetilde{w}_t}\right)$$

which implies

$$l_t^S = 1 - \left(\frac{1-\mu}{\mu}\right)\left(\frac{1+\tau_c}{1-\tau_w}\right)\left(\frac{\tilde{c}_t + \Theta\widetilde{G}_t}{\widetilde{w}_t}\right) = 1 - \left(\frac{1-\mu}{\mu}\right)\left(\frac{1+\tau_c}{1-\tau_w}\right)\frac{\left\{\tilde{c}_t + \Theta\left[\begin{array}{c}\tau_c\tilde{c}_t \\ +\left[\left\{R_{t-1}^P(1-s)-1\right\}\theta_G + \tau_w\right]\widetilde{w}_t l_t \\ +\frac{\tau_k r_t \tilde{k}_{t-1}}{1+\gamma}\end{array}\right]\right\}}{\widetilde{w}_t}$$

$$= 1 - \left(\frac{1-\mu}{\mu}\right)\left(\frac{1+\tau_c}{1-\tau_w}\right)\frac{\left\{\left(1+\Theta\tau_c\right)\tilde{c}_t + \Theta\left[\begin{array}{c}\left\{\left[R_{t-1}^P(1-s)-1\right]\theta_G + \tau_w\right\}\widetilde{w}_t l_t \\ +\frac{\tau_k r_t \tilde{k}_{t-1}}{1+\gamma}\end{array}\right]\right\}}{\widetilde{w}_t}$$

This implies

$$l_t^S\left[1 + \Theta\left(\frac{1-\mu}{\mu}\right)\left(\frac{1+\tau_c}{1-\tau_w}\right)\left\{\left[R_{t-1}^P(1-s)-1\right]\theta_G + \tau_w\right\}\right] = 1 - \left(\frac{1-\mu}{\mu}\right)\left(\frac{1+\tau_c}{1-\tau_w}\right)\frac{\tilde{c}_t}{\widetilde{w}_t}\left\{\left(1+\Theta\tau_c\right) + \frac{\Theta\tau_k r_t \tilde{k}_{t-1}}{(1+\gamma)\tilde{c}_t}\right\}$$

Define

$$D_{t-1} = \left[1 + \Theta\left(\frac{1-\mu}{\mu}\right)\left(\frac{1+\tau_c}{1-\tau_w}\right)\left\{\left[R_{t-1}^P(1-s)-1\right]\theta_G + \tau_w\right\}\right].$$

Therefore,

$$l_t^S = \frac{1}{D_{t-1}} - \frac{\tilde{c}_t}{\widetilde{w}_t}\left(\frac{1-\mu}{\mu}\right)\left(\frac{1+\tau_c}{1-\tau_w}\right)\left[\frac{1+\Theta\tau_c}{D_{t-1}} + \frac{\Theta\tau_k r_t \tilde{k}_{t-1}}{(1+\gamma)\tilde{c}_t D_{t-1}}\right]$$

$$= \frac{1+\Theta\left(\frac{1-\mu}{\mu}\right)\left(\frac{1+\tau_c}{1-\tau_w}\right)\left\{\left[R_{t-1}^P(1-s)-1\right]\theta_G + \tau_w\right\}}{D_{t-1}} - \frac{\tilde{c}_t}{\widetilde{w}_t}\left(\frac{1-\mu}{\mu}\right)\left(\frac{1+\tau_c}{1-\tau_w}\right)\left[\frac{1+\Theta\tau_c}{D_{t-1}} + \frac{\Theta\tau_k r_t \tilde{k}_{t-1}}{(1+\gamma)\tilde{c}_t D_{t-1}}\right]$$

$$- \frac{\Theta\left(\frac{1-\mu}{\mu}\right)\left(\frac{1+\tau_c}{1-\tau_w}\right)\left\{\left[R_{t-1}^P(1-s)-1\right]\theta_G + \tau_w\right\}}{D_{t-1}}$$

