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New International Monetary Arrangements and the Exchange Rate

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Editorial

On April 19 - 20, 2001 the Oesterreichische Nationalbank sponsored a Workshop organized by Richard Clarida (Columbia University), Helmut Frisch (TU Wien) and Eduard Hochreiter (OeNB) on „Exchange Rate and Monetary Policy Issues". It took place at the Institute for Advanced Studies, Vienna. A number of papers presented at this workshop is being made available to a broader audience in the Working Paper series of the Bank. This volume contains the eighth of these papers. The first ones were issued as OeNB Working Papers No. 44, 46, 47 and 50 to 53. The paper by Tommaso Monacelli is followed by discussions by Sven W. Arndt (p. 29ff.) and by Frank Smets (p. 35ff.).

October 10, 2001

New International Monetary Arrangements and the Exchange Rate*

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Abstract

I show how to implement in a simple manner the comparison of alternative monetary policy rules in a two-country model of the new generation. These rules are: Full Price Stability, Taylor, Fixed and Managed Exchange Rates. I find, first, that the exchange rate dynamic is non-stationary unless some form of management is undertaken by the respective monetary authorities of the two countries. However, eliminating the excess volatility of the exchange rate does not significantly alter the overall macroeconomic volatility.

Second, a floating exchange rate regime based on a Taylor-type rule seems to better approximate the full price stability benchmark, but at the cost of boosting interest rate volatility. In this respect limiting exchange rate flexibility is desirable. Finally, in all cases the model delivers positive cross-country correlation of interest rates but negative cross-country correlation of output.

Keywords: monetary policy rules, exchange rate.
JEL Classification Number: E52, F41.

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1 Introduction

The emergence of the European Central Bank as a new player in the world scene has radically changed the scale of the international monetary policy game. The response of academic economists to this structural change is taking the form of the so-called New International Macroeconomics. Such literature is undertaking a rapid expansion. In its core it tries to tackle both traditional and new issues of the open economy macroeconomic literature with the spirit of the New Neoclassical synthesis[1]. One aspect of this approach that seems to gain some comparative advantage from the open economy dimension is the description and analysis of monetary policy in terms of endogenous rules. Both the implications of alternative exchange rate regimes and the strategic study of international policy arrangements can be addressed in such a framework. In this paper I describe a version of the new generation of dynamic stochastic general equilibrium models of the open economy and propose a simple way of comparing the effects of alternative monetary policy arrangements in a two-country world[2]. The main ingredients of such a model are: i) A full specification of the dynamics rooted in forward looking decisions by both consumers and firms; ii) The presence of nominal rigidities in an imperfectly competitive framework; iii) The conduct of monetary policy according to some feed-back rule. This benchmark model features complete state-contingent asset markets and a full pass-through of exchange rate movements onto prices.[3] I first derive a specification of the equilibrium in terms of a policy rule featuring a goal of complete stabilization of the price level in both countries[4]. I then compare the implied dynamics of the exchange rate and of other variables across alternative *symmetric* policy arrangements: 1) A Taylor rule, followed independently by the monetary authorities of both countries under floating exchange rates; 2) Fixed and 3) Managed exchange rates.

The analysis lends itself to a number of interesting insights. I find, first, that the exchange rate dynamic is non-stationary unless some form of management is undertaken by

[1] Goodfriend-King (1998).

[2] Benigno-Benigno (2000) have the same purpose within a different type of model. In the same direction see also Weerapana (1999), Pappa (2000). An analysis close to the one in this paper is in Gali-Monacelli (2000) but within the context of a small open economy model.

[3] An extension to address the interaction between alternative monetary policy arrangements and the presence of either imperfect asset markets or imperfect exchange rate pass-through is definitely worthwile. See Corsetti-Pesenti (2001).

[4] The issue of whether such a rule constitutes the optimal international monetary arrangement is beyond the scope of this paper. Benigno-Benigno (2000) discuss the conditions under which a symmetric full price stability rule is a Nash equilibrium. Such an outcome requires that both countries maintain a positive degree of imperfect competition distortion in the steady state.

the respective monetary authorities of the two countries. Interestingly a simple symmetric Taylor rule, which implies trying to stabilize the inflation rate as opposed to the price level, delivers excess volatility in the exchange rate. It is shown that a simple extension of the Taylor rule to include a partial feed-back from the exchange rate is able to restore stationarity in the exchange rate for very low values of the same feed-back parameter. A striking feature of the resulting equilibrium, though, is that the dynamics remains virtually unchanged.

