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Working Paper No. 2011-96

November 2011

National Institute of Public Finance and Policy
New Delhi
http://www.nipfp.org.in

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May 11, 2011

Abstract

We develop a optimal rules-based interpretation of the 'three pillars macroeconomic policy framework': a combination of a freely floating exchange rate, an explicit target for inflation, and a mechanism than ensures a stable government debt-GDP ratio around a specified long run. We show how such monetary-fiscal rules need to be adjusted to accommodate specific features of emerging market economies. The model takes the form of two-blocs, a DSGE emerging small open economy interacting with the rest of the world and features, in particular, financial frictions It is calibrated using India and US data. Alongside the optimal Ramsey policy benchmark, we model the three pillars as simple monetary and fiscal rules including and both domestic and CPI inflation targeting interest rate rules. A comparison with a fixed exchange rate regime is made. We find that domestic inflation targeting is superior to partially or implicitly (through a CPI inflation target) or fully attempting to stabilizing the exchange rate. Financial frictions require fiscal policy to play a bigger role and lead to an increase in the costs associated with simple rules as opposed to the fully optimal policy. These policy prescriptions contrast with the monetary-fiscal policy stance of the Indian authorities

JEL Classification: E52, E37, E58
Keywords: monetary policy, emerging economies, fiscal and monetary rules, financial accelerator, liability dollarization.

*We acknowledge financial support for this research from the Foreign Commonwealth Office as a contribution to the project "Building Capacity and Consensus for Monetary and Financial Reform" led by the National Institute for Public Finance Policy (NIPFP). The paper has benefited from excellent research assistance provided by Rudrani Bhattachrya and Radhika Pandey, NIPFP. This paper is preliminary and is not to be quoted without the permission of the authors.

Contents

1 Introduction

Over the past decade and prior to the current financial crisis, key emerging markets including Brazil, Chile, the Czech Republic, Mexico and South Africa have adopted macroeconomic frameworks aimed at making them more resilient to domestic and external economic shocks. Many of these frameworks are characterized by the 'three pillars macroeconomic policy framework': a combination of a freely floating exchange rate, an explicit target for inflation over the medium run, and a mechanism that ensures a stable government debt-GDP ratio around a specified long run. By contrast, the currency monetary policy stance of the Indian Reserve Bank intervenes in the foreign exchange market to prevent what it regards as excessive volatility of the exchange rate. On the fiscal side, Central Government has a rigid fiscal deficit target of 3% of GDP irrespective of whether the economy is in boom or recession. The purpose of this paper is to contrast these implied policy prescriptions for interest rate and fiscal rules.

In this paper we develop a optimal rules-based interpretation of the 'three pillars' and show how such monetary-fiscal rules need to be adjusted to accommodate specific features of emerging market small open economies (SOEs).[1] Such emerging SOEs face substantially different policy issues from those of advanced, larger, more closed economies. The price of consumer goods depends on the exchange rate and exporting firms typically set their prices in foreign currency and bear the risk of currency fluctuations. They often borrow from international capital markets in foreign currency, so that debt repayment is similarly affected. Foreign shocks have significant effects on the domestic economy. Thus, we expect monetary and fiscal policy prescriptions in a emerging SOE to be fundamentally different from those in a advanced closed economy.

There is a large literature on optimal monetary and fiscal policy in response to exogenous shocks; Kirsanova and Wren-Lewis (2006); Schmitt-Grohe and M.Uribe (2007); Chadha and Nolan (2007); and Leith and Wren-Lewis (2007) are some recent examples for the closed economy; Wren-Lewis (2007) provides an insightful overview. We depart from these works in three principal ways. First, our focus is on a small open economy (SOE). Second, we want to consider an emerging economy where frictions and distortions are quantitatively important. To this end, we introduce financial frictions in the form of a 'financial accelerator'. Finally we will impose a zero lower bound (ZLB) constraint on the nominal interest rate that limits its variability and increases the role for fiscal stabilization policy, a feature again absent in almost all the literature (Schmitt-Grohe and

[1]Our focus is in this paper is monetary and fiscal rules in 'normal' conditions where exogenous shocks are small but frequent. Building into rules escape clauses for large infrequent credit-crunch type shocks is beyond the scope of this paper, but we do consider financial shocks and their effects on the real economy.

M.Uribe (2007) is an exception).

We build a two-bloc DSGE emerging markets SOE - rest of the world model to examine the implications of financial frictions for the relative contributions of optimal Ramsey fiscal and monetary stabilization policy and the simple rules that will, as far as possible, mimic the Ramsey policy. Alongside standard features of SOE economies such as local currency pricing for exporters, oil imports, our model incorporates liability dollarization, as well as financial frictions including a financial accelerator, where capital financing is partly or totally in foreign currency as in Gertler *et al.* (2003) and Gilchrist (2003)). The model is calibrated to India and US data.

The rest of the paper is organized as follows. Section 2 presents the model. Sections 3 and 4 set out the form of monetary and fiscal rules under investigation. Section 5 addresses the requirement that monetary rules should be 'operational' in the sense that, in the face of shocks, the zero lower bound constraint on the nominal interest rate is very rarely hit. In Section 6 we examine the benchmark Ramsey policy as first the financial accelerator and then liability dollarization are introduced. In section 7 we derive and compare alternative simple monetary and fiscal policy rules. Section 8 provides concluding remarks.

2 The Model

Our modelling strategy is to start from a fairly standard two-bloc 'New Open Economy' micro-founded DSGE model and then proceed to introduce various features appropriate to an emerging economy such as India. The benefits of this step-by-step approach are two-fold: first, it builds upon a large emerging literature and second, it enables the researcher to assess both the policy implications and the empirical relevance of each modelling stage.

First the standard model: the two blocs are asymmetric and unequally-sized, each one with different household preferences and technologies. The single (relatively) small open economy then emerges as the limit when the relative size of the larger bloc tends to infinity. Households are Ricardian, and work, save and consume tradable goods produced both at home and abroad. In a Wicksellian framework with a nominal interest rate target as the monetary instrument, we assume a 'cashless economy' and thus ignore seigniorage from money creation. There are three types of firms: wholesale, retail and capital producers. Wholesale firms borrow from households to buy capital used in production and capital producers build new capital in response to the demand of wholesalers. Monopolistic retailers adopt staggered price-setting with both producer and local currency pricing for exports in the home bloc, but only producer currency pricing in the large foreign bloc. Households supply a differentiated factor input which provides a further source of market power. In principle we could introduce staggered wage setting, but in accordance with labour market conditions in India we assume that wages are flexible. Oil imports enter into consumption and production in both blocs.

With these foundations we now proceed to some important features of emerging markets. First we introduce an imported oil input into output and consumption which has an exogenous price in dollars. However our main focus is on *financial frictions*. In many developing countries including India, firms face significant capital market imperfections when they seek external funds to finance new investment. Along the lines of Bernanke *et al.* (1999), Gertler *et al.* (2003), Gilchrist (2003) (see also Cespedes *et al.* (2004)), we introduce a 'financial accelerator' in the form of an external finance premium for wholesale firms that increases with leverage. We assume that part of the the debt of wholesale firms is financed in foreign currency (dollars), because it is impossible for firms to borrow 100 percent in domestic currency owing to 'original sin' type constraints – a phenomenon dubbed 'liability dollarization'. There are two further forms of financial frictions: first households face a risk premium when borrowing in world financial markets which introduces a 'national financial accelerator' as in Benigno (2001). Liability dollarization and the national financial accelerator departures add additional dimensions to openness.[2] Finally we assume that a significant proportion of households are excluded altogether from credit markets, do not save and can only consume out of current post-tax and transfer income.

Details of the model are as follows.

2.1 Households

Normalizing the total population to be unity, there are ν households in the 'home', emerging economy bloc and $(1-\nu)$ households in the 'foreign' bloc. A representative household h in the home country maximizes

$$E_t \sum_{t=0}^{\infty} \beta^t U\left(C_t(h), H_{C,t}, \frac{M_t(h)}{P_t}, L_t(h)\right) \tag{1}$$

where E_t is the expectations operator indicating expectations formed at time t, β is the household's discount factor, $C_t(h)$ is a Dixit-Stiglitz index of consumption defined below in (5), $H_{C,t} = h_C C_{t-1}$ is 'external habit', $M_t(h)$ is the end-of-period holding of nominal domestic money balances, P_t is a Dixit-Stiglitz price index defined in (14) below, and $L_t(h)$ are hours worked. An analogous symmetric intertemporal utility is defined for the

[2] See also Batini *et al.* (2007) for a SOE model with these features and, in addition, transactions dollarization owing to the assumption that households derive utility from holdings of both domestic and foreign currency.

'foreign' representative household and the corresponding variables (such as consumption) are denoted by $C_t^*(h)$, etc.

We incorporate financial frictions facing households as in Benigno (2001). There are two risk-free one-period bonds denominated in the currencies of each bloc with payments in period t, $B_{H,t}$ and $B_{F,t}$ respectively in (per capita) aggregate. The prices of these bonds are given by

$$P_{B,t} = \frac{1}{1+R_{n,t}}; \quad P_{B,t}^* = \frac{1}{(1+R_{n,t}^*)\phi(\frac{B_t}{P_{H,t}Y_t})} \tag{2}$$

where $\phi(\cdot)$ captures the cost in the form of a risk premium for home households to hold foreign bonds, B_t is the aggregate foreign asset position of the economy denominated in home currency and $P_{H,t}Y_t$ is nominal GDP. We assume $\phi(0) = 0$ and $\phi' < 0$. $R_{n,t}$ and $R_{n,t}^*$ denote the nominal interest rate over the interval $[t, t+1]$. The representative household h must obey a budget constraint:

$$\begin{aligned} & (1+\tau_{C,t})P_tC_t(h) + P_{B,t}B_{H,t}(h) + P_{B,t}^*S_tB_{F,t}(h) + M_t(h) + TL_t \\ = \; & W_t(h)(1-\tau_{L,t}))L_t(h) + B_{H,t-1}(h) + S_tB_{F,t-1}(h) + M_{t-1}(h) \\ + \; & (1-\tau_{\Gamma,t})\Gamma_t(h) \end{aligned} \tag{3}$$

where $W_t(h)$ is the wage rate, TL_t are lump-sum taxes net of transfers, $\tau_{L,t}$ and $\tau_{\Gamma,t}$ are labour income and profits tax rates respectively and $\Gamma_t(h)$, dividends from ownership of firms. In addition, if we assume that households' labour supply is differentiated with elasticity of supply η, then (as we shall see below) the demand for each consumer's labor supplied by ν identical households is given by

$$L_t(h) = \left(\frac{W_t(h)}{W_t}\right)^{-\eta} L_t \tag{4}$$

where $W_t = \left[\frac{1}{\nu}\sum_{r=1}^{\nu} W_t(h)^{1-\eta}\right]^{\frac{1}{1-\eta}}$ and $L_t = \left[\left(\frac{1}{\nu}\right)\sum_{r=1}^{\nu} L_t(h)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}$ are the average wage index and average employment respectively.

Let the number of differentiated goods produced in the home and foreign blocs be n and n^* respectively. We assume that the the ratio of households to firms are the same in each bloc. It follows that n and n^* (or ν and ν^*) are measures of size. The per capita consumption index in the home country is given by

$$C_t(h) = \left[\mathrm{w}_C^{\frac{1}{\mu_C}} C_{Z,t}(h)^{\frac{\mu_C-1}{\mu_C}} + (1-\mathrm{w}_C)^{\frac{1}{\mu_C}} C_{O,t}(h)^{\frac{\mu_C-1}{\mu_C}}\right]^{\frac{\mu_C}{\mu_C-1}} \tag{5}$$

where μ_C is the elasticity of substitution between and composite of home and foreign final goods and oil imports,

$$C_{Z,t}(h) = \left[\mathrm{w}_Z^{\frac{1}{\mu_Z}} C_{H,t}(h)^{\frac{\mu_Z-1}{\mu_Z}} + (1-\mathrm{w}_Z)^{\frac{1}{\mu_Z}} C_{F,t}(h)^{\frac{\mu_Z-1}{\mu_Z}}\right]^{\frac{\mu_Z}{\mu_Z-1}} \tag{6}$$

where μ_Z is the elasticity of substitution between home and foreign goods,

$$C_{H,t}(h) = \left[\left(\frac{1}{n}\right)^{\frac{1}{\zeta}} \sum_{f=1}^{n} C_{H,t}(f,h)^{(\zeta-1)/\zeta} \right]^{\zeta/(\zeta-1)}$$

$$C_{F,t}(h) = \left[\left(\frac{1}{n^*-n}\right)^{\frac{1}{\zeta}} \left(\sum_{f=1}^{n^*-n} C_{F,t}(f,h)^{(\zeta-1)/\zeta} \right) \right]^{\zeta/(\zeta-1)}$$

where $C_{H,t}(f,h)$ and $C_{F,t}(f,h)$ denote the home consumption of household h of variety f produced in blocs H and F respectively and $\zeta > 1$ is the elasticity of substitution between varieties in each bloc. Analogous expressions hold for the foreign bloc which indicated with a superscript '$*$' and we impose $\zeta = \zeta^*$ for reasons that become apparent in section 2.2.3.[3] Weights in the non-oil consumption baskets in the two blocs are defined by

$$\mathrm{w}_Z \equiv 1 - \frac{n^*}{n+n^*}(1-\omega)\,; \quad \mathrm{w}_Z^* \equiv 1 - \frac{n}{n+n^*}(1-\omega^*) \tag{7}$$

In (7), ω, $\omega^* \in [0,1]$ are a parameters that captures the degree of 'bias' in the two blocs. If $\omega = \omega^* = 1$ we have autarky, while $\omega = \omega^* = 0$ gives us the case of perfect integration. In the limit as the home country becomes small $n \to 0$ and $\nu \to 0$. Hence $\mathrm{w}_Z \to \omega$ and $\mathrm{w}_Z^* \to 1$. Thus the foreign bloc becomes closed, but as long as there is a degree of home bias and $\omega > 0$, the home country continues to consume foreign-produced consumption goods.

