Country-Specific Risk Premium, Taylor Rules, and Exchange Rates*

Barbara Annicchiarico† University of Rome "Tor Vergata"

Alessandro Piergallini‡ SOAS, University of London

May 2007

Abstract

The adoption of a monetary policy rule and an inflation target for emerging market economies that choose a flexible exchange rate regime is often advocated. This paper investigates the issue of exchange rate determination when interest-rate feedback rules are implemented in a continuous-time optimizing model of a small open economy facing an imperfect global capital market. In this framework, the Taylor principle is not a necessary condition for determinacy of equilibrium. On the other hand, it is shown that exchange rate dynamics critically depends on whether monetary policy is active or passive.

JEL Classification: F31, F32, E52.

Keywords: Risk Premium on Foreign Debt; Taylor Rules; Exchange Rate Dynamics.

*We wish to thank Mikael Bask, Andrea Costa, Ester Faia, Laurence Harris, Giancarlo Marini, Giovanni Piersanti, Pasquale Scaramozzino and other participants at the II RIEF Conference on International Economics and Finance - University of Rome "Tor Vergata" for helpful comments and suggestions.

†Department of Economics, University of Rome 'Tor Vergata', Via Columbia 2, 00133 Roma, Italy. E-mail: barbara.annicchiarico@uniroma2.it.

‡*Corresponding Author*: Department of Financial and Management Studies (CeFiMS), SOAS, University of London, Thornhaugh Street, London WC1H 0XG, UK. E-mail: ap50@soas.ac.uk.

monetary theory. First, we investigate dynamic stability to evaluate whether uniqueness of equilibrium requires that the central bank reacts to inflation with a more than proportional increase in the nominal interest rate (the so-called 'Taylor principle'), as predicted by the standard theory on Taylor rules (e.g. Woodford 2003). Second, we reconsider the issue of exchange rate dynamics in response to exogenous changes in the domestic nominal interest rate, government spending, the level of productivity, the subjective discount rate, the foreign nominal interest rate and the foreign inflation rate.

As it emerges from the dynamic analysis, the Taylor principle is not a necessary condition for determinacy of equilibrium. 'Passive' interest rate policies, that underreact to inflation by increasing the nominal interest rate by less than a raise in domestic inflation, are compatible with saddle-path stability.

Despite the fact that saddle-path stability does not require an aggressive interest rate policy, the study of transitional dynamics we perform demonstrates that exchange rate adjustment in response to exogenous disturbances depends in a critical way on whether monetary policy is active or passive. In this respect, our analysis yields additional insights into the question of exchange rate determination.

The scheme of the paper is as follows. Section 2 presents the optimizing model and describes the monetary policy regimes. Section 3 derives the perfect-foresight macroeconomic equilibrium. Section 4 develops the steady-state analysis. Section 5 studies the stability properties of the setup and examines the issue of transitional dynamics. Section 6 concludes.

2 The Model

We consider a small open economy operating in a world of ongoing inflation and flexible exchange rates. The economy is described by a one-good-monetary model and consists of four types of agents: consumers, firms, the government and the central bank. All agents

where R is the nominal rate of interest on bonds issued by the domestic government.

2.1 Consumers

The infinitely-lived representative consumer faces the following lifetime utility function:

$$\int_0^\infty [U(c,\ell)+V(m)]e^{-\beta t}dt, \tag{5}$$

where β is the rate of time preference and c, ℓ and m denote consumption, labor and real money balances, respectively. Functions $U(\cdot)$ and $V(\cdot)$ satisfy the following conditions: $U_c > 0$, $U_\ell < 0$, $V' > 0$, $U_{cc} < 0$, $U_{\ell\ell} < 0$, $U_{c\ell} < 0$, and $V'' < 0$.

The flow budget constraint in real terms is:

$$\dot{m}+\dot{b}+\dot{a} = w\ell + z - \tau - c + (R-\pi)b + (R^* - \pi^*)a - \pi m, \tag{6}$$

where b denotes government bonds, a foreign assets, w the wage rate, z profits, and τ lump-sum taxes. Notice that, by definition, $a = -f$. Throughout the paper, for any generic variable of the model x, $\dot{x}$ denotes dx/dt.