$$\Rightarrow l_t^S = 1 - \frac{\tilde{c}_t}{\widetilde{w}_t}\left(\frac{1-\mu}{\mu}\right)\left(\frac{1+\tau_c}{1-\tau_w}\right)\left[\frac{1+\Theta\tau_c}{D_{t-1}} + \frac{\Theta\tau_k r_t \tilde{k}_{t-1}}{(1+\gamma)\tilde{c}_t D_{t-1}} + \frac{\Theta\left\{\left[R_{t-1}^P(1-s)-1\right]\theta_G + \tau_w\right\}\widetilde{w}_t}{D_{t-1}\tilde{c}_t}\right]$$

$$\Rightarrow l_t^S = 1 - \frac{\tilde{c}_t}{\widetilde{w}_t}\left(\frac{1-\mu}{\mu}\right)\left(\frac{1+\tau_c}{1-\tau_w}\right)\frac{\Psi_t}{D_{t-1}} \Rightarrow l_t^S = 1 - \frac{\tilde{c}_t}{\widetilde{w}_t}\left(\frac{1-\mu}{\mu}\right)\Gamma_t.$$

Let's now define

$$\varrho_{t-1} = \left\{\left[R_{t-1}^P(1-s)-1\right]\theta_G + \tau_w\right\} > 0.$$

We can therefore re-write Γ_t

$$\Gamma_t = \left(\frac{1+\tau_c}{1-\tau_w}\right)\left[\frac{1+\Theta\tau_c + \frac{\Theta\tau_k r_t \tilde{k}_{t-1}}{(1+\gamma)\tilde{c}_t} + \frac{\Theta\varrho_{t-1}\widetilde{w}_t}{\tilde{c}_t}}{1 + \Theta\left(\frac{1-\mu}{\mu}\right)\left(\frac{1+\tau_c}{1-\tau_w}\right)\varrho_{t-1}}\right].$$

$\Gamma_t > 1$ if

$$(1+\tau_c)\left[1 + \Theta\tau_c + \frac{\Theta\tau_k r_t \tilde{k}_{t-1}}{(1+\gamma)\tilde{c}_t} + \frac{\Theta\varrho_{t-1}\widetilde{w}_t}{\tilde{c}_t}\right] > (1-\tau_w)\left[1 + \Theta\left(\frac{1-\mu}{\mu}\right)\left(\frac{1+\tau_c}{1-\tau_w}\right)\varrho_{t-1}\right].$$

Ignoring the positive term $\frac{\Theta \tau_k r_t \tilde{k}_{t-1}}{(1+\gamma)\tilde{c}_t} + \frac{\Theta \varrho_{t-1} \bar{w}_t}{\tilde{c}_t}$, if

$$(1 + \tau_c)(1 + \Theta \tau_c) > (1 - \tau_w)\left[1 + \Theta\left(\frac{1-\mu}{\mu}\right)\left(\frac{1+\tau_c}{1-\tau_w}\right)\varrho_{t-1}\right],$$

we can be assured that Γ_t surely is greater than 1. We will look for sufficient conditions under which the above inequality holds.

$$(1 + \tau_c)(1 + \Theta \tau_c) > (1 - \tau_w)\left[1 + \Theta\left(\frac{1-\mu}{\mu}\right)\left(\frac{1+\tau_c}{1-\tau_w}\right)\varrho_{t-1}\right] \Rightarrow \tau_c + \tau_w + \Theta \tau_c + \Theta \tau_c^2 > \Theta\left(\frac{1-\mu}{\mu}\right)(1 + \tau_c)\varrho_{t-1}.$$

Now if

$$\mu > 0.5,$$

clearly, for

$$\left[\frac{\tau_c + \tau_w + \Theta \tau_c + \Theta \tau_c^2}{\Theta(1 + \tau_c)\varrho_{t-1}}\right] > 1 > \left(\frac{1-\mu}{\mu}\right).$$

to hold true, we need

$$\tau_c + \tau_w + \Theta \tau_c + \Theta \tau_c^2 > \Theta(1 + \tau_c)\varrho_{t-1},$$

or,

$$\tau_c + \tau_w + \Theta \tau_c + \Theta \tau_c^2 > \Theta(1 + \tau_c)\left[R_{t-1}^P(1 - s) - 1\right]\theta_G + \Theta \tau_w(1 + \tau_c).$$