Denote by $P_{H,t}(f)$, $P_{F,t}(f)$ the prices in domestic currency of the good produced by firm f in the relevant bloc. Then the optimal intra-temporal decisions are given by standard results:

$$C_{H,t}(r,f) = \left(\frac{P_{H,t}(f)}{P_{H,t}}\right)^{-\zeta} C_{H,t}(h)\,;\; C_{F,t}(r,f) = \left(\frac{P_{F,t}(f)}{P_{F,t}}\right)^{-\zeta} C_{F,t}(h) \tag{8}$$

$$C_{Z,t}(h) = \mathrm{w}_C \left(\frac{P_{Z,t}}{P_t}\right)^{\mu_C} C_t(h)\,;\; C_{O,t}(h) = (1-\mathrm{w}_C)\left(\frac{P_{O,t}}{P_t}\right)^{-\mu_C} C_t(h) \tag{9}$$

$$C_{H,t}(h) = \mathrm{w}_Z \left(\frac{P_{H,t}}{P_{Z,t}}\right)^{-\mu_Z} C_{Z,t}(h)\,;\; C_{F,t}(h) = (1-\mathrm{w}_Z)\left(\frac{P_{F,t}}{P_{Z,t}}\right)^{-\mu_Z} C_{Z,t}(h) \tag{10}$$

[3] Consistently we adopt a notation where subscript H or F refers to goods H or F produced in the home and foreign bloc respectively. The presence (for the foreign bloc) or the absence (for the home country) of a superscript '$*$' indicates where the good is consumed or used as an input. Thus $C_{H,t}^*$ refers to the consumption of the home good by households in the foreign bloc. Parameter w and w* refer to the home and foreign bloc respectively, etc.

where aggregate price indices for domestic and foreign consumption bundles are given by

$$P_{H,t} = \left[\frac{1}{n}\sum_{f=1}^{n} P_{H,t}(f)^{1-\zeta}\right]^{\frac{1}{1-\zeta}} \tag{11}$$

$$P_{F,t} = \left[\frac{1}{n^*}\sum_{f=1}^{n^*} P_{F,t}(f)^{1-\zeta}\right]^{\frac{1}{1-\zeta}} \tag{12}$$

and the domestic consumer price index P_t given by

$$P_t = \left[\mathrm{w}_C(P_{Z,t})^{1-\mu_C} + (1-\mathrm{w}_C)(P_{O,t})^{1-\mu_C}\right]^{\frac{1}{1-\mu_C}} \tag{13}$$

$$P_{Z,t} = \left[\mathrm{w}_Z(P_{H,t})^{1-\mu_Z} + (1-\mathrm{w}_Z)(P_{F,t})^{1-\mu_Z}\right]^{\frac{1}{1-\mu_Z}} \tag{14}$$

with a similar definition for the foreign bloc.

Let S_t be the nominal exchange rate. If the law of one price applies to differentiated goods so that $\frac{S_t P^*_{F,t}}{P_{F,t}} = \frac{S_t P^*_{H,t}}{P_{H,t}} = 1$. Then it follows that the real exchange rate $RER_t = \frac{S_t P^*_t}{P_t}$. However with local currency pricing the real exchange rate and the terms of trade, defined as the domestic currency relative price of imports to exports $\mathcal{T}_t = \frac{P_{F,t}}{P_{H,t}}$, are related by the relationships

$$RER_{Z,t} \equiv \frac{S_t P^*_{Z,t}}{P_t} = \frac{\left[\mathrm{w}^*_Z + (1-\mathrm{w}^*_Z)\mathcal{T}_t^{\mu^*_Z-1}\right]^{\frac{1}{1-\mu^*_Z}}}{\left[1-\mathrm{w}_Z + \mathrm{w}_Z\mathcal{T}_t^{\mu_Z-1}\right]^{\frac{1}{1-\mu_Z}}} \tag{15}$$

$$RER_t \equiv \frac{S_t P^*_t}{P_t} = RER_{Z,t}\frac{\left[\mathrm{w}^*_C + (1-\mathrm{w}^*_C)\mathcal{O}_t^{\mu^*_C-1}\right]^{\frac{1}{1-\mu^*_C}}}{\left[\mathrm{w}_C + (1-\mathrm{w}_C)\mathcal{O}_t^{\mu_C-1}\right]^{\frac{1}{1-\mu_C}}} \tag{16}$$

$$\mathcal{O}_t \equiv \frac{P_{O,t}}{P_{Z,t}} \tag{17}$$

Thus if $\mu = \mu^*$, then $RER_t = 1$ and the law of one price applies to the aggregate price indices iff $\mathrm{w}^* = 1 - \mathrm{w}$. The latter condition holds if there is no home bias. If there is home bias, the real exchange rate appreciates (RER_t falls) as the terms of trade deteriorates.

We assume flexible wages. Then maximizing (1) subject to (3) and (4), treating habit as exogenous, and imposing symmetry on households (so that $C_t(h) = C_t$, etc) yields standard results:

$$
\begin{aligned}
P_{B,t} &= \beta E_t \left[\frac{U_{C,t+1}}{U_{C,t}} \frac{P_t(1+\tau_{C,t})}{P_{t+1}(1+\tau_{C,t+1}} \right] && (18) \\
P^*_{B,t} &= \beta E_t \left[\frac{U_{C,t+1}}{U_{C,t}} \frac{S_{t+1}P_t(1+\tau_{C,t})}{S_t P_{t+1}(1+\tau_{C,t+1}} \right] && (19) \\
U_{M,t} &= U_{C,t} \left[\frac{R_{n,t}}{1+R_{n,t}} \right] && (20) \\
\frac{W_t(1-\tau_{L,t})}{P_t(1+\tau_{C,t})} &= -\frac{\eta}{(\eta-1)} \frac{U_{L,t}}{U_{C,t}} && (21)
\end{aligned}
$$

where $U_{C,t}$, $U_{M,t}$, and $-U_{L,t}$ are the marginal utility of consumption, money holdings in the two currencies and the marginal disutility of work respectively. $\tau_{C,t}$ is a consumption tax rate. In what follows we assume that this and other all tax rates are held fixed and only lump-sum taxes of transfers are used for stabilization. Then $\tau_{C,t} = \tau_{C,t+1} = \tau_C$ and taking expectations of the Keynes-Ramsey rule (**??**) and its foreign counterpart, we arrive at the *modified UIP condition*

$$
\frac{P_{B,t}}{P^*_{B,t}} = \frac{E_t \left[U_{C,t+1} \frac{P_t}{P_{t+1}} \right]}{E_t \left[U_{C,t+1} \frac{S_{t+1}P_t}{S_t P_{t+1}} \right]} \tag{22}
$$

In (20), the demand for money balances depends positively on the marginal utility of consumption and negatively on the nominal interest rate. If, as is common in the literature, one adopts a utility function that is separable in money holdings, then given the central bank's setting of the latter and ignoring seignorage in the government budget constraint money demand is completely recursive to the rest of the system describing our macro-model. However separable utility functions are implausible (see Woodford (2003),chapter 3, section 3.4) and following Felices and Tuesta (2006) we will not go down this route. Finally, in (21) the real disposable wage is proportional to the marginal rate of substitution between consumption and leisure, $-\frac{U_{L,t}}{U_{C,t}}$, and the constant of proportionality reflects the market power of households that arises from their monopolistic supply of a differentiated factor input with elasticity η.

2.1.1 Rule of Thumb (RT) Households

Suppose now there are two groups of household, a fixed proportion $1-\lambda$ without credit constraints and the remaining proportion λ who consume out of post-tax income. Let $C_{1,t}(h)$, $W_{1,t}(h)$ and $L_{1,t}(h)$ be the per capita consumption, wage rate and labour supply respectively for this latter group. Then the optimizing households are denoted as before with $C_t(h)$, $W_t(h)$ and $L_t(h)$ replaced with $C_{2,t}(h)$, $W_{2,t}(h)$ and $L_{2,t}(h)$. We then have the budget constraint of the RT consumers

$$P_t(1+\tau_{C,t})C_{1,t}(h) = (1-\tau_{L,t})W_{1,t}(h)L_{1,t}(r) + TL_{1,t} \tag{23}$$

where $TL_{1,t}$ is net lump-sum *transfers* received per credit-constrained household. Following Erceg *et al.* (2005) we further assume that RT households set their wage to be the average of the optimizing households. Then since RT households face the same demand schedule as the optimizing ones they also work the same number of hours. Hence in a symmetric equilibrium of identical households of each type, the wage rate is given by $W_{1,t}(r) = W_{1,t} = W_{2,t}(r) = W_{2,t} = W_t$ and hours worked per household is $L_{1,t}(h) = L_{2,t}(h) = L_t$. The only difference between the income of the two groups of households is that optimizing households as owners receive the profits from the mark-up of domestic monopolistic firms.

As before, optimal intra-temporal decisions are given by

$$C_{1H,t}(h) \quad = \quad \mathrm{w}\left(\frac{P_{H,t}}{P_t}\right)^{-\mu} C_{1,t}(h)\,; \;\; C_{1F,t}(h) = (1-\mathrm{w})\left(\frac{P_{F,t}}{P_t}\right)^{-\mu} C_{1,t}(h) \tag{24}$$

and average consumption per household over the two groups is given by

$$C_t = \lambda C_{1,t} + (1-\lambda)C_{2,t} \tag{25}$$

Aggregates $C^*_{1H,t}$, $C^*_{1F,t}$, C^*_t etc are similarly defined.

2.2 Firms

There are three types of firms, wholesale, retail and capital producers. Wholesale firms are run by risk-neutral entrepreneurs who purchase capital and employ household labour to produce a wholesale goods that is sold to the retail sector. The wholesale sector is competitive, but the retail sector is monopolistically competitive. Retail firms differentiate wholesale good at no resource cost and sell the differentiated (repackaged) goods to households. The capital goods sector is competitive and converts the final good into capital. The details are as follows.

2.2.1 Wholesale Firms

Wholesale goods are homogeneous and produced by entrepreneurs who combine differentiated labour, capital, oil inputs with and a technology

$$Y^W_t = A_t K^{\alpha_1}_t L^{\alpha_2}_t (\mathrm{OIL}_t)^{1-\alpha_1-\alpha_2} \tag{26}$$

where K_t is beginning-of-period t capital stock,

$$L_t = \left[\left(\frac{1}{\nu} \right)^{\frac{1}{\eta}} \sum_{r=1}^{\nu} L_t(h)^{(\eta-1)/\eta} \right]^{\eta/(\eta-1)} \tag{27}$$

where we recall that $L_t(h)$ is the labour input of type h, A_t is an exogenous shock capturing shifts to trend total factor productivity in this sector. [4] Minimizing wage costs $\sum_{h=1}^{\nu} W_t(h)L_t(h)$ gives the demand for each household's labour as

$$L_t(h) = \left(\frac{W_t(h)}{W_t} \right)^{-\eta} L_t \tag{28}$$

Wholesale goods sell at a price $P^W_{H,t}$ in the home country. Equating the marginal product and cost of aggregate labour gives

$$W_t = P^W_{H,t} \alpha_2 \frac{Y^W_t}{L_t} \tag{29}$$

Similarly letting $P_{O,t}$ be the price of oil in home currency, we have

$$P_{O,t} \quad = \quad P^W_{H,t} \alpha_3 \frac{Y^W_t}{\mathrm{OIL}_t} \tag{30}$$

Let Q_t be the real market price of capital in units of total household consumption. Then noting that profits per period are $P^W_{H,t} Y_t - W_t L_t - P_{O,t}\mathrm{OIL}_t = \alpha_1 P^W_{H,t} Y_t$, using (29), the expected return on capital, acquired at the beginning of period t, net of depreciation, over the period is given by

$$E_t(1 + R^k_t) = \frac{\frac{P^W_{H,t}}{P_t} \alpha_1 \frac{Y_t}{K_t} + (1 - \delta) E_t[Q_{t+1}]}{Q_t} \tag{31}$$

where δ is the depreciation rate of capital. This expected return must be equated with the expected cost of funds over $[t, t+1]$, taking into account credit market frictions.[5] Wholesale firms borrow in both home and foreign currency, with exogenously given proportion[6] of the former given by $\varphi \in [0, 1]$, so that this expected cost is

$$\begin{aligned} & (1 + \Theta_t)\varphi E_t \left[(1 + R_{n,t}) \frac{P_t}{P_{t+1}} \right] + (1 + \Theta_t)(1 - \varphi) E_t \left[(1 + R^*_{n,t}) \frac{P^*_t}{P^*_{t+1}} \frac{RER_{t+1}}{RER_t} \right] \\ = \ & (1 + \Theta_t) \left[\varphi E_t \left[(1 + R_t) \right] + (1 - \varphi) E_t \left[(1 + R^*_t) \frac{RER_{t+1}}{RER_t} \right] \right] \end{aligned} \tag{32}$$

[4] Following Gilchrist *et al.* (2002) and Gilchrist (2003), we ignore the managerial input into the production process and later, consistent with this, we ignore the contribution of the managerial wage in her net worth.

[5] We assume all financial returns are taxed at the same rate and therefore do not affect arbitrage conditions.

[6] We do not attempt to endogenize the decision of firms to partially borrow foreign currency; this lies outside the scope of this paper.

If $\varphi = 1$ or if UIP holds this becomes $(1+\Theta_t)E_t[1+R_t]$. In (32), $RER_t \equiv \frac{P_t^* S_t}{P_t}$ is the real exchange rate, $R_{t-1} \equiv \left[(1+R_{n,t-1})\frac{P_{t-1}}{P_t}\right] - 1$ is the ex post real interest rate over $[t-1, t]$ and $\Theta_t \geq 0$ is the external finance premium given by

$$\Theta_t = \Theta\left(\frac{B_t}{N_t}\right) \; ; \; \Theta'(\cdot) > 0, \, \Theta(0) = 0, \; \Theta(\infty) = \infty \tag{33}$$

where $B_t = Q_t K_t - N_t$ is bond-financed acquisition of capital in period t and N_t is the beginning-of-period t entrepreneurial net worth, the equity of the firm.[7] Note that the *ex post* return at the beginning of period t, R^k_{t-1}, is given by

$$1 + R^k_{t-1} = \frac{\frac{P^W_{H,t-1}}{P_{t-1}}\alpha_1 \frac{Y_{t-1}}{K_{t-1}} + (1-\delta)Q_t}{Q_{t-1}} \tag{34}$$

and this can deviate from the *ex ante* return on capital.