The representative agent chooses the optimal plan for c, ℓ, m, b and a in order to maximize her lifetime utility (5), subject to (6) and given the initial conditions:

$$m(0) = \frac{M_0}{P(0)},\ b(0) = \frac{B_0}{P(0)} \text{ and } a(0) = \frac{A_0}{P^*}, \tag{7}$$

where M, B and A denote the nominal stocks of money, government bonds and foreign assets, respectively. Note that consumers take the rate at which the country can borrow from abroad as given in making their decisions. In other words, R^* is intended to be increasing in the aggregate level of foreign debt, which each consumer assumes she is unable to influence.

2.3 The Government

The domestic government faces the following flow budget constraint expressed in real terms:

$$\dot{m} + \dot{b} = g - \tau + (R - \pi)b - \pi m, \tag{16}$$

where g is government spending. The government is assumed to adopt a tax policy consisting in balancing the budget at all times:

$$\tau = g + (R - \pi)b - \pi m. \tag{17}$$

2.4 Monetary Authorities

The monetary authorities set the nominal interest rate as an increasing function of the inflation rate, as in Benhabib, Schmitt-Grohé and Uribe (2001):

$$R = i + \rho(\pi), \tag{18}$$

where $\rho(\cdot)$ is continuous, non-decreasing, and there exists at least one $\overline{\pi} > -\beta$ such that $i + \rho(\overline{\pi}) = \beta + \overline{\pi}$; i is a positive parameter capturing exogenous deviations from the feedback component of the rule. Following Leeper (1991), the interest rate rule (18) is 'active ('passive') if $\rho' > (<)1$. In other words, under an active (passive) monetary policy, the central bank responds to inflation by raising (lowering) the real interest rate.

2.5 Current Account Dynamics

The dynamic equation describing the accumulation of net foreign assets is given by the trade balance plus interest payments:

$$\dot{a} = y - c - g + (R^* - \pi^*)a. \tag{19}$$

4 Steady-State Analysis

Under the assumption of perfect foresight, the transitional dynamics of the model depends in part on the expectations of the long-run steady state. This Section derives the steady-state equilibrium and the long-run effects of changes in both domestic and foreign exogenous variables.

The steady state of the economy is obtained when the shadow value of wealth is constant and external debt accumulation ceases, that is when $\dot{\mu} = \dot{f} = 0$. From (21)-(27), the steady state consists of the following set of relationships:

$$\beta = i^* + \sigma(\overline{f}) - \pi^*, \tag{28}$$

$$\Lambda\phi(\ell(\overline{\mu}, \Lambda)) = (i^* + \sigma(\overline{f}) - \pi^*)\overline{f} + c(\overline{\mu}, \Lambda) + g, \tag{29}$$

$$\overline{c} = c(\overline{\mu}, \Lambda), \tag{30}$$

$$\overline{\ell} = \ell(\overline{\mu}, \Lambda), \tag{31}$$

$$\overline{y} = \Lambda\phi(\overline{\ell}), \tag{32}$$

$$\overline{m} = m(\overline{\mu}) + \frac{1}{\rho' - 1}\eta\left(i^*, \overline{f}, i, \pi^*\right), \tag{33}$$

$$\overline{e} = \frac{1}{\rho' - 1}\epsilon(i^*, \overline{f}, i, \pi^*). \tag{34}$$

Equations (28)-(34) jointly determine the steady-state equilibrium solutions for $\overline{\mu}$, $\overline{f}$, $\overline{c}$, $\overline{\ell}$, $\overline{y}$, $\overline{m}$ and $\overline{e}$ as functions of the rate of time preference β, the technology parameter Λ, public spending g, the monetary policy rule exogenous component i, foreign inflation π^*, and the interest rate prevailing in the world market i^*.

To study exchange rate dynamics, it is convenient to write down the long-run responses to changes in exogenous variables of foreign debt and of the rate of depreciation, respectively. The responses to changes in domestic variables are given by:

time path of external debt and the international parity conditions. Whether monetary policy is active or passive is immaterial for determinacy.

Focusing now on the stable path, the solutions for f and e are given by:

$$f = \overline{f} + \left(f_0 - \overline{f}\right) e^{\lambda t}, \tag{40}$$

$$e = \overline{e} + \frac{1}{\rho' - 1}\epsilon_f \left(f - \overline{f}\right), \tag{41}$$

where $\lambda < 0$ is the stable eigenvalue and f_0 is the initial condition on foreign debt (see Appendix C for full derivations). Using the steady-state multipliers given by (35)-(38), the impact effects on the rate of depreciation of changes in domestic and foreign variables are, respectively:

$$\frac{de\left(0\right)^{+}}{di} = -\frac{1}{\rho' - 1} < (>)0 \quad \text{if} \quad \rho > (<)1, \frac{de\left(0\right)^{+}}{d\beta} = \frac{de\left(0\right)^{+}}{d\Lambda} = \frac{de\left(0\right)^{+}}{dg} = 0, \tag{42}$$

$$\frac{de\left(0\right)^{+}}{d\pi^{*}} = -\frac{\rho'}{\rho' - 1} < (>)0, \frac{de\left(0\right)^{+}}{di^{*}} = \frac{1}{\rho' - 1} > (<)0 \quad \text{if} \quad \rho > (<)1. \tag{43}$$

The impact effects on all endogenous variables of changes in domestic and foreign variables are summarized in Tables 3 and 4 (see Appendix D for details).