Second, a Taylor-type rule featuring only an aggressive response to the deviations of inflation from the target seems to approximate fairly well the full price stability benchmark. This is obtained, though, at the cost of a much higher instability in nominal interest rates. Interestingly, relatively lower instability of interest rates is obtained under a regime of purely fixed exchange rates. Other than that, the latter regime seems to imply the largest deviation from the flexible price allocation within the class of policy rules examined.

Finally, the model delivers positive cross-country correlation of interest rates in all cases but one, the Taylor rule. Interestingly such positive correlation is a feature of the full price stability outcome under purely flexible exchange rates. On the other hand, the model always predicts a negative cross-country correlation of output. In all cases the expenditure switching mechanism that lies at the heart of the international transmission of shocks needs to be amended in order to improve the empirical performance of the model.

The remainder paper is as follows. In section 2 a benchmark fully dynamic model for the analysis of monetary policy rules in a two-country world is described. Section 3 conducts a comparative analysis of alternative international policy arrangements, with particular emphasis on the nominal exchange rate behavior. Section 4 concludes.

2 The Model

The world economy is composed by two symmetric countries, *Home* and *Foreign*. Each country is specialized in the production of a single good. The model is characterized by the following assumptions: i) All goods are tradeable; ii) Pass-through of the exchange rate on prices is complete; iii) The law of one price holds; iv) Complete markets for state-contingent securities exist at the international level. The domestic market is populated by infinitely-lived households, consuming Dixit-Stiglitz aggregates of Home (C^H) and imported (C^F) goods, and by domestic firms producing a differentiated good. By analogy C^{H*} denotes foreign consumption of the Home good and C^{F^*} consumption of the foreign good by the foreign residents. Henceforth let $\widehat{H}_t \equiv \log(\frac{H_t}{\overline{H}})$ for a generic variable H, where $\overline{H}$ denotes the steady state value of $\overline{H}$.

2.1 Aggregate Demand

Total consumption is given by, in Home and Foreign respectively:

$$\widehat{C}_t = (1-\gamma)\widehat{C}_t^H + \gamma\widehat{C}_t^F \tag{1}$$

$$\widehat{C}_t^* = (1-\gamma^*)\widehat{C}_t^{F^*} + \gamma^*\widehat{C}_t^{H^*} \tag{2}$$

where γ and γ^* denote the shares of imported goods in the two countries. Utility-based price indexes in the two economies are (in units of home and foreign currency respectively):

$$\widehat{P}_t = (1-\gamma)\widehat{P}_t^H + \gamma\widehat{P}_t^F \tag{3}$$

$$\widehat{P}_t^* = (1-\gamma^*)\widehat{P}_t^{F^*} + \gamma^*\widehat{P}_t^{H^*} \tag{4}$$

2.1.1 Real exchange rate and the terms of trade

Let's define the real exchange rate as the relative CPI:

$$\widehat{q}_t = \widehat{e}_t + \widehat{P}_t^* - \widehat{P}_t$$

and the terms of trade as the relative price of imports:

$$\widehat{S}_t = \widehat{P}_t^F - \widehat{P}_t^H = \widehat{e}_t + \widehat{P}_t^{F^*} - \widehat{P}_t^H$$

A relationship between the real exchange rate and the terms of trade can be derived by using (1) and (2)[5]:

$$\begin{aligned}
\widehat{q}_t &= \widehat{e}_t + \widehat{P}_t^* - \widehat{P}_t \\
&= (1-(\gamma+\gamma^*))\widehat{S}_t
\end{aligned}$$

Notice also that CPI inflation will satisfy:

[5] To obtain this notice that:

$$\widehat{S}_t^* = \widehat{P}_t^{H^*} - \widehat{P}_t^{F^*} = -\widehat{S}_t$$

$$\widehat{\pi}_t = (1-\gamma)\widehat{\pi}_t^H + \gamma\widehat{\pi}_t^F = \widehat{\pi}_t^H + \gamma\Delta\widehat{S}_t \tag{5}$$

and

$$\widehat{\pi}_t^* = (1-\gamma^*)\widehat{\pi}_t^{F^*} + \gamma^*\widehat{\pi}_t^{H^*} = \widehat{\pi}_t^{F^*} - \gamma^*\Delta\widehat{S}_t \tag{6}$$

2.1.2 Optimal consumption allocation

Static efficient allocation of consumption between domestic and imported goods yields simple demand functions:

$$\widehat{C}_t^H = \eta\gamma\widehat{S}_t + \widehat{C}_t \tag{7}$$

$$\widehat{C}_t^F = -\eta(1-\gamma)\widehat{S}_t + \widehat{C}_t \tag{8}$$

and, for the consumer in Foreign,

$$\widehat{C}_t^{F^*} = -\eta\gamma^*\widehat{