Assuming that entrepreneurs exit with a given probability $1-\xi_e$, net worth accumulates according to

$$N_t = \xi_e V_t + (1-\xi_e)D_t \tag{35}$$

where D_t are transfers from exiting to newly entering entrepreneurs continuing, and V_t, the net value carried over from the previous period, is given by

$$\begin{aligned} V_t &= \Big[(1+R^k_{t-1})Q_{t-1}K_{t-1} \\ &- (1+\Theta_{t-1})\left(\varphi(1+R_{t-1}) + (1-\varphi)(1+R^*_{t-1})\frac{RER_t}{RER_{t-1}}\right)(Q_{t-1}K_{t-1} - N_{t-1})\Big] \end{aligned} \tag{36}$$

A reasonable assumption is that $D_t = \nu V_t$. Note that in (36), $(1+R^k_{t-1})$ is the ex post return on capital acquired at the beginning of period $t-1$, $(1+R_{t-1})$ is the ex post real cost of borrowing in home currency and $(1+R^*_{t-1})\frac{RER_t}{RER_{t-1}}$ is the ex post real cost of borrowing in foreign currency. Also note that net worth N_t at the beginning of period t is a non-predetermined variable since the ex post return depends on the current market value Q_t, itself a non-predetermined variable.

Along a deterministic balanced growth path (BGP) with balanced trade and therefore no net overseas assets we have that $\bar{N}_t = (1+g)\bar{N}_{t-1}$ and $1 + R^k = (1+\Theta)(1+R) = 1+\Theta)(1+R^*)$. Therefore

$$\bar{N}_t = (1+g)\bar{N}_{t-1} = (\xi_e + (1-\xi_e)\nu)\bar{V}_t = (\xi_e + (1-\xi_e)\nu)(1+\Theta)(1+R)\bar{N}_{t-1} \tag{37}$$

[7] The entrepreneur borrows from a financial intermediary that in turn obtains funds from households at a real ex post cost $R_{t-1} = (1+R_{n,t-1})\frac{P_t}{P_{t-1}}$. Entrepreneurs can borrow up to $K_t Q_t$. The return to capital is subject to idiosyncratic shocks for which the lender pays a monitoring cost to observe. Bernanke *et al.* (1999) show that the optimal financial contract between a risk-neutral intermediary and entrepreneur takes the form of a risk premium given by (33). Thus the risk premium is an increasing function of leverage of the firm. Following these authors, in the general equilibrium we ignore monitoring costs.

Thus from (36), given values for ξ_e, Θ and R, for a BGP the remaining parameter ν must be set such that $(\xi_e + (1-\xi_e)\nu)(1+\Theta)(1+R) = 1+g$.

Exiting entrepreneurs consume C_t^e, the remaining resources, given by

$$C_t^e = (1-\xi_e)(V_t - D_t) = (1-\xi_e)(1-\mu)V_t = \frac{(1-\xi_e)(1-\nu)}{\xi_e + (1-\xi_e)\nu} N_t \tag{38}$$

of which consumption of the domestic and foreign goods, as in (9), are given respectively by

$$C_{H,t}^e = \mathrm{w}_Z \left(\frac{P_{H,t}}{P_t}\right)^{-\mu_Z} C_{Z,t}^e \, ; \quad C_{F,t}^e = (1-\mathrm{w}_Z)\left(\frac{P_{F,t}}{P_t}\right)^{-\mu_Z} C_{Z,t}^e \tag{39}$$

$$C_{Z,t}^e = \mathrm{w}_C \left(\frac{P_{Z,t}}{P_t}\right)^{-\mu_C} C_t^e \tag{40}$$

2.2.2 Retail Firms

Retail firms are monopolistically competitive, buying wholesale goods and differentiating the product at a fixed resource cost F. In a free-entry equilibrium profits are driven to zero. Retail output for firm f is then $Y_t(f) = Y_t^W(f) - F$ where Y_t^W is produced according to production technology (26). We provide a general set-up in which a fixed proportion $1-\theta$ of retailers set prices in the Home currency (producer currency pricers, PCP) and a proportion θ set prices in the dollars (local currency pricers, LCP).[8] In the model used for the policy exercises we assume LCP only ($\theta = 1$). Details are as follows:

2.2.3 PCP Exporters

Assume that there is a probability of $1-\xi_H$ at each period that the price of each good f is set optimally to $\hat{P}_{H,t}(f)$. If the price is not re-optimized, then it is held constant.[9] For each producer f the objective is at time t to choose $\hat{P}_{H,t}(f)$ to maximize discounted profits

$$E_t \sum_{k=0}^{\infty} \xi_H^k D_{t,t+k} Y_{t+k}(f) \left[\hat{P}_{H,t}(f) - P_{H,t+k}\mathrm{MC}_{t+k}\right]$$

where $D_{t,t+k}$ is the discount factor over the interval $[t, t+k]$, subject to a common[10] downward sloping demand from domestic consumers and foreign importers of elasticity ζ

[8] As with the foreign currency borrowing parameter φ, we make no attempt to endogenize the choice of PCP and LCP.

[9] Thus we can interpret $\frac{1}{1-\xi_H}$ as the average duration for which prices are left unchanged.

[10] Recall that we have imposed a symmetry condition $\zeta = \zeta^*$ at this point; i.e., the elasticity of substitution between differentiated goods produced in any one bloc is the same for consumers in both blocs.

as in (8) and $MC_t = \frac{P^W_{H,t}}{P_{H,t}}$ are marginal costs. The solution to this is

$$E_t \sum_{k=0}^{\infty} \xi_H^k D_{t,t+k} Y_{t+k}(f) \left[\hat{P}_{Ht}(f) - \frac{\zeta}{(\zeta-1)} P_{H,t+k} \mathrm{MC}_{t+k} \right] = 0 \tag{41}$$

and by the law of large numbers the evolution of the price index is given by

$$P_{H,t+1}^{1-\zeta} = \xi_H \left(P_{H,t}\right)^{1-\zeta} + (1-\xi_H)(\hat{P}_{H,t+1}(f))^{1-\zeta} \tag{42}$$

For later use in the evaluation of tax receipts, we require monopolistic profits as a proportion of GDP. This is given by

$$\frac{\Gamma_t}{P_{H,t}Y_t} \equiv \frac{P_{H,t}Y_t - P^W_{H,t}Y^W_t}{P_{H,t}Y_t} = 1 - \mathrm{MC}_t \left(1 + \frac{F}{Y}\right) \tag{43}$$

For good f imported by the home country from PCP foreign firms the price $P^p_{F,t}(f)$, set by retailers, is given by $P^p_{F,t}(f) = S_t P^*_{F,t}(f)$. Similarly $P^{*\,p}_{H,t}(f) = \frac{P_{H,t}(f)}{S_t}$.

2.2.4 LCP Exporters

Price setting in export markets by domestic LCP exporters follows is a very similar fashion to domestic pricing. The optimal price in units of domestic currency is $\hat{P}^{\ell}_{H,t}S_t$, costs are as for domestically marketed goods so (41) and (42) become

$$E_t \sum_{k=0}^{\infty} \xi_H^k D_{t,t+k} Y^*_{T,t+k}(f) \left[\hat{P}_{H,t}(f)^{*\,\ell} S_{t+k} - \frac{\zeta_T}{(\zeta_T-1)} P_{H,t+k} \mathrm{MC}_{T,t+k} \right] = 0 \tag{44}$$

and by the law of large numbers the evolution of the price index is given by

$$(P^{*\,\ell}_{H,t+1})^{1-\zeta_T} = \xi_H (P^{*\,\ell}_{H,t})^{1-\zeta_T} + (1-\xi_H)(\hat{P}^{*\,\ell}_{H,t+1}(f))^{1-\zeta_T} \tag{45}$$

Foreign exporters from the large ROW bloc are PCPers so we have

$$P_{F,t} = S_t P^*_{F,t} \tag{46}$$

Table 1 summarizes the notation used.

Origin of Good	Domestic Market	Export Market (PCP)	Export Market(LCP)
Home	P_H	$P^{*\,p}_H = \frac{P_H}{S_t}$	$P^{*\,\ell}_H \neq \frac{P_H}{S_t}$
Foreign	P^*_F	$P^p_F = S_t P^*_F$	$P^{\ell}_F \neq S_t P^*_F$

Table 1. Notation for Prices

2.2.5 Capital Producers

As in Smets and Wouters (2003), we introduce a delayed response of investment observed in the data. Capital producers combine existing capital, K_t, leased from the entrepreneurs to transform an input I_t, gross investment, into new capital according to

$$K_{t+1} = (1-\delta)K_t + (1 - S\left(I_t/I_{t-1}\right))I_t\,;\;\; S',\, S'' \geq 0\,;\;\; S(1) = S'(1) = 0 \qquad (47)$$

This captures the ideas that adjustment costs are associated with *changes* rather than *levels* of investment.[11] Gross investment consists of domestic and foreign final goods

$$I_t = \left[\mathrm{w}_I^{\frac{1}{\rho_I}} I_{H,t}^{\frac{\rho_I-1}{\rho_I}} + (1-\mathrm{w}_I)^{\frac{1}{\rho_I}} I_{F,t}^{\frac{\rho_I-1}{\rho_I}}\right]^{\frac{\rho_I}{1-\rho_I}} \qquad (48)$$

where weights in investment are defined as in the consumption baskets, namely

$$\mathrm{w}_I \;=\; 1-(1-n)(1-\omega_I)\,;\quad \mathrm{w}_I^* = 1 - n(1-\omega_I^*) \qquad (49)$$

with investment price given by

$$P_{I,t} = \left[\mathrm{w}_I(P_{H,t})^{1-\rho_I} + (1-\mathrm{w}_I)(P_{F,t})^{1-\rho_I}\right]^{\frac{1}{1-\rho_I}} \qquad (50)$$

Capital producers choose the optimal combination of domestic and foreign inputs according to the same form of intra-temporal first-order conditions as for consumption:

$$I_{H,t} = \mathrm{w}_I\left(\frac{P_{H,t}}{P_{I,t}}\right)^{-\rho_I} I_t\,;\;\; I_{F,t} = (1-\mathrm{w}_I)\left(\frac{P_{F,t}}{P_{I,t}}\right)^{-\rho_I} I_t \qquad (51)$$

The capital producing firm at time t then maximizes expected discounted profits[12]

$$E_t \sum_{k=0}^{\infty} D_{t,t+k}\left[Q_{t+k}(1 - S\left(I_{t+k}/I_{t+k-1}\right))I_{t+k} - \frac{P_{I,t+k}I_{t+k}}{P_{t+k}}\right]$$

which results in the first-order condition

$$Q_t(1 - S(I_t/I_{t-1}) - I_t/I_{t-1}S'(I_t/I_{t-1})) + E_t\left[D_{t,t+1}\,Q_{t+1}S'(I_{t+1}/I_t)\frac{I_{t+1}^2}{I_t^2}\right] = \frac{P_{I,t}}{P_t} \qquad (52)$$

2.3 The Government Budget Constraint and Foreign Asset Accumulation

The government issues bonds denominated in home currency. The government budget identity is given by

$$P_{B,t}B_{G,t} + M_t = B_{G,t-1} + P_{H,t}G_t - T_t + M_{t-1} \qquad (53)$$

[11] In a balanced growth steady state adjustment costs are associated with change relative to trend so that the conditions on $S(\cdot)$ along the balanced growth path become $S(1+g) = S'(1+g) = 0$.

[12] This ignores leasing costs which Gertler *et al.* (2003) show to be of second order importance.

Taxes are levied on labour income, monopolistic profits, consumption and capital returns at rates $\tau_{L,t}$, τ_Γ, $\tau_{C,t}$ and $\tau_{K,t}$. Then adding lump-sum taxes[13] levied on all consumers, $\mathrm{TL}_{2,t}$, and subtracting net lump-sum transfers to the constrained consumers, $\mathrm{TL}_{1,t}$, per capita total taxation net of transfers is given

$$T_t = \tau_{L,t} W_t L_t + \tau_{\Gamma,t} \Gamma_t + \tau_{C,t} P_t C_t - \lambda \mathrm{TL}_{1,t} + (1-\lambda)\mathrm{TL}_{2,t} + \tau_{K,t} R_{t-1}^k P_t Q_t K_t \quad (54)$$

In what follow we take lump-sum taxes and transfers to be the dynamic fiscal instruments keeping tax rates constant at their steady-state values. For later use we then write T_t in (54) as a sum of the instrument $T_t^I = -\lambda \mathrm{TL}_{1,t} + (1-\lambda)\mathrm{TL}_{2,t}$ and remaining taxes which change endogenously, T_t^{NI}.

Turning to foreign asset accumulation, let $\sum_{h=1}^{\nu} B_{F,t}(h) = \nu B_{F,t}$ be the net holdings by the household sector of foreign bonds. An convenient assumption is to assume that home households hold no foreign bonds so that $B_{F,t} = 0$, and the net asset position of the home economy $B_t = -B_{H,t}^*$; i.e., minus the foreign holding of domestic government bonds.[14] Summing over the household budget constraints (including entrepreneurs and capital producers), and subtracting (53), we arrive at the accumulation of net foreign assets:

$$\begin{aligned} P_{B,t} B_t &= B_{t-1} + W_t L_t + \Gamma_t + (1-\xi_e) P_t V_t + P_t Q_t (1 - S(X_t)) I_t \\ &- P_t C_t - P_t C_t^e - P_{I,t} I_t - P_{H,t} G_t - P_{O,t} \mathrm{OIL}_t \\ &\equiv B_{t-1} + TB_t \end{aligned} \quad (55)$$

where the trade balance, TB_t, is given by the national accounting identity

$$P_{H,t} Y_t - P_{O,t} \mathrm{OIL}_t = P_t C_t + P_t C_t^e + P_{I,t} I_t + P_{H,t} G_t + \mathrm{TB}_t \quad (56)$$

Terms on the left-hand-side of (56) are oil revenues and the value of *net* output; on the right-hand-side are public and private consumption plus investment plus the trade surplus.

So far we have aggregated consumption across constrained and unconstrained consumers. To obtain separately per capita consumption within these groups, first consolidate the budget constraints (53) and (3), to give

$$\begin{aligned} &(1 + \tau_{C,t}) P_t C_{2,t} + P_{B,t} \frac{B_t}{1-\lambda} + TL_{2,t} \\ &= W_t (1 - \tau_{L,t})) L_t(h) + \frac{B_{t-1}}{1-\lambda} + \frac{T_t - P_{H,t} G_t}{1-\lambda} \end{aligned}$$

[13] If tax rates are held fixed, then the 'lump-sum tax' can be considered to be minus the income tax rate times the threshold at which labour income tax starts to operate. An decrease in the threshold is then equivalent to an increase in a lump-sum tax.