The LHS is given by

$$\tau_c(1 + \Theta) + \tau_w + \Theta \tau_c^2$$

and the RHS is given by

$$\Theta(1 + \tau_c)\left[R_{t-1}^P(1 - s) - 1\right]\theta_G + \Theta \tau_w + \Theta \tau_w \tau_c.$$

If we assume that

$$\tau_c > \tau_w, \text{ and } \quad 0 < \Theta < 1,$$

we get

$$\tau_w + \Theta \tau_c^2 > \Theta \tau_w + \Theta \tau_w \tau_c.$$

Hence now the comparison is between $\tau_c(1 + \Theta)$ and $\Theta(1 + \tau_c)\left[R_{t-1}^P(1 - s) - 1\right]\theta_G$. Define

$$\bar{q} = \left[R_{t-1}^P(1 - s) - 1\right]\theta_G.$$

Clearly

$$0 < \bar{q} < 1.$$

Since

$$0 < \Theta, \bar{q} < 1 \text{ and } \quad 0 < \bar{q} < 1, \tau_c(1 + \Theta) > \Theta\bar{q}(1 + \tau_c),$$

if

$$\tau_c > \bar{q}, \mu > 0.5.$$

Note, if

$$\tau_c > \tau_w,$$

we get

$$\left[\frac{\tau_c + \tau_w + \Theta \tau_c + \Theta \tau_c^2}{\Theta(1 + \tau_c)\varrho_{t-1}}\right] > 1 \Rightarrow \Gamma_t > 1. \qquad \blacksquare$$

Proof of Proposition 3

In Eq. (27),

$$\frac{\partial l_{t+1}^D}{\partial R_t^P} = -\frac{l_{t+1}^D\left(\theta - s\theta_G\right)}{\alpha\left[\left(1-\theta\right) + R_t^P\left(\theta - s\theta_G\right)\right]},$$

and hence

$$\left|\frac{1}{\frac{\partial l_{t+1}^D}{\partial R_t^P}}\right| = \frac{\alpha\left[\left(1-\theta\right) + R_t^P\left(\theta - s\theta_G\right)\right]}{l_{t+1}^D\left(\theta - s\theta_G\right)} = \frac{\alpha\left(1-\theta\right)}{l_{t+1}^D\left(\theta - s\theta_G\right)} + R_t^P.$$

Therefore $\left|\frac{\partial l_{t+1}^D}{\partial R_t^P}\right|$ is decreasing in s and θ_G.

References

Agénor, P.-R., McDermott, C. J., & Prasad, E. S. (2000). Macroeconomic fluctuations in developing countries: some stylized facts. *World Bank Economic Review*, *14*, 251–285.

Aguiar, M., & Gopinath, G. (2007). Emerging market business cycles: the cycle is the trend. *Journal of Political Economy*, *115*(1), 69–102.

Ambler, S., & Paquet, A. (1996). Fiscal spending shocks, endogenous government spending, and real business cycles. *Journal of Economic Dynamics and Control*, *20*(1–3), 237–256.

Barro, R. J. (1981). Output effects of government purchases. *Journal of Political Economy*, *89*, 1086–1121.

Christiano, L. J., & Eichenbaum, M. (1992). Current real business cycle theories and aggregate labor market fluctuations. *American Economic Review*, *82*, 430–450.

Cuadra, G., Sanchez, J., & Sapriza, H. (2010). Fiscal policy and default risk in emerging markets. *Review of Economic Dynamics*, *13*(2), 452–469.

Eaton, J., & Gersovitz, M. (1981). Potential repudiation: theoretical and empirical analysis. *The Review of Economic Studies*, *48*(2), 289–309.

Frankel, J. A., Vegh, C. A., & Vuletin, G. (2013). On graduation from fiscal procyclicality. *Journal of Development Economics*, *100*, 32–47.

Gali, J. (1994). Government size and macroeconomic stability. *European Economic Review*, *38*, 117–132.