From the analysis of both the steady-state equilibrium and the transitional dynamics, it emerges that the dynamic behavior of the nominal exchange rate critically depends upon whether the monetary policy reaction coefficient ρ' is above or below unity. Examining (41), in fact, the exchange depreciation rate is correlated with foreign debt along the transitional path towards the steady-state equilibrium, with a coefficient, $\epsilon_f / \left(\rho' - 1\right)$, which is greater (lower) than zero if $\rho' > (<)\, 1$. An intuitive explanation is the following. A change in external indebtedness alters the international parity conditions given by the risk-adjusted interest rate parity, thereby influencing exchange rate dynamics. In particular, an increase in foreign debt makes the country-specific risk premium rise, leading to an increase in the nominal interest rate faced by the small open economy. This brings

asymptotically a new steady-state below its original level.

Figure 1d shows that an increase in the world interest rate i^* determines an upward jump of the rate of exchange depreciation on impact, since foreign bonds become more attractive. This implies a decline in the steady-state foreign debt, as it emerges from (37). As long as the monetary authorities are engaged in an active interest rate policy, the reduction in the level of external debt over time must be associated with a decline in e, along the adjustment path towards the new steady-state equilibrium. This can occur if only if there is an instantaneous upward jump in e.

From Figures 2a-2d, one can see how the responses of the nominal exchange rate obtained under an interest rate rule satisfying the Taylor principle are reversed in the case of an accommodating monetary policy, underreacting to inflation. A passive Taylor rule requires a decline in the exchange depreciation rate each time that a domestic real interest rate increase is necessary to restore the equilibrium due, for example, to increases in β or i^* (see Figures 2b and 2d). On the other hand, an increase in i requires a reduction in the endogenous component of the domestic real rate implying, under a passive rule, a higher depreciation rate (see Figure 2a). An increase in foreign inflation requires a long-run fall in the rate of exchange depreciation, although it brings about an upward jump of e on impact (see Figure 2c). In this case, only the short-run response crucially depends on the monetary policy regime, while the effects of the PPP prevail in the long run.

6 Conclusions

External indebtedness poses constraints on the borrowing opportunities of emerging market and developing economies, as empirically evidenced. We have analyzed the dynamic effects of interest rate rules in the spirit of Taylor (1993, 1999) in an optimizing model of exchange rate determination that incorporates a risk premium on foreign debt. An imperfect global capital market has strong implications for the design of monetary policy rules

Leeper, E.M. (1991), 'Equilibria under 'Active' and 'Passive' Monetary and Fiscal Policy', *Journal of Monetary Economics*, 27, 129-147.

McCallum, B.T. (2003), 'Multiple-Solution Indeterminacies in Monetary Policy Analysis', *Journal of Monetary Economics*, 50, 1153-1175.

Montiel, P.J. (2003), *Macroeconomics in Emerging Markets*, Cambridge: Cambridge University Press.

Obstfeld, M. (1982), 'Aggregate Spending and the Terms of Trade: Is There a Laursen-Metzler Effect?', *Quarterly Journal of Economics*, 97, 251-270.

Taylor, J.B. (1993), 'Discretion Versus Policy Rules in Practice', *Carnegie-Rochester Conference Series on Public Policy*, 39, 195-214.

Taylor, J.B. (1999), *Monetary Policy Rules*, Chicago and London: University of Chicago Press.

Taylor, J.B. (2001), 'Using Monetary Policy Rules in Emerging Market Economies', in *Stabilization and Monetary Policy: The International Experience*, Mexico City: Bank of Mexico, 441-458.

Turnovsky, S.J. (1997), *International Macroeconomic Dynamics*, Cambridge (MA): The MIT Press.

Woodford, M. (2003), *Interest and Prices*, Princeton and Oxford: Princeton University Press.