[14] An alternative assumption with the same effect is to assume that and the government issues bonds denominated in foreign currency (see Medina and Soto (2007)).

Then using (23) and (55), we arrive at

$$C_{2,t} = C_{1,t} + \frac{\frac{1}{1-\lambda}\left[-TB_t + T_t - P_{H,t}G_t + (1-\tau_{\Gamma,t})\Gamma_t - \lambda TL_{1,t}\right] - TL_{2,t}}{(1+\tau_{C,t})P_t} \tag{57}$$

In a balanced growth steady state with negative net foreign assets and government debt, the national and government budget constraints require a primary trade surplus ($TB > 0$) and a primary government surplus ($T > P_H G$). Since private sector assets are exclusively owned by unconstrained consumers this may result in a higher consumption per head by that group. The same applies to profits from retail firms since they are assumed to also be exclusively owned by unconstrained consumers. On the other hand lump-sum transfers to constrained consumers plus lump-sum taxes on unconstrained consumers, $-\lambda TL_{1,t} + (1-\lambda)TL_{2,t}$ tend to lower the consumption gap.

2.4 The Equilibrium

In equilibrium, final goods markets, money markets and the bond market all clear. Equating the supply and demand of the home consumer good and assuming that government expenditure, taken as exogenous, goes exclusively on home goods we obtain for the final goods market[15]

$$Y_t = C_{H,t} + C^e_{H,t} + I_{H,t} + \frac{1-\nu}{\nu}\left[C^*_{H,t} + C^{e\,*}_{H,t} + I^*_{H,t}\right] + G_t \tag{58}$$

Shocks are to technology in wholesale goods sectors, government spending in the two blocs, the interest rate rule in the foreign bloc and to the risk premia facing unconstrained households, in the modified UIP condition (22) and facing wholesale firms in their external finance premium given by (33).

This completes the model. Given nominal interest rates $R_{n,t}, R^*_{n,t}$ the money supply is fixed by the central banks to accommodate money demand. By Walras' Law we can dispense with the bond market equilibrium conditions. Then the equilibrium is defined at $t = 0$ as stochastic sequences $C_{1,t}$, $C_{2,t}$, C_t, C^e_t, $C_{H,t}$, $C_{F,t}$, $P_{H,t}$, $P_{F,t}$, P_t, $P_{C,t}$, M_t, $B_{H,t} = B_{G,t}$, $B_{F,t}$, W_t, Y_t, L_t, $P^0_{H,t}$, P^I_t, K_t, I_t, Q_t, V_t, foreign counterparts $C^*_{1,t}$, etc, RER_t, and S_t, given the monetary instruments $R_{n,t}$, $R^*_{n,t}$, the fiscal instruments and exogenous processes.

2.5 Specialization of The Household's Utility Function

The choice of utility function must be chosen to be consistent with the balanced growth path (henceforth BGP) set out in previous sections. As pointed out in Barro and Sala-i-Martin (2004), chapter 9, this requires a careful choice of the form of the utility as a

[15]Note that all aggregates, Y_t, $C_{H,t}$, etc are expressed in per capita (household) terms.

function of consumption and labour effort. As in Gertler *et al.* (2003), it is achieved by a utility function which is non-separable. A utility function of the form

$$U \equiv \frac{\left[\Phi(h)^{1-\varrho}(1-L_t(h))^{\varrho}\right]^{1-\sigma}}{1-\sigma} \tag{59}$$

where

$$\Phi_t(h) \equiv \left[b(C_t(h) - h_C C_{t-1})^{\frac{\theta-1}{\theta}} + (1-b)\left(\frac{M_t}{P_t}\right)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}} \tag{60}$$

and where labour supply, $L_t(h)$, is measured as a proportion of a day, normalized at unity, satisfies this requirement.[16] For this function, $U_{\Phi L} > 0$ so that consumption and money holdings together, and leisure (equal to $1 - L_t(h)$) are substitutes.

2.6 State Space Representation

We linearize around a deterministic zero inflation, zero net private sector debt, balanced growth steady state. We can write the two-bloc model in state space form as

$$\begin{aligned} \begin{bmatrix} \mathsf{z}_{t+1} \\ E_t \mathsf{x}_{t+1} \end{bmatrix} &= A \begin{bmatrix} \mathsf{z}_t \\ \mathsf{x}_t \end{bmatrix} + B\mathsf{o}_t + C \begin{bmatrix} r_{n,t} \\ r^*_{n,t} \end{bmatrix} + D\mathsf{v}_{t+1} \\ \mathsf{o}_t &= H \begin{bmatrix} \mathsf{z}_t \\ \mathsf{x}_t \end{bmatrix} + J \begin{bmatrix} r_{n,t} \\ r^*_{n,t} \\ tr_t \\ tr^*_t \end{bmatrix} \end{aligned} \tag{61}$$

where z_t is a vector of predetermined exogenous variables, x_t are non-predetermined variables, and o_t is a vector of outputs.[17] Matrices A, B, etc are functions of model parameters. Rational expectations are formed assuming an information set $\{z_{1,s}, z_{2,s}, x_s\}$, $s \leq t$, the model and the monetary rule. Details of the linearization are provided in Batini *et al.* (2010).

2.7 The Small Open Economy

Following Felices and Tuesta (2006), we can now model a SOE by letting its relative size in the world economy $n \to 0$ whilst retaining its linkages with the rest of the world (ROW).

[16] A BGP requires that the real wage, real money balances and consumption grow at the same rate at the steady state with labour supply constant. It is straightforward to show that (59) has these properties.

[17] We define all lower case variables as proportional deviations from this baseline steady state except for rates of change which are absolute deviations. That is, for a typical variable X_t, $x_t = \frac{X_t - X}{X} \simeq \log\left(\frac{X_t}{X}\right)$ where X is the baseline steady state. For variables expressing a rate of change over time such as the nominal interest rate $r_{n,t}$ and inflation rates, $x_t = X_t - X$.

In particular the demand for exports is modelled in a consistent way that retains its dependence on shocks to the home and ROW economies. We now need a fully articulated model of the ROW. From (7) we have that $\mathrm{w} \to \omega$ and $\mathrm{w}^* \to 1$ as $n \to 0$. Similarly for investment we have $\mathrm{w}_I \to \omega_I$ and $\mathrm{w}_I^* \to 1$ as $n \to 0$. It seems at first glance then that the ROW becomes closed and therefore exports from our SOE must be zero. However this is not the case. Consider the linearized form of the output demand equations in the two blocs:

$$\begin{aligned} y_t &= \alpha_{C,H}c_{Z,t} + \alpha^e_{C,H}c^e_{Z,t} + \alpha^*_{C,H}c^*_{Z,t} + \alpha_{I,H}i_t + \alpha^*_{I,H}i^*_t + \alpha_G g_t \\ &+ [\mu(\alpha_{C,H} + \alpha^e_{C,H})(1-\mathrm{w}_Z) + \mu^*\alpha^*_{C,H}\mathrm{w}^*_Z + \rho_I\alpha_{I,H}(1-\mathrm{w}_I) + \rho^*_I\alpha^*_{I,H}\mathrm{w}^*_I]\tau_t \quad (62) \\ y^*_t &= \alpha^*_{C,F}c^*_{Z,t} + \alpha_{C,F}c_{Z,t} + \alpha^e_{C,F}c^e_t + \alpha^*_{I,F}i^*_t + \alpha_{I,F}i_t + \alpha^*_G g^*_t \\ &- [\mu^*(\alpha^*_{C,F}(1-\mathrm{w}^*_Z) + \mu\alpha_{C,F}\mathrm{w}_Z + \rho^*_I\alpha^*_{I,F}(1-\mathrm{w}^*_I) + \rho_I\alpha_{I,F}\mathrm{w}_I]\tau_t \quad (63) \end{aligned}$$

where the elasticities and their limits as $n \to 0$ are given by

$$\begin{aligned} \alpha_{C,H} &= \frac{\mathrm{w}(1-s_e)C}{Y} \to \frac{\omega(1-s_e)C}{Y} \\ \alpha^e_{C,H} &= \frac{\mathrm{w}s_eC}{Y} \to \frac{\omega s_e C}{Y} \\ \alpha^*_{C,H} &= \frac{(1-\mathrm{w}^*)C^*}{Y^*}\frac{(1-n)Y^*}{nY} \to \frac{(1-\omega^*)C^*}{Y^*}\frac{Y^*}{Y} \\ \alpha_G &= \frac{G}{Y} \\ \alpha_{I,H} &= \frac{\mathrm{w}_I I}{Y} \to \frac{\omega_I I}{Y} \\ \alpha^*_{I,H} &= \frac{(1-\mathrm{w}^*_I)I^*}{Y^*}\frac{(1-n)Y^*}{nY} \to \frac{(1-\omega^*_I)I^*}{Y^*}\frac{Y^*}{Y} \\ \alpha^*_{C,F} &= \frac{\mathrm{w}^*C^*}{Y^*} \to \frac{C^*}{Y^*} \\ \alpha^{e*}_{C,F} &= 0 \\ \alpha_{C,F} &= \frac{(1-\mathrm{w})C}{Y}\frac{nY}{(1-n)Y^*} \to 0 \\ \alpha^e_{C,F} &= \frac{(1-\mathrm{w})(1-\xi^e)n_k k_y}{\xi_e}\frac{nY}{(1-n)Y^*} \to 0 \\ \alpha^*_G &= \frac{G^*}{Y^*} \\ \alpha^*_{I,F} &= \frac{\mathrm{w}^*_I I^*}{Y^*} \to \frac{I^*}{Y^*} \\ \alpha_{I,F} &= \frac{(1-\mathrm{w}_I)I}{Y^*}\frac{nY}{(1-n)Y^*} \to 0 \end{aligned}$$

Thus we see that from the viewpoint of the ROW our SOE becomes invisible, but not vice versa. Exports to and imports from the ROW are now modelled explicitly in a way that captures all the interactions between shocks in the ROW and the transmission to the SOE.

2.8 Calibration

2.8.1 Home Bias Parameters

The bias parameters we need to calibrate are: ω, ω^*, ω_I and ω_I^*. Let in the steady state $C^e = s_e C$ be consumption by entrepreneurs, and $c_y = \frac{C}{Y}$. Let $cs_{imports}$ be the GDP share of imported consumption of the foreign (F) consumption good. Let $cs_{exports}$ be the GDP share of exports of the home (H) consumption good. Then we have that

$$\begin{aligned}
\alpha_{C,H} &= \frac{C_H}{Y} = \frac{\omega C}{Y} = (c_y - cs_{imports})(1 - s_e) \\
\alpha_{C,H}^e &= \frac{C_H{}^e}{Y} = \frac{\omega C^e}{Y} = (c_y - cs_{imports})s_e \\
\alpha_{C,H}^* &= \frac{C_H^*}{Y} = \frac{(1-\omega^*)C^*}{Y^*}\frac{Y^*}{Y} = cs_{exports}
\end{aligned}$$

Similarly for investment define $is_{imports}$ to be the GDP share of imported investment of the F investment and $is_{exports}$ be the GDP share of exports of H investment good. Then with $i_y = \frac{I}{Y}$, we have

$$\begin{aligned}
\alpha_{I,H} &= \frac{I_H}{Y} = \frac{\omega_I I}{Y} = i_y - is_{imports} \\
\alpha_{I,H}^* &= \frac{I_H^*}{Y} = \frac{(1-\omega_I^*)I^*}{Y^*}\frac{Y^*}{Y} = is_{exports}
\end{aligned}$$

in the steady state. We linearize around a zero trade balance $TB = 0$, so we require

$$cs_{imports} + is_{imports} = cs_{exports} + is_{exports} \tag{64}$$

in which case $\alpha_{C,H} + \alpha_{C,H}^e + \alpha_{C,H}^* + \alpha_{I,H} + \alpha_{I,H}^* = c_y + i_y$ as required. Thus we can use trade data for consumption and investment goods, consumption shares and relative per capita GDP to calibrate the bias parameters ω, ω^*, ω_I and ω_I^*. We need the home country biases elsewhere in the model, but for the ROW we simply put $\omega^* = \omega_I^* = 1$ everywhere else, so these biases are not required as such.

2.8.2 Calibration of Household Preference Parameters

We now show how observed data on the household wage bill as a proportion of total consumption, real money balances as a proportion of consumption and estimates of the elasticity of the marginal utility of consumption with respect to total money balances can be used to calibrate the preference parameters ϱ, b and θ in (59).

Calibrating parameters to the BG steady state, we first note that from (21) we have

$$\frac{(\eta-1)}{\eta}\frac{W(1-L)}{PC} = \frac{\varrho\Phi}{C\Phi_C(1-\varrho)} \tag{65}$$

In (65), $\frac{WL}{PC}$ is the household wage bill as a proportion of total consumption, which is observable. From the definition of Φ in (60), we have that

$$\frac{\Phi}{C\Phi_C} = \frac{(1-b)cz^{\frac{1-\theta}{\theta}}+b}{b} \tag{66}$$

where $cz \equiv \frac{C(1-h_C)}{Z}$ is the 'effective-consumption' –real money balance ratio (allowing for external habit). From (59), the elasticity the marginal utility of consumption with respect to total money balances, Ψ say is given by

$$\frac{ZU_{CZ}}{U_C} \equiv \Psi = \frac{(1-b)[(1-\varrho)(1-\sigma)-1+\frac{1}{\theta}}{bcz^{\frac{\theta-1}{\theta}}+1-b} \tag{67}$$

From the first-order conditions in the steady state (**??**) and (**??**) with $R_n = R_n^* = R$ we have

$$\frac{b(1-h_C)}{1-b}cz^{-\frac{1}{\theta}} = \frac{1+R}{R} \tag{68}$$

Thus given σ, β, g, h_C, $\frac{W(1-L)}{PC}$, cz and Ψ, equations (65)–(68) can be solved for ϱ, b and θ. The calculations for these parameters for the calibrated values of σ, β, g, h_C, $\frac{W(1-L)}{PC}$ and cz are out in Batini *et al.* (2010).[18] of $\Psi \in [0, 0.01]$. Since $\Psi > 0$ we impose on our calibration the property that money and consumption are *complements.*

2.8.3 Remaining Parameters

As far as possible parameters are chosen based on quarterly data for India. Full details are provided in Batini *et al.* (2010). Estimates for shocks are taken from Gabriel *et al.* (2011). Elsewhere the parameters reflect broad characteristics of emerging economies. For emerging economies more generally and for parameters related to the financial accelerator we use Yang (2008), Gertler *et al.* (2003) and Bernanke *et al.* (1999). The rest of the world is represented by US data. Here we draw upon Levin *et al.* (2006). In places we match Indian with European estimates using Smets and Wouters (2003).