Ghate, C., Pandey, R., & Patnaik, I. (2013). Has indian emerged? Business cycle stylized facts from a transitioning economy. *Structural Change and Economic Dynamics*, *24*, 157–172.

Ghate, C., Glomm, G., & Liu, J. (2012). Sector infrastructure investment in an unbalanced growing economy: The case of India. *Indian Statistical Institute Discussion Paper* 12-07.

Greenwood, J., Hercowitz, Z., & Huffman, G. W. (1988). Investment, capacity utilization, and the real business cycle. *American Economic Review*, *78*(3), 402–417.

Handbook of Statistics of the Indian Economy, (2012). Reserve Bank of India.

Income Tax Department, (2015). Table on Rates of depreciation for income-tax, ⟨http://www.incometaxindia.gov.in/charts%20%20tables/depreciation%20rates.htm⟩.

Kuehlwein, M. (1998). Evidence on the substitutability between government purchases and consumer spending within specific spending categories. *Economics Letters*, *58*, 325–329.

Lane, P. R., & Milesi-Ferretti, G. M. (2007). The external wealth of nations mark II: revised and extended estimates of foreign assets and liabilities, 1970–2004. *Journal of International Economics*, *73*(2), 223–250.

Lane, P. R. (2003a). The cyclical behaviour of fiscal policy: evidence from the OECD. *Journal of Public Economics*, *87*, 2661–2675.

Lane, P. R. (2003b). Business cycles and macroeconomic policy in emerging market economies. *International Finance*, *6*(1), 89–108.

Li, N. (2011). Cyclical wage movements in emerging markets compared to developed economics: the role of interest rates. *Review of Economic Dynamics*, *14*, 686–704.

Ljungqvist, L., & Uhlig, H. (2000). Tax policy and aggregate demand management under catching up with the joneses. *American Economic Review*, *90*(3), 356–366.

Loayza, N., Ranciére, R., Servén, L., & Ventura, J. (2007). Macroeconomic volatility and welfare in developing countries: an introduction. *The World Bank Economic Review*, *21*(3), 343–357.

Male, R. (2010). *Developing country business cycles: revisiting the stylized facts*. Working paper No. 664. School of Economics and Finance, Queen Mary University of London.

Mountford, A., & Uhlig, H. (2009). What are the effects of fiscal policy shocks? *Journal of Applied Econometrics*, *24*(6), 960–992.

Neumeyer, P. A., & Perri, F. (2005). Business cycles in emerging economies: the role if interest rates. *Journal of Monetary Economics*, *52*, 345–380.

Ni, S. (1995). An empirical analysis on the substitutability between private consumption and government purchases. *Journal of Monetary Economics*, *36*, 593–605.

Penn World Tables Version 8.1, (2015). http://www.rug.nl/research/ggdc/data/pwt/pwt-8.1.

Poirson, Héléne, (2006). The Tax System in India: Could Reform Spur Growth? *IMF Working Paper* WP/06/93.

Prescott, E. C. (2002). Prosperity and depression: 2002 Richard T. Ely Lecture, *Working Papers 618*. Federal Reserve Bank of Minneapolis.

Rand, J., & Tarp, F. (2002). Business cycles in developing countries: are they different. *World Development*, *30*(12), 2071–2088.

Roche, M. J. (1996). Government spending and the international business cycle. *Canadian Journal of Economics*, *29*(4), 865–884.

Schmitt-Grohe, S., & Uribe, M. (2003). Closing small open economy models. *Journal of International Economics*, *61*(1), 163–185.

Talvi, E., & Vegh, C. A. (2005). Tax base variability and procyclicality of fiscal policy. *Journal of Development Economics*, *78*(1), 156–190.

Tiryaki, S. T. (2012). Interest rates and real business cycles in emerging markets. *The B.E. Journal of Macroeconomics*, *11*(1). (Topics), Article 41.

Uribe, M., & Yue, V. Z. (2006). Country spreads and emerging economies: who drives whom? *Journal of International Economics*, *69*(1), 6–36.