Appendix A

Consumption and labor supply can be expressed as function of μ and Λ as follows. Totally differentiate (8) and (9), given (15), and write the results in matrix notation:

$$\begin{pmatrix} U_{cc} & U_{c\ell} \\ U_{\ell c} & U_{\ell\ell} + \Lambda\phi''\mu \end{pmatrix} \begin{pmatrix} dc \\ d\ell \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ -\Lambda\phi' & -\phi'\mu \end{pmatrix} \begin{pmatrix} d\mu \\ d\Lambda \end{pmatrix}. \tag{A1}$$

by combining (10) with (11), given the Taylor rule (18):

$$V'(m) = \mu \left(i + \rho(\pi^* + e)\right). \tag{A8}$$

Totally differentiating yields:

$$V''dm = Rd\mu + \mu \left(di + \rho' d\pi^* + \rho' de\right), \tag{A9}$$

which, given (A7), can be re-written as:

$$dm = \frac{R}{V''}d\mu + \frac{1}{\rho' - 1}\frac{\rho'\sigma' df - di - \rho' d\pi^* + \rho' di^*}{V''}\mu. \tag{A10}$$

Letting $\frac{dm}{d\mu} = m_\mu = \frac{R}{V''}$, $\frac{dm}{d_{i^*}}(\rho' - 1) = \eta_{i^*} = \frac{\rho'\mu}{V''}$, $\frac{dm}{df}(\rho' - 1) = \eta_f = \frac{\rho'\sigma'\mu}{V''}$, $\frac{dm}{di}(\rho' - 1) = \eta_i = -\frac{\mu}{V''}$ and $\frac{dm}{d_{\pi^*}}(\rho' - 1) = \eta_{\pi^*} = -\frac{\rho'\mu}{V''}$, equation (26) immediately follows.

Appendix B

Totally differentiate (28) and (29) and express the results in matrix notation:

$$\begin{pmatrix} 0 & \sigma' \\ c_\mu(\overline{\mu}, \Lambda) - \Lambda\phi'\ell_\mu(\overline{\mu}, \Lambda) & \beta \end{pmatrix} \begin{pmatrix} d\overline{\mu} \\ d\overline{f} \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 1 & -1 \\ -\overline{f} & \kappa & -1 & 0 & 0 \end{pmatrix} \begin{pmatrix} d\beta \\ d\Lambda \\ dg \\ d\pi^* \\ di^* \end{pmatrix},$$

where $\kappa \equiv \phi(\ell(\overline{\mu}, \Lambda)) + \Lambda\phi'\ell_\Lambda(\overline{\mu}, \Lambda) - c_\Lambda(\overline{\mu}, \Lambda) > 0$.

Letting $\Delta \equiv -\sigma' \left(c_\mu(\overline{\mu}, \Lambda) - \Lambda\phi'\ell_\mu(\overline{\mu}, \Lambda)\right) > 0$ we obtain the following set of deriva-

$$\frac{d\overline{f}}{d\pi^*} = \frac{\begin{vmatrix} 0 & 1 \\ c_\mu(\overline{\mu},\Lambda) - \Lambda\phi'\ell_\mu(\overline{\mu},\Lambda) & 0 \end{vmatrix}}{\Delta} = -\frac{c_\mu(\overline{\mu},\Lambda) - \Lambda\phi'\ell_\mu(\overline{\mu},\Lambda)}{\Delta} = \frac{1}{\sigma'} > 0, \tag{B9}$$

$$\frac{d\overline{f}}{di^*} = \frac{\begin{vmatrix} 0 & -1 \\ c_\mu(\overline{\mu},\Lambda) - \Lambda\phi'\ell_\mu(\overline{\mu},\Lambda) & 0 \end{vmatrix}}{\Delta} = \frac{c_\mu(\overline{\mu},\Lambda) - \Lambda\phi'\ell_\mu(\overline{\mu},\Lambda)}{\Delta} = -\frac{1}{\sigma'} < 0. \tag{B10}$$

Given the above results and using (23)-(27), one obtains the long-run effects on consumption, labor inputs, income, real money balances and exchange rates. This shows results reported in Tables 1 and 2.