3 Monetary Policy Interest Rate Rules

In line with the literature on open-economy interest rate rules (see, for example, Benigno and Benigno (2004)), we assume that the central bank in the emerging market bloc has

[18] See Woodford (2003), chapter 2 for a discussion of this parameter.

three options : (i) set the nominal interest to keep the exchange rate fixed (fixed exchange rates, 'FIX'); (ii) set the interest rate to track deviations of domestic or CPI inflation from a predetermined target (inflation targeting under fully flexible exchange rates, 'FLEX(D)' or 'FLEX(C)'); or, finally (iii) follow a hybrid regime, in which the nominal interest rates responds to both inflation deviations from target and exchange rate deviations from a certain level (managed float, 'HYB'). Many emerging market countries follow one or another of these options and most are likely to in the near future. Formally, the rules are:

Fixed Exchange Rate Regime, 'FIX'. In a simplified model without an exchange rate premium analyzed in section 4 we show this is implemented by

$$r_{n,t} = r^*_{n,t} + \theta_s s_t \tag{69}$$

where any $\theta_s > 0$ is sufficient to the regime. In our full model with an exchange rate premium, we implement 'FIX' as a 'HYB' regime below, with feedback coefficients chosen to minimize a loss function that includes a large penalty on exchange rate variability. (Note that values for the loss function reported below remove the latter contribution).
Inflation Targets under a Fully Flexible Exchange Rate, 'FLEX(D)' or 'FLEX(C)'. This takes the form of Taylor rule with domestic or CPI inflation and output targets:

$$r_{n,t} = \rho r_{n,t-1} + \theta_\pi \pi_{H,t} + \theta_y y_t \tag{70}$$

$$r_{n,t} = \rho r_{n,t-1} + \theta_\pi \pi_t + \theta_y y_t \tag{71}$$

where $\rho \in [0, 1]$ is an interest rate smoothing parameter.
Managed Float, 'HYB'. In this rule the exchange rate response is direct rather than indirect as in the CPI inflation rule, (71):[19]

$$r_{n,t} = \rho r_{n,t-1} + \theta_\pi \pi_{H,t} + \theta_y y_t + \theta_s s_t \tag{72}$$

In all cases we assume that the central bank and the fiscal authorities in the emerging market bloc enjoy full credibility. Although this assumption may have been considered heroic a few years ago, today there are several emerging market countries that have succeeded in stabilizing inflation at low levels and have won the trust of, including economies

[19] Rule (71) describes one of many possible specifications of a managed float, namely one where the central bank resists deviations of the exchange rate from a certain level–considered to be the equilibrium–as well as deviations of inflation from target and output from potential. An equally plausible specification involves a feedback on the rate of change of the exchange rate, in which case the central bank aim is to stabilize exchange rate volatility, i.e. the pace at which the domestic currency appreciates or depreciates over time. For a discussion see Batini *et al.* (2003). To limit the number of simulations and results to be compared, here we limit ourselves to one specification only.

with a history of high or hyper-inflation (e.g. Brazil, Israel, Peru and Mexico, among others. See Batini *et al.* (2006). Accounting for imperfect credibility of the central bank remains nonetheless important for many other emerging market countries, and can lead to higher stabilization costs than under full credibility (under inflation targeting and floating exchange rate, see Aoki and Kimura (2007) or even sudden stops and financial crises (under fixed exchange rates, see IMF (2005)).

4 Fiscal Rules

First we rewrite the government budget identity (53) in terms of the market price of bonds $\hat{B}_{G,t} = P^*_{B,t} B_{G,t}$ to give

$$\hat{B}_{G,t} = (1 + R_{n,t-1})\hat{B}_{G,t-1} + G_t - T_t \equiv \hat{B}_{G,t-1} - FS_t \tag{73}$$

where FS_t is the fiscal surplus. In terms of GDP ratios this can be written as

$$\frac{\hat{B}_{G,t}}{P_{H,t}Y_t} = (1 + R_{g,t-1})\frac{\hat{B}_{G,t-1}}{P_{H,t}Y_t} + \frac{G_t}{P_{H,t}Y_t} - \frac{T_t}{P_{H,t}Y_t} \equiv \frac{\hat{B}_{G,t-1}}{P_{H,t}Y_t} - \frac{FS_t}{P_{H,t}Y_t} \tag{74}$$

defining a growth-adjusted real interest rate $R_{g,t-1}$ over the interval $[t-1, t]$ by

$$1 + R_{g,t-1} = \frac{1 + R_{n,t-1}}{(1 + \pi_{H,t})(1 + \Delta y_t)} \tag{75}$$

where $\pi_{H,t} \equiv \frac{P_{H,t} - P_{H,t-1}}{P_{H,t-1}}$ is the home price inflation rate and $\Delta y_t \equiv \frac{Y_t - Y_{t-1}}{Y_{t-1}}$ is output growth.

Given a target steady-state government debt-to-GDP ratio $\frac{\hat{B}_G}{P_H Y}$, the steady state primary (PS) and overall fiscal surpluses are given by

$$\frac{PS}{P_H Y} \equiv \frac{(T - G)}{P_H Y} = R_g \frac{\hat{B}_G}{P_H Y} \tag{76}$$

$$\frac{FS}{P_H Y} = \left(\frac{1}{(1 + \pi_H)(1 + g_y)} - 1 \right) \frac{\hat{B}_G}{P_H Y} \tag{77}$$

Thus if inflation and growth are zero the steady state fiscal surplus is zero, but if inflation and/or growth are positive, then a steady state *fiscal deficit* (but positive primary surplus) is sustainable.

In the exercises that follow fiscal policy is carried out in using a component of taxation as the instrument, keeping government spending exogenous. Since it is desirable to avoid frequent changes of distortionary taxes, our chosen tax instrument consists of lump-sum tax receipts paid by Ricardian households $(1 - \lambda)TL_{2,t}$ minus lump-sum transfers to constrained households $\lambda TL_{1,t}$. Thus we have

$$T_t^I = (1 - \lambda)\mathrm{TL}_{2,t} - \lambda \mathrm{TL}_{1,t} \tag{78}$$

All other tax rates are kept fixed at their steady-state values.[20]

We consider tax rules that acknowledge the following: while interest rates can be set very frequently, often monthly, fiscal policy is set less frequently and involves an implementation lag. We assume in fact that the fiscal authority set tax rates every two periods (quarters in our calibration) whereas the central bank changes the nominal interest rate every period. This means in quarter t, a state-contingent fiscal policy can only respond to outcomes in quarter $t-1$ or earlier. It follows that the fiscal instrument Taylor-type (fixed feedback) commitment rule that is compatible with a two-period fiscal plan must take one of two forms

$$T_t^I = f(\mathsf{X}_{t-1}) \tag{79}$$

$$T_t^I = f(E_{t-1}(\mathsf{X}_t)) \tag{80}$$

where X_t is a vector of macroeconomic variables that define the simple fiscal rule. We can express the rule in terms of adjustments to the two groups of households by writing (78) in linear-deviation form

$$t_t^I = -\frac{\lambda \mathrm{TF}_1}{T^I}\mathrm{tl}_{1,t} + \frac{(1-\lambda)\mathrm{TF}_2}{T^I}\mathrm{tl}_{2,t} \tag{81}$$

where $t_t^I = \frac{T_t^I - T^I}{T^I}$, $\mathrm{tl}_{1,t} = (TL_{1,t} - TF_1)/TF_1$ etc are proportional changes in tax receipts relative to steady state values.

What now remains is to assign the adjustment of the lump-sum tax on the Ricardian group 2 and the transfer to the constrained group 1. We assume a '*shared burden or gain principle*' that as lump-sum rates rise (or fall) then transfers must fall (or rise). Thus we have

$$\mathrm{tl}_{1,t} - p_{H,t-1} = -\frac{k}{1-k}(\mathrm{tl}_{2,t} - p_{H,t-1}) \tag{82}$$

$$\mathrm{tl}_{1,t} - E_{t-1}p_{H,t} = -\frac{k}{1-k}(\mathrm{tl}_{2,t} - E_{t-1}p_{H,t}) \tag{83}$$

corresponding to forms (79) and (80) respectively. Thus fiscal expansion (contraction) involves reducing (increasing) real taxes for group 2 and increasing (reducing) real transfers to group 1. If $k=0$ all the adjustment is borne by the unconstrained second group and if $k=1$ by the constrained first group. In our results we put $k=0.5$. It remains to specify the rule for $tl_{2,t}$.

[20] An alternative instrument choice would be government spending. In our welfare-based analysis, this would require us to model the welfare implications of changes in government spending. We have chosen not to undertake this approach, but we anticipate that the results would not change dramatically.

The form of our fiscal rule is fairly standard: real tax receipts as a proportion of GDP feeds back on government debt as a proportion of GDP, $\frac{\hat{B}_{G,t}}{P_{H,t}Y_t}$, and output, Y_t. Denoting $b_{G,t} = \frac{\hat{B}_{G,t}}{P_{H,t}Y_t} - \frac{\hat{B}_G}{P_H Y}$, the fiscal rule in linearized form corresponding to (79) and (80) is

$$\mathrm{tl}_{2,t} = p_{H,t-1} + (1+\alpha_y)y_{t-1} + \alpha_{bg}b_{G,t-1} \tag{84}$$

$$\mathrm{tl}_{2,t} = E_{t-1}[p_{H,t} + (1+\alpha_y)y_t + \alpha_{bg}b_{G,t}] \tag{85}$$

5 Imposing the Nominal Interest Rate Zero Lower Bound

We now modify our interest-rate rules to approximately impose an interest rate ZLB so that this event hardly ever occurs. Although so far only a few emerging market countries have experienced deflationary episodes (Peru and Israel in 2007 are examples of this), most inflation-targeting emerging market countries have chosen low single digit inflation targets (see IMF, 2005), which makes the design of rules robust to ZLB problems germane. Our quadratic approximation to the single-period loss function can be written as $L_t = \mathsf{y}_t' Q \mathsf{y}_t$ where $\mathsf{y}_t' = [\mathsf{z}_t', \mathsf{x}_t']'$ and Q is a symmetric matrix. As in Woodford (2003), chapter 6, the ZLB constraint is implemented by modifying the single period welfare loss to $L_t + w_r r_{n,t}^2$. Then following Levine *et al.* (2007), the policymaker's optimization problem is to choose w_r and the unconditional distribution for $r_{n,t}$ (characterized by the steady state variance) shifted to the right about a new non-zero steady state inflation rate and a higher nominal interest rate, such that the probability, p, of the interest rate hitting the lower bound is very low. This is implemented by calibrating the weight w_r *for each of our policy rules* so that $z_0(p)\sigma_r < R_n$ where $z_0(p)$ is the critical value of a standard normally distributed variable Z such that prob $(Z \leq z_0) = p$, $R_n = \frac{1}{\beta(1+g_{u_c})} - 1 + \pi^*$ is the steady state nominal interest rate, $\sigma_r^2 = \mathrm{var}(r_n)$ is the unconditional variance and π^* is the new steady state inflation rate. Given σ_r the steady state positive inflation rate that will ensure $r_{n,t} \geq 0$ with probability $1-p$ is given by[21]

$$\pi^* = \max[z_0(p)\sigma_r - \left(\frac{1}{\beta(1+g_{u_c})} - 1\right) \times 100, 0] \tag{86}$$

[21]If the inefficiency of the steady-state output is negligible, then $\pi^* \geq 0$ is a credible new steady state inflation rate. Note that in our LQ framework, the zero interest rate bound is very occasionally hit. Then interest rate is allowed to become negative, possibly using a scheme proposed by Gesell (1934) and Keynes (1936). Our approach to the ZLB constraint (following Woodford, 2003) in effect replaces it with a nominal interest rate variability constraint which ensures the ZLB is hardly ever hit. By contrast the work of a number of authors including Adam and Billi (2007), Coenen and Wieland (2003), Eggertsson and Woodford (2003) and Eggertsson (2006) study optimal monetary policy with commitment in the face of a non-linear constraint $i_t \geq 0$ which allows for frequent episodes of liquidity traps in the form of $i_t = 0$.

In our linear-quadratic framework we can write the intertemporal expected welfare loss at time $t = 0$ as the sum of stochastic and deterministic components, $\Omega_0 = \tilde{\Omega}_0 + \bar{\Omega}_0$. Note that $\bar{\Omega}_0$ incorporates in principle the new steady state values of all the variables; however the NK Phillips curve being almost vertical, the main extra term comes from the π^2 term in (**??**). By increasing w_r we can lower σ_r thereby decreasing π^* and reducing the deterministic component, but at the expense of increasing the stochastic component of the welfare loss. By exploiting this trade-off, we then arrive at the optimal policy that, in the vicinity of the steady state, imposes the ZLB constraint, $r_t \geq 0$ with probability $1 - p$.

6 The Financial Accelerator and Model Variants

We parameterize the model according to three alternatives, ordered by increasing degrees of frictions:

- **Model I**: no financial accelerator and no liability dollarization. ($\chi_\theta = \chi_\theta^* = 0$, $\Theta = \Theta^* = 0$, $\epsilon_p = \epsilon_p^* = 0$, $\varphi = 1$). This is a fairly standard small open-economy model similar to many in the New Keynesian open-economy literature with the only non-standard features being a non-separable utility function in money balances, consumption, and leisure consistent with a balanced growth path and a fully articulated ROW bloc;

- **Model II**: financial accelerator (FA) only; ($\chi_\theta, \chi_\theta^* < 0$, $\Theta, \Theta^* > 0$, $\epsilon_p, \epsilon_p^* \neq 0$, $\varphi = 1$).

- **Model III**: financial accelerator (FA) and liability dollarization (LD), assuming that firms borrow a fraction of their financing requirements $1-\varphi \in [0, 1]$ in dollars.($\chi_\theta, \chi_\theta^* < 0$, $\Theta, \Theta^* > 0$, $\epsilon_p, \epsilon_p^* \neq 0$, $\varphi \in [0, 1)$)

To understand how the transmission of policy and shocks for different levels of frictions and dollarization, we need first to take a step back and illustrate some of the mechanisms driving the real exchange rate, and the behavior of net worth of the wholesale firms sector.

6.1 Departures from UIP

Movements in the real exchange rate (and the related terms of trade) are critical for understanding our results. Linearization of the modified UIP condition (22) gives

$$rer_t = E_t rer_{t+1} + E_t(r_t^* - r_t) - \delta_r b_{F,t} + \epsilon_{UIP,t} \tag{87}$$

Solving (87) forward in time we see that the real exchange rate is a sum of future expected real interest rate differentials with the ROW plus a term proportional to the sum of future expected net liabilities plus a sum of expected future shocks $\epsilon_{UIP,t}$. The real exchange will depreciate (a rise in rer_t) if the sum of expected future interest rate differentials are positive and/or the sum of expected future net liabilities are positive and/or a positive shock to the risk premium, $\epsilon_{UIP,t}$ occurs.

6.2 The Financial Accelerator

Also crucial to the understanding of the effects of the FA and LD is the behaviour of the net worth of the wholesale sector. In linearized form this is given by

$$\begin{aligned} n_t &= \frac{\xi_e}{1+g}\Big[\frac{1}{n_k}r^k_{t-1} + (1+\Theta)(1+R)n_{t-1} \\ &+ \left(1-\frac{1}{n_k}\right)\left[(1+R)\theta_{t-1} + (1+\Theta)(\varphi r_{t-1} + (1-\varphi)(r^*_{t-1} + (1+R)(rer_t - rer_{t-1})\right]\Big] \end{aligned} \quad (88)$$

where the ex post real interest rates in period $t-1$ are in linearized form defined as

$$r_{t-1} = r_{n,t-1} - (1+R)\pi_t \quad (89)$$

$$r_{t-1}{}^* = r^*_{n,t-1} - (1+R)\pi^*_t \quad (90)$$

and where the ex ante cost of capital is given by r^k_{t-1}. In (88) since leverage $\frac{1}{n_k} > 1$ we can see that net worth increases with the ex post return on capital at the beginning of period t, r^k_{t-1}, and decreases with the risk premium θ_{t-1} charged in period $t-1$ and the the ex post cost of capital in home currency and dollars, $\varphi r_{t-1} + (1-\varphi)(r^*_{t-1} + (1+R)(rer_t - rer_{t-1}))$, noting that $(rer_t - rer_{t-1})$ is the real depreciation of the home currency.

Starting at the steady state at $t = 0$, from (88) at $t = 1$ we have

$$n_1 = \frac{\xi_e}{1+g}\left[(1-\delta)q_1 + \left(1-\frac{1}{n_k}\right)(1+\Theta)[(1-\varphi)(1+R)rer_1 - \varphi\pi_1 - (1-\varphi)\pi^*_1]\right] \quad (91)$$

Thus net worth falls if Tobin's Q falls and if some borrowing is in dollars ($\varphi < 1$), we see that a *depreciation* of the real exchange rate ($rer_1 > 0$) brings about a further drop in net worth. However an *appreciation* of the real exchange rate ($rer_1 < 0$) will offset the drop in net worth. Finally net worth also falls the domestic and foreign inflation rates fall and thereby increase the ex post real interest rates and therefore the ex post cost of capital. If net worth falls, output also falls through two channels: first, a drop in Tobin's Q and a subsequent fall in investment demand and second, through a reduction in consumption demand by entrepreneurs.

Finally we confirm that for a fixed exchange rate regime with $r_{n,t} = r^*_{n,t}$ (i.e., no financial friction in the international bond market) liability dollarization has no impact on net worth. For this regime $rer_t = p^*_t - p_t$ and therefore $\Delta rer_t = \pi^*_t - \pi_t$. Then it is straightforward to show that (88) becomes

$$\begin{aligned} n_t &= \frac{\xi_e}{1+g}\Big[\frac{1}{n_k}r^k_{t-1} + (1+\Theta)(1+R)n_{t-1} \\ &+ \left(1-\frac{1}{n_k}\right)[(1+R)\theta_{t-1} + (1+\Theta)r_{t-1}]\Big] \end{aligned} \tag{92}$$

which corresponds to the accumulation of net worth in the absence of LD.

6.3 A Credit Crunch: Impulse Responses to a Risk Premium Shock

Further insights into monetary and fiscal policy transmission mechanisms with a financial accelerator can be obtained from impulses following an unanticipated 1% risk premium shock with AR1 process $\epsilon_{P,t+1} = 0.95\epsilon_{P,t}$. We confine ourselves to very simple ad hoc rules of the form

$$r_{n,t} = \rho r_{n,t-1} + (1-\rho)(\theta_\pi \pi_{H,t} + \theta_y y_t) \tag{93}$$

$$\mathrm{tl}_{2,t} = p_{H,t} + \alpha_{bg} b_{G,t-1} \tag{94}$$

$$\mathrm{tl}_{1,t} = p_{H,t} \tag{95}$$

Thus the real transfers to non-Ricardian households are held fixed and the implementation lag problem is ignored. Figure 1 shows various impulse response functions for the three model variants. For model III with LD we choose a modest degree of foreign currency borrowing with $\varphi = 0.9$. Fiscal policy only impacts on government debt and is otherwise independent of the parameter α_{bg}. For the monetary Taylor rule we choose the following parameters: $\rho = 0.74$, $\theta_\pi = 1.67$, $\theta_y = 0.39$ which are in the standard range for estimated rules.

Following the 1% risk premium shock ($\epsilon_{P,0} = 1$) there is an immediate output rise which is driven by the immediate increase in demand following the fall in the terms of trade. This occurs because the commitment rule promises a drawn out period where the nominal interest rate is below the foreign rate and so the nominal exchange rate depreciates. The increase in the cost of capital drives Tobin's Q down and investment falls. However installation costs ensure this negative demand effect is gradual; after a few quarters it begins to dominate the terms of trade effect on demand and output starts to fall. Net worth falls as a result of the increase in the cost of capital and the FA accentuates both these effects. The FA plus the LD accentuates these further and in turn 'accelerates' the fall in output and investment.

7 Optimal Monetary and Fiscal Policy with Financial Frictions

How do financial frictions in emerging market economies affect the transmission mechanism of monetary and fiscal policy and the subsequent contributions of each to stabilization in the face of shocks? To answer this question we parameterize three representations of the model with increasing frictions and solve them subject to the corresponding optimal monetary and fiscal policy rules based on maximizing the household's utility. This then provides a benchmark against which to assess the welfare implications of the fixed-exchange rate regime and various Taylor-type flexible exchange rate rules alongside the fiscal policy.

7.1 The Welfare Criteria

We adopt a linear-quadratic framework for the optimization problem facing the monetary authority. This is particularly convenient as we can then summarize outcomes in terms of unconditional (asymptotic) variances of macroeconomic variables and the local stability and determinacy of particular rules. The framework also proves useful for addressing the issue of the zero lower bound on the nominal interest rate.

Following Woodford (2003), we adopt a 'small distortions' quadratic approximation to the household's single period utility which is accurate as long as the zero-inflation steady state is close to the social optimum. There are three distortions that result in the steady state output being below the social optimum: namely, output and labour market distortions from monopolistic competition and distortionary taxes required to pay for government-provided services. Given our calibration these features would make our distortions far from small. However there is a further distortion, external habit in consumption, that in itself raises the equilibrium steady state output above the social optimum. If the habit parameter h_C is large enough the two sets of effects can cancel out and thus justify our small distortions approximation. In fact this is the case in our calibration.[22]

Results obtained below are for a single-period quadratic approximation $L_t = \mathsf{y}_t' Q \mathsf{y}_t$ obtained numerically following the procedure set out in Batini *et al.* (2010). Insight into the result can be gleaned from the special case where there are no oil inputs into production or consumption. Then the quadratic approximation to the household's intertemporal expected loss function is given by

$$\Omega_0 = E_t \left[(1-\beta) \sum_{t=0}^{\infty} \beta^t L_t \right] \tag{96}$$

[22]See Levine *et al.* (2007) and Levine *et al.* (2008) for a discussion of these issues. The former paper provides details of all the optimization procedures in this paper.

where

$$\begin{aligned}
2L_t &= w_c \left(\frac{c_t - h_C c_{t-1}}{1-h_C}\right)^2 + w_\tau \tau_t^2 + w_{cl}\left(\frac{c_t - h_C c_{t-1}}{1-h_C}\right) l_t + w_l l_t^2 \\
&+ w_k (k_{t-1} - l_t)^2 - w_{ay} y_t a_t + w_{ci\tau} ci_t \tau_t + w_{cls\tau} cls_t \tau_t + w_\pi \pi_{H,t}^2 \qquad (97) \\
ci_t &\equiv \mu\omega(1-\omega) c_y c_t + \mu(1-\omega^*) c_y c_t^* + \rho_I \omega_I (1-\omega_I) i_y i_t + \rho_I^* (1-\omega_I^*) i_y i_t^* \\
cls_t &\equiv [(1-\sigma)(1-\varrho)-1]\frac{c_t^* - h c_{t-1}^*}{1-h} - (1-\sigma)\varrho \frac{L^* l_t^*}{1-L^*}
\end{aligned}$$

and the weights w_c, w_τ, etc are defined in Batini *et al.* (2010). Thus from (97) welfare is reduced as a result of volatility in consumption adjusted to external habit, $c_t - h_C c_{t-1}$; the terms of trade, τ_t, labour supply l_t, domestic inflation $\pi_{H,t}$ and foreign shocks. There are also some covariances that arise from the procedure for the quadratic approximation of the loss function. The policymaker's problem at time $t = 0$ is then to minimize (96) subject to the model in linear state-space form given by (61), initial conditions on predetermined variables z_0 and the Taylor rule followed by the ROW. Our focus is on stabilization policy in the face of stochastic shocks, so we set $z_0 = 0$.[23] The monetary instruments is the nominal interest rate and the fiscal instrument consists of lump-sum taxes net of transfers. By confining fiscal policy to lump-sum taxes on Ricardian households only we eliminate its stabilization contribution; this we refer to as 'monetary policy alone'. Details of the optimization procedure are provided in Levine *et al.* (2007).

We subject all three variants of the model to eight exogenous and independent shocks: total factor productivity (a_t), government spending (g_t) in both blocs; the external risk premium facing firms, $\epsilon_{P,t}$ in the home country; an oil shock; a risk premium shock to the modified UIP condition, $\epsilon_{UIP,t}$; and a shock to the foreign interest rate rule $\epsilon_{R,t}^*$. The foreign bloc is fully articulated, so the effect of these shocks impacts on the domestic economy through changes in the demand for exports, though since the domestic economy is small, there is no corresponding effect of domestic shocks on the ROW.

7.2 Policy in the Foreign Bloc

The foreign bloc is closed from its own viewpoint so we can formulate its optimal policy without any strategic considerations. Since our focus is on the home country we choose a standard model without a FA in the foreign bloc and very simple monetary and fiscal

[23]That is we choose the *conditional welfare* in the vicinity of the steady state as our criteria. It is in this sense that our policy exercise is for 'normal times'.

rules of the form

$$
\begin{aligned}
r^*_{n,t} &= \rho^* r^*_{n,t-1} + \theta^*_\pi \pi^*_{F,t} + \theta^*_y y^*_t + \epsilon^*_{r,t} && (98)\\
tl^*_{2,t} &= p^*_{F,t-1} + y^*_{t-1} + \alpha^*_{bg} b^*_{G,t-1} && (99)\\
\mathrm{tl}^*_{1,t} &= p^*_{F,t-1} - (\mathrm{tl}^*_{2,t} - p^*_{F,t-1}) && (100)
\end{aligned}
$$

Maximizing the quadratic discounted loss function in the four parameters $\rho^* \in [0,1]$, $\theta^*_\pi \in [1,10]$,[24] α^*_y, $\alpha^*_{bg} \in [0,\infty]$ and imposing a ZLB constraint in a way described in detail below for the home country, we obtain for the calibration in that bloc: $\rho^* = 1$, $\theta^*_\pi = 10$, $\theta^*_y = 0$ and $\alpha^*_{bg} = 0.87$. The optimized monetary rule then is of a difference or 'integral' form that aggressively responds to any deviation of inflation from its zero baseline but does not react to deviations of output.[25]

7.3 Optimal Policy without a ZLB Constraint

With the foreign bloc completely specified we turn to policy in the home country. Table 2 sets out the essential features of the outcome under optimal monetary and fiscal policy and their relative contributions to stabilization. There are no ZLB considerations at this stage. We report the the conditional welfare loss from fluctuations in the vicinity of the steady state for optimal monetary and fiscal policy and for monetary policy alone as we progress from model I without a financial accelerator (FA) to model III with the FA alongside liability dollarization (LD). We also report the long-run variance of the interest rate.

Model	M+F		M		c_e^{MF}
	Ω_0^{MF}	σ_r^2	Ω_0^M	σ_r^2	
I	3.26	2.35	3.35	2.82	0.006
II	3.48	5.01	3.97	4.08	0.034
III	13.92	8.38	15.34	7.89	0.099

Table 2. Welfare Outcomes under Optimal Policy: No ZLB Constraint

To assess the contribution of fiscal stabilization policy we calculate the welfare loss difference between monetary policy alone (Ω_0^M) and monetary and fiscal policy together (Ω_0^{MF}). From Batini *et al.* (2010) in consumption equivalent terms this is given by

$$
c_e^{MF} = \frac{(\Omega_0^M - \Omega_0^{F+M})}{(1-\varrho)(1-h_C)c_y} \times 10^{-2} \ (\%) \qquad (101)
$$

[24]We restrict our search to $\pi^*_\theta \in [1,10]$: the lower bound ensures the rule satisfies the 'Taylor Principle' for all ρ and the imposed upper bound avoids large initial jumps in the nominal interest rate.

[25]The latter feature is a common one in the DSGE literature - see, for example, Schmitt-Grohe and M.Uribe (2005).

The results appear to indicate that the stabilization role of fiscal policy is rather small, but increases as financial frictions are introduced. At most in model III with both a FA and LD the consumption equivalent contribution of fiscal policy is at most around 0.1%. However this conclusion is misleading because we have ignored the ZLB constraint. The high variances reported in Table 1 indicate a very frequent violation of this constraint in the model economies under these optimal policies.