Appendix C

Focusing on the stable path, the solutions for μ, f, c, ℓ, y, m and e are of the following form:

$$\mu = \overline{\mu} - \frac{\sigma'\overline{\mu}}{\lambda}\left(f_0 - \overline{f}\right)e^{\lambda t}, \tag{C1}$$

$$f = \overline{f} + \left(f_0 - \overline{f}\right)e^{\lambda t}, \tag{C2}$$

$$c = \overline{c} + c_\mu(\mu - \overline{\mu}), \tag{C3}$$

$$\ell = \overline{\ell} + \ell_\mu(\mu - \overline{\mu}), \tag{C4}$$

$$y = \overline{y} + \phi'\ell_\mu(\mu - \overline{\mu}), \tag{C5}$$

$$m = \overline{m} + m_\mu(\mu - \overline{\mu}) + \frac{1}{\rho' - 1}\eta_f\left(f - \overline{f}\right), \tag{C6}$$

$$e = \overline{e} + \frac{1}{\rho' - 1}\epsilon_f\left(f - \overline{f}\right), \tag{C7}$$

where $\lambda < 0$ is the stable eigenvalue and f_0 is the initial condition on foreign debt.

Table 1: Steady-State Effects of Changes in Domestic Variables

	i	β	Λ	g
$\overline{\mu}$	0	$\frac{\beta+\sigma'\overline{f}}{\Delta} > 0$	$-\frac{\left[\phi(\bar{\ell})+\Lambda\phi'\ell_\Lambda-c_\Lambda\right]\sigma'}{\Delta} < 0$	$\frac{\sigma'}{\Delta} > 0$
$\overline{f}$	0	$\frac{1}{\sigma'} > 0$	0	0
$\bar{c}$	0	$c_\mu\frac{\beta+\sigma'\overline{f}}{\Delta} < 0$	$c_\Lambda - \frac{\left[\phi(\bar{\ell})+\Lambda\phi'\ell_\Lambda-c_\Lambda\right]\sigma' c_\mu}{\Delta} > 0$	$\frac{\sigma' c_\mu}{\Delta} < 0$
$\bar{\ell}$	0	$\ell_\mu\frac{\beta+\sigma'\overline{f}}{\Delta} > 0$	$\ell_\Lambda - \frac{\left[\phi(\bar{\ell})+\Lambda\phi'\ell_\Lambda-c_\Lambda\right]\sigma'\ell\mu}{\Delta} \lesseqgtr 0$	$\frac{\sigma'\ell_\mu}{\Delta} > 0$
$\overline{y}$	0	$\phi'\ell_\mu\frac{\beta+\sigma'\overline{f}}{\Delta} > 0$	$\phi'\ell_\Lambda - \frac{\left[\phi(\bar{\ell})+\Lambda\phi'\ell_\Lambda-c_\Lambda\right]\sigma'\phi'\ell_\mu}{\Delta} \lesseqgtr 0$	$\frac{\sigma'\phi'\ell_\mu}{\Delta} > 0$
$\overline{m}$	$-\frac{\mu}{V''}\frac{1}{\rho'-1} \gtrless 0$	$\frac{R}{V''}\frac{\beta+\sigma'\overline{f}}{\Delta} + \frac{\mu}{V''(\rho'-1)}\rho' \lessgtr 0$	$-\frac{\left[\phi(\bar{\ell})+\Lambda\phi'\ell_\Lambda-c_\Lambda\right]\sigma'}{\Delta}\frac{R}{V''} > 0$	$\frac{\sigma'}{\Delta}\frac{R}{V''} < 0$
$\bar{e}$	$-\frac{1}{\rho'-1} \lessgtr 0$	$\frac{1}{\rho'-1} \gtrless 0$	0	0

Table 2: Steady-State Effects of Changes in Foreign Variables

	π^*	i^*
$\overline{\mu}$	$\frac{\beta}{\Delta} > 0$	$-\frac{\beta}{\Delta} < 0$
$\overline{f}$	$\frac{1}{\sigma'} > 0$	$-\frac{1}{\sigma'} < 0$
$\bar{c}$	$-c_\mu\frac{\beta}{\Delta} < 0$	$c_\mu\frac{\beta}{\Delta} > 0$
$\bar{\ell}$	$-\ell_\mu\frac{\beta}{\Delta} > 0$	$\ell_\mu\frac{\beta}{\Delta} < 0$
$\overline{y}$	$-\phi'\ell_\mu\frac{\beta}{\Delta} > 0$	$\phi'\ell_\mu\frac{\beta}{\Delta} < 0$
$\overline{m}$	$\frac{R}{V''}\frac{\beta}{\Delta} < 0$	$-\frac{R}{V''}\frac{\beta}{\Delta} > 0$
$\bar{e}$	-1	0

Figure 1: Exchange Rate Dynamics under Active Monetary Policy, $\rho' > 1$