7.4 Imposing the ZLB

Tables 3 imposes the ZLB constraint as described in the previous section. We first consider monetary policy alone. We choose $p = 0.001$. Given w_r, denote the expected intertemporal loss (stochastic plus deterministic components) at time $t = 0$ by $\Omega_0(w_r)$. This includes a term penalizing the variance of the interest rate which does not contribute to utility loss as such, but rather represents the interest rate lower bound constraint. Actual utility, found by subtracting the interest rate term, is given by $\Omega_0(0)$. The steady-state inflation rate, π^*, that will ensure the lower bound is reached only with probability $p = 0.001$ is computed using (86). Given π^*, we can then evaluate the deterministic component of the welfare loss, $\bar{\Omega}_0$. Since in the new steady state the real interest rate is unchanged, the steady state involving real variables are also unchanged, so from (97) we can write $\bar{\Omega}_0(0) = w_\pi \pi^{*2}$.[26]

The optimal policy under the constraint that the ZLB is violated with a probability $p = 0.001$ per period (in our quarterly model, once every 250 years) occurs when we put $w_r = 3.75$ and the steady state quarterly inflation rises to $\pi^* = 0.29$.

w_r	σ_r^2	$\tilde{\Omega}_0$	π^*	$\bar{\Omega}_0$	Ω_0
0.001	2.82	3.35	2.59	12.84	16.19
1.00	1.84	3.57	1.62	5.04	8.61
2.00	1.32	3.94	1.00	1.90	5.85
3.00	1.00	4.33	0.55	0.59	4.92
3.25	0.94	4.23	0.46	0.41	4.83
3.50	0.88	4.52	0.37	0.27	4.79
3.75	**0.83**	**4.61**	**0.29**	**0.17**	**4.77**
4.00	0.79	4.70	0.22	0.09	4.79

Table 3. Optimal Policy with a ZLB Constraint: Monetary Policy Only for Model I

[26] The ex ante optimal deterministic welfare loss that results from guiding the economy from a zero-inflation steady state to $\pi = \pi^*$ differ from $\bar{\Omega}_0(0)$ (but not by much because the steady-state contributions by far outweighs the transitional one)

Notation: $\pi^* = \max[z_0(p)\sigma_r - (\frac{1}{\beta(1+g_{u_c})} - 1) \times 100, 0] = \max[3.00\sigma_r - 2.44, 0]$ with $p =$ 0.001 probability of hitting the ZLB and $\beta = 0.99$, $g_{u_c} = -0.014$. $\bar{\Omega} = \frac{1}{2} w_\pi \pi^{*2} = 3.829\pi^{*2}$. $\Omega = \tilde{\Omega} + \bar{\Omega} =$ stochastic plus deterministic components of the welfare loss.

Table 4 repeats this exercise for monetary and fiscal policy together. With the benefit of fiscal stabilization policy the ZLB constraint is now more easily imposed at values $w_r = 0.5$ and without any rise in the inflation rate from its zero baseline value. Figure 1 presents the same results in graphical form with Figure 2 providing analogous results for Model III.

w_r	σ_r^2	$\tilde{\Omega}_0$	π^*	$\bar{\Omega}_0$	Ω_0
0.001	2.35	3.25	2.16	8.93	12.18
0.25	0.86	3.26	0.33	0.21	3.47
0.50	**0.55**	**3.27**	**0**	**0**	**3.27**
0.75	0.40	3.29	0	0	3.29
1.00	0.31	3.30	0	0	3.30

Table 4. Optimal Commitment with a ZLB Constraint. Monetary Plus Fiscal Policy for Model I

Finally in this subsection we return to the question of how much stabilization role there is for fiscal policy, but now with the ZLB imposed. Table 5 recalculates the consumption equivalent contribution of fiscal stabilization with a ZLB. We now find this contribution to be significant, rising from $c_e = 0.10\%$ to $c_e = 0.64\%$ as we move from Model I to Model III.

Model	M+F			M			c_e^{MF}
	Ω_0	σ_r^2	π^*	Ω_0	σ_r^2	π^*	
I	3.27	0.55	0.00	4.77	0.84	0.29	0.104
II	3.74	0.69	0.05	6.98	1.00	0.57	0.225
III	14.90	0.72	0.10	24.19	1.20	0.85	0.644

Table 5. Welfare Outcomes under Optimal Policy: ZLB Constraint

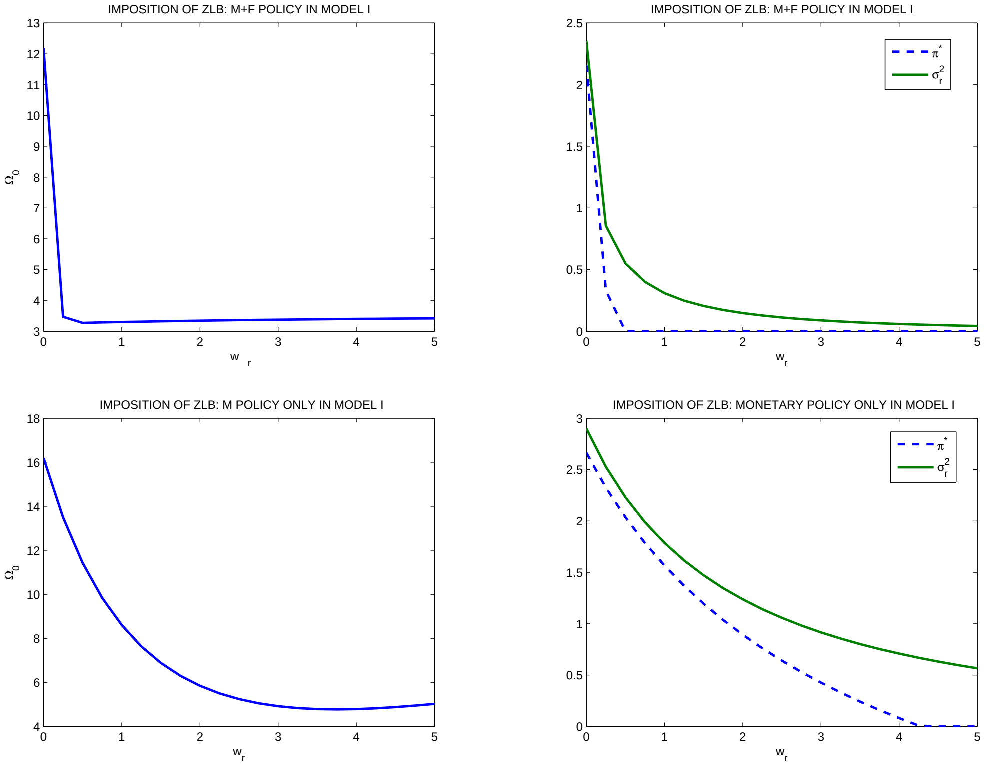

Figure 1: **Imposition of ZLB: Model I**

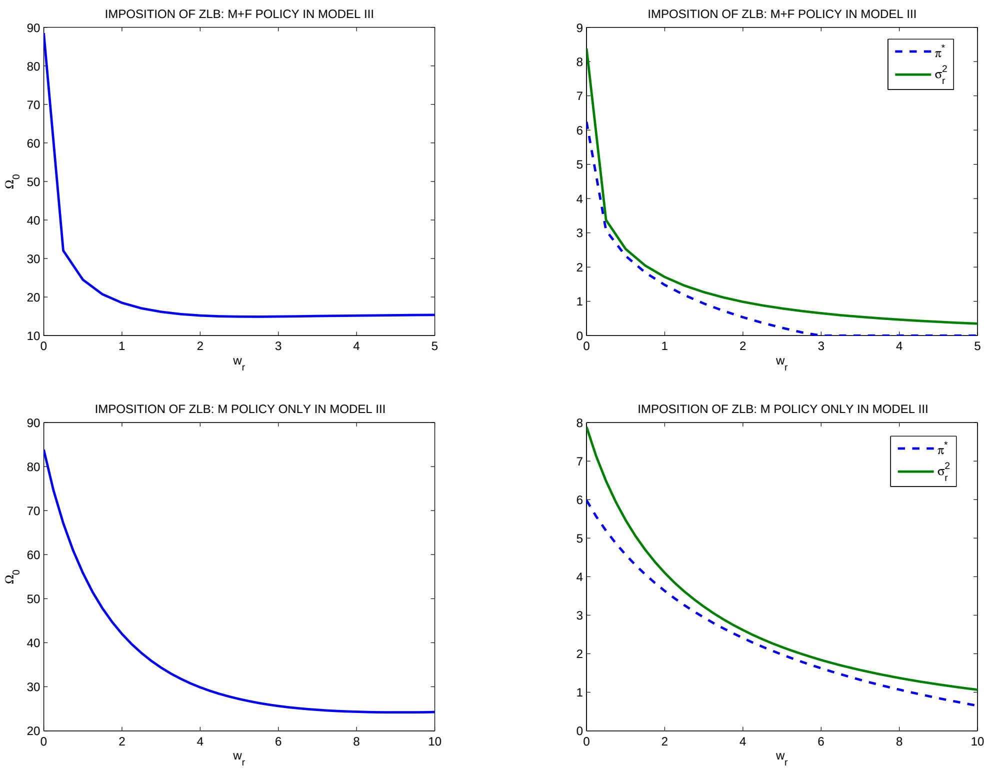

Figure 2: **Imposition of ZLB: Model III**

8 The Performance of Optimized Simple Rules

The optimal monetary and fiscal policy with commitment considered up to now can be implemented as feedback rules but, as now acknowledged in the literature, the form these take is complex and would not be easy to monitor (see for example, Levine and Currie (1987), Currie and Levine (1993), Woodford (2003)). This point has added force when the need for a planning horizon of more than one period for fiscal policy is introduced into policy design. We therefore turn to simple rules and examine the ranking of various options and the extent to which they can match the fully optimal benchmark. For monetary policy we examine two of the options discussed in section 3: FLEX(D) where the nominal interest rate responds to current domestic inflation, $\pi_{H,t}$ and output, y_t, as in (70); and the fixed exchange rate regime as in (69). In the first set of exercises the fiscal rule is the conventional type of the form (82) (with $k = 0.5$) and (84) which allow tax changes to be planned two periods ahead. We now maximize the quadratic discounted loss function in the five parameters $\rho \in [0, 1]$, $\theta_\pi \in [1, 10]$, θ_y, α_y, $\alpha_{bg} \in [0, 5]$ and impose the ZLB constraint as before.

	M+F				M				c_e^{MF}	c_e^{SIM}
	Ω_0	σ_r^2	π^*	$[\rho,\ \theta_\pi,\ \theta_y,\ \alpha_{bg},\ \alpha_y]$	Ω_0	σ_r^2	π^*	$[\rho,\ \theta_\pi,\ \theta_y]$		
I	5.05	0.86	0.34	$[1.0, 10.0, 0.00, 0.67, 3.08]$	5.87	0.96	0.50	$[1.0, 10.0, 0.05]$	0.06	0.12
II	13.18	1.74	1.51	$[1.0, 10.0, 0.05, 3.99, 1.86]$	13.65	1.77	1.55	$[1.0, 10.0, 0.01]$	0.03	0.66
III	44.75	3.64	3.28	$[1.0, 4.49, 0.30, 5.0, 2.63]$	58.21	4.68	4.05	$[1.0, 7.84, 0.00]$	0.93	2.07

Table 7. Welfare Outcomes under Optimized Simple Rules: FLEX(D) with a Fiscal Rule. Models I, II and III.

Table 7 summarizes the outcomes under this combination of rules. In addition to the the measure c_e^{MF} which as before quantifies the the contribution to welfare of fiscal stabilization in consumption equivalent terms, we provide a further measure of the costs of simplicity as opposed to implementing the fully optimal benchmark. Denoting the latter by OPT and any simple rule by SIM, this is given by

$$c_e^{SIM} = \frac{(\Omega_0^{SIM} - \Omega_0^{OPT})}{(1-\varrho)(1-h_C)c_y} \times 10^{-2} \ (\%) \tag{102}$$

Using this measure we see from Table 7 that the ability of the optimized simple rule to closely match the fully optimal benchmark deteriorates sharply as financial frictions are introduced rising from 0.12% in Model I to 0.66% and 2.07% in Models II and III respectively. The primary reason for this lies in the existence of a lower bound on σ_r^2 as w_r is increased. This is demonstrated in Figures 4 and 5.

What is the welfare cost of maintaining a fixed rate (FIX) and what are the implications of this regime for fiscal policy? We address these questions by introducing the interest rate rule (69) alongside the same simple fiscal rule as before. Table 8 sets out the outcome after imposing the ZLB.[27]. Under FIX there is no scope for trading off the variance of the nominal exchange rate with other macroeconomic variances that impact on welfare. Thus the *only* ways of reducing the probability of hitting the lower bound are to shift the stabilization burden onto fiscal policy or increase the steady state inflation rate. This imposes a very large welfare losses[28] in all models which as before increase as financial frictions are introduced. This feature is reflected in the very large costs of simplicity c_e^{MF} which rise from almost 5% to over 11% as we progress from model I to III. The higher values for the measure of the role of fiscal policy, c_e^{MF}, indicate the shift to fiscal means of stabilization.

Of course faced with these results there is an alternative of full dollarization, for example via a currency board, that would simply result in $r_{n,t} = r^*_{n,t}$ and the ZLB then ceases to be a concern for the domestic country. However this would still leave a significant welfare losses only slightly lower that those of the FIX regime. These can be calculated from the purely stochastic components of the welfare loss, $\tilde{\Omega}_0$ and the corresponding consumption equivalent measures $\tilde{c}_e^{MF}$ and $\tilde{c}_e^{SIM}$.

	M+F					M				c_e^{MF}	c_e^{SIM}	$\tilde{c}_e^{MF}$	$\tilde{c}_e^{SIM}$
	Ω_0	$\tilde{\Omega}_0$	σ_r^2	π^*	$[\alpha_{bg},\ \alpha_y]$	Ω_0	$\tilde{\Omega}_0$	σ_r^2	π^*				
I	73.8	73.7	0.81	0.26	[10.0, −0.01]	84.0	83.9	0.82	0.27	0.71	4.90	0.71	4.89
II	136.2	135.4	1.07	0.66	[6.35, −0.64]	152.9	152.1	1.05	0.63	1.16	9.19	1.16	9.14
III	175.2	165.8	2.42	2.22	[7.80, 0.64]	190.9	181.9	2.37	2.17	1.09	11.13	1.12	10.47

Table 8. Welfare Outcomes under Optimized Simple Rules: FIX with a Fiscal Rule. Models I, II and III.

[27]Note there is no 'optimal' FIX regime since the parameter θ_s is simply set at a value sufficiently high to ensure a fixed exchange rate.

[28]It is of interest to compare these losses with 'minimum stabilization' that stabilizes the model economy with a very low interest rate variability. One candidate for such a rule is $\Delta r_{n,t} = 0.01\pi_{H,t}$ alongside no fiscal stabilization. Then for model I we find $\Omega_0 = 101$, $\sigma_r^2 = 0.003$ and $c_e^{SIM} = 7.0\%$, an outcome rather worse than the FIX regime. Thus the latter provides *some* stabilization benefit.

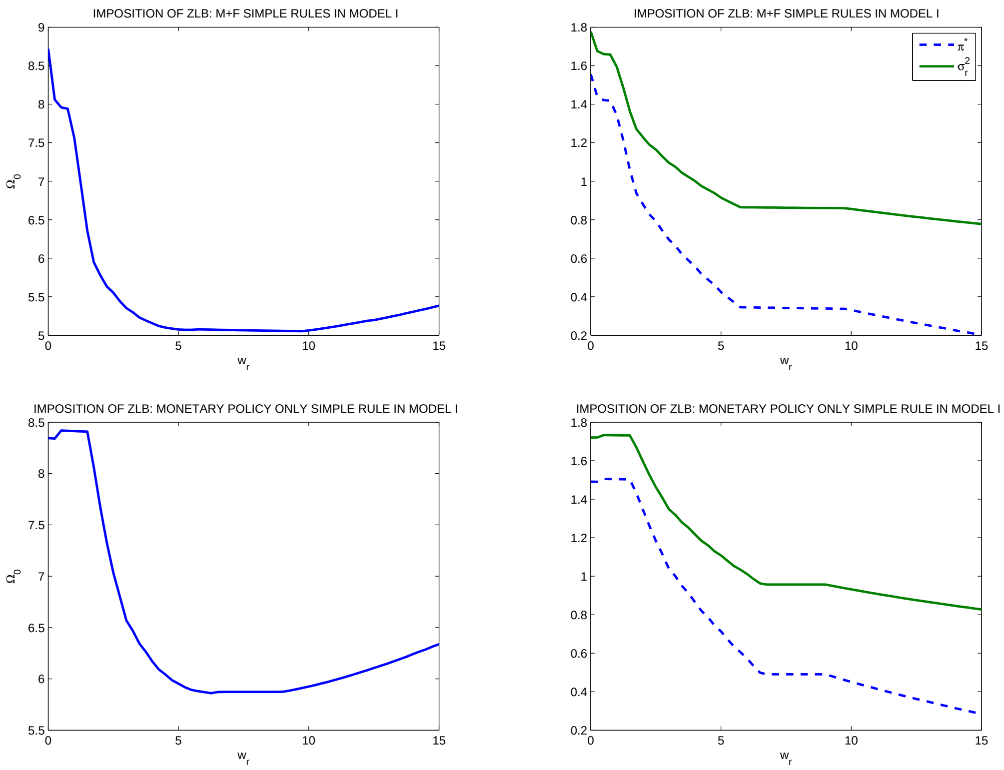

Figure 3: **Imposition of ZLB: Flex(D) Fiscal Rule, Model I**

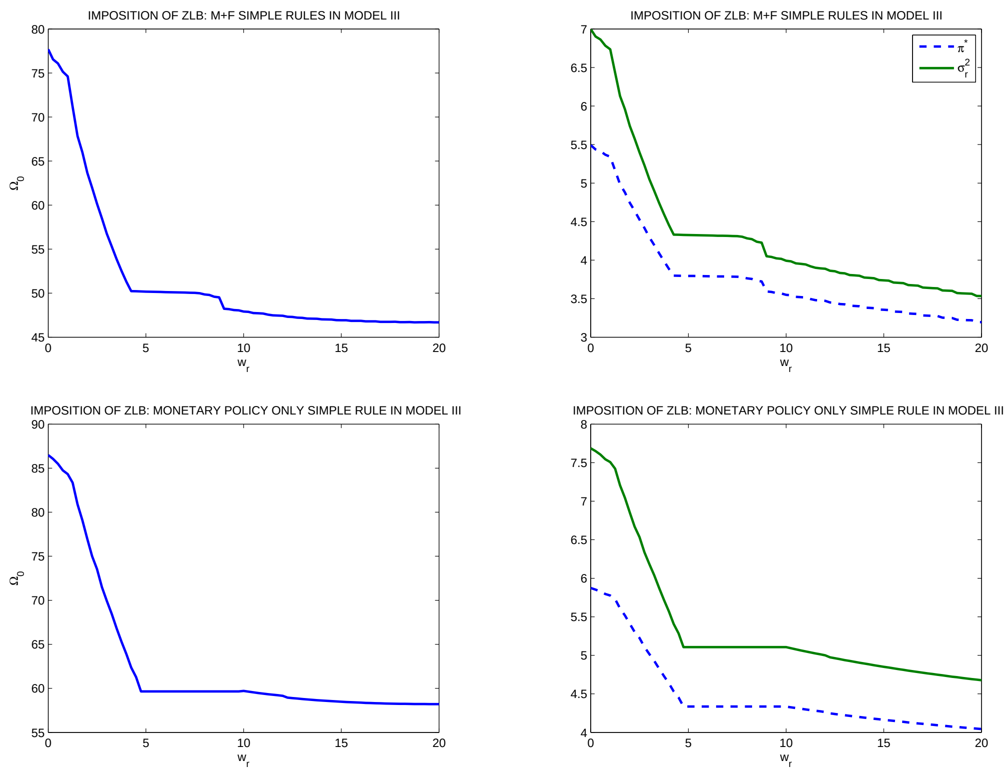

Figure 4: **Imposition of ZLB: Flex(D) Fiscal Rule, Model III**

We have now established that domestic inflation targeting, FLEX(D), alongside a counter-cyclical simple fiscal rule stabilizes the model economy far better than a fixed exchange rate regime. Two questions now remain: would a compromise 'managed float' of the type (72) improve upon FLEX(D)? How does CPI inflation targeting FLEX(C), the usual form of the target, compare with FLEX(D)?

Given the very poor performance of FIX one would not expect a hybrid regime to improve matters; nor do we expect a target that implicitly includes an element of an exchange rate target to outperform the domestic target. Indeed we find this to be the case. We find that the optimal feedback parameter in (72), θ_s with a ZLB imposed to be zero across all three models. Results for FLEX(C) are reported in Table 9. These confirm the FLEX(D) is vastly superior to FLEX(C); the costs of simplicity c_e^{SIM} now rise from 1.41% to 3.37% as we proceed from model I to model III compared with 0.12% to 2.07% for FLEX(D). CPI as opposed to domestic inflation targeting has a welfare cost of over a 1% permanent fall in consumption from the steady-state.

	M+F				M				c_e^{MF}	c_e^{SIM}
	Ω_0	σ_r^2	π^*	$[\rho,\ \theta_\pi,\ \theta_y,\ \alpha_{bg},\ \alpha_y]$	Ω_0	σ_r^2	π^*	$[\rho,\ \theta_\pi,\ \theta_y]$		
I	23.07	1.00	0.56	$[1.0, 3.66, 0.30, 4.68, 1.52]$	23.64	1.01	0.56	$[1.0, 2.48, 0.01]$	0.04	1.41
II	35.29	1.50	1.23	$[1.0, 2.45, 0.37, 5.00, 0.01]$	36.68	1.52	1.26	$[1.0, 2.63, 0.41]$	0.10	2.24
III	62.28	2.57	2.36	$[1.0, 1.29, 0.10, 5.0, 0.01]$	64.01	2.66	2.45	$[1.0, 1.39, 0.11$	0.12	3.37

Table 9. Welfare Outcomes under Optimized Simple Rules: FLEX(C) with a Fiscal Rule. Models I, II and III.

9 Conclusions

Our results provide broad support for the 'three-pillars' macroeconomic framework such as that pursued by many emerging economies in the form of an explicit inflation target, a floating exchange rate and a counter-cyclical fiscal rule as opposed to the monetary-fiscal policy stance of the Indian authorities. Domestic inflation targeting is superior to partially or fully attempting to stabilizing the exchange rate. Responding to the exchange rate explicitly or implicitly makes it more expensive in terms of output variability to stabilize inflation. A model corollary is that stabilizing domestic inflation (e.g., measured by changes in the producer price index) enhances welfare outcomes somewhat, since stabilizing changes in the consumer price index implies a partial response to the exchange rate via imported consumer goods.[29]

Financial frictions increase the costs of stabilizing the exchange rate, as shown in GGN and Batini et al. (2007), because the central bank cannot offset a drop in net worth by allowing the exchange rate to adjust. Emerging markets faced with financial frictions should thus 'fear to fix' rather than 'fear to float'.

Results for optimal monetary and fiscal policy compared with monetary stabilization alone indicate that potentially fiscal stabilization can have a significant role and more so if there are financial frictions. However the ability of best simple optimized counterpart to mimic the optimal policy deteriorates sharply as we first introduce the financial accelerator in model II and then liability dollarization in model III. This suggests that future research should explore alternative rules that respond to indicators of financial stress such as the risk premium facing firms in capital markets or the international risk premium facing households or the asset price (Tobin's Q in our model – see Bernanke and Gerler (1999)). Also relaxing the 'shared burden and gain principle' for the lump-sum tax on and the transfers to Ricardian and non-Ricardian households respectively, by choosing two separate rules would potentially improve the performance on the fiscal side. Furthermore, given the sharp deterioration of the stabilization performance of both optimal policy and optimized rules as LD is introduced, future developments of the model could usefully attempt to endogenize the decision to borrow in different currencies.[30] Finally, although we have drawn upon consistent Bayesian-ML estimates (BMLE) for shocks using Indian data for the core model, and US data for the ROW, a BMLE of all three variants of the model, using data from a number of emerging SOEs, would both indicate the empirical importance of various financial frictions and enhance our assessment of the implications for policy.[31]

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[29]This finding is inherent in the type of models employed by this chapter and does not suggest a different monetary policy objective, given that it is contingent on maximization of the utility of the representative agent as opposed to non-utility-based loss functions used elsewhere in the literature.

[30]Armas *et al.* (2006), chapter 2 provides some possible approaches to this challenge.

[31]See Castillo *et al.* (2006) for a BMLE assessment of transactions and price dollarization in a DSGE model fitted to Peruvian data.

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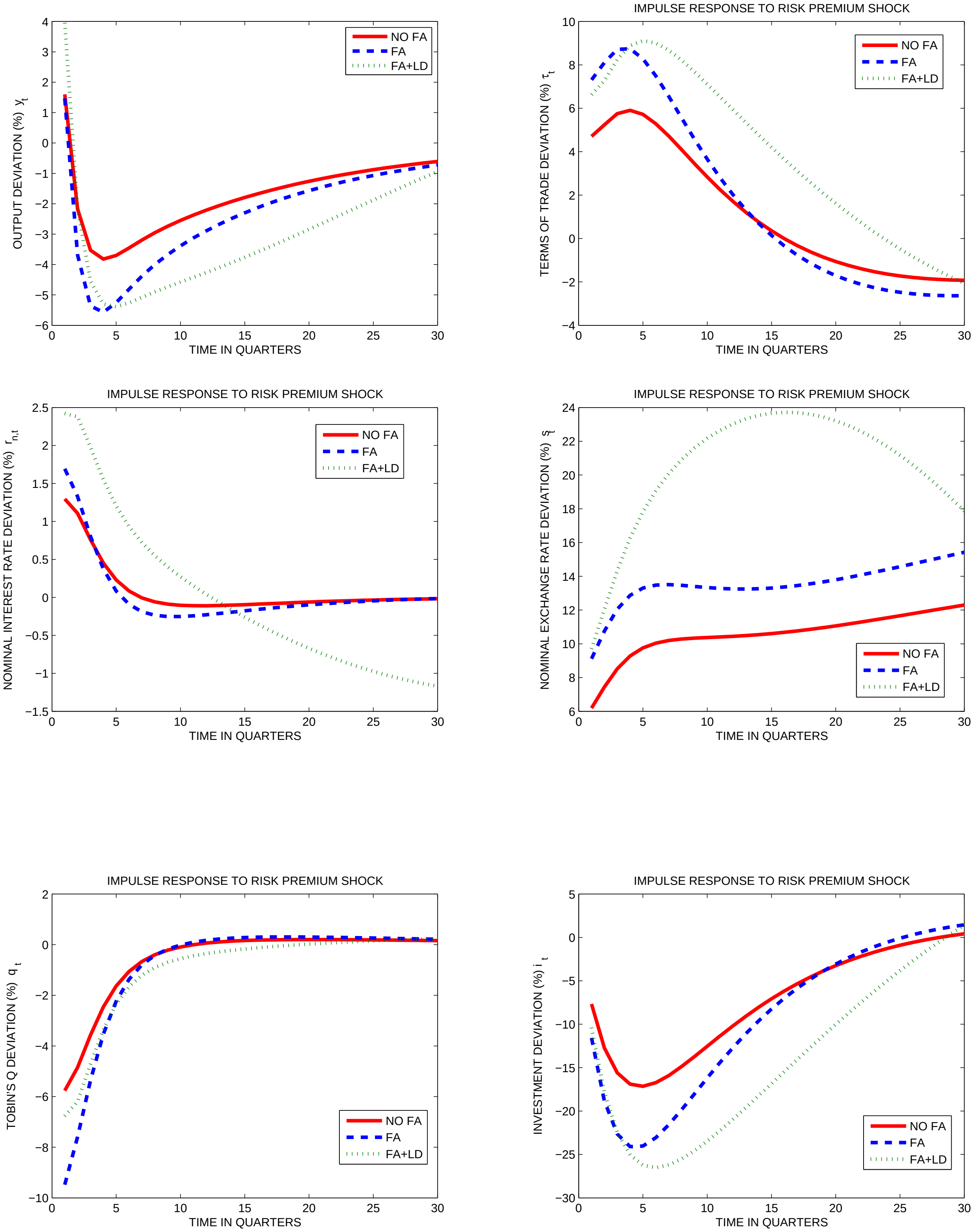

Figure 5: **A Credit Crunch: Impulse Responses to a 1% External Finance Premium AR1 Shock** $\epsilon_{P,t+1} = 0.95\epsilon_{P,t}$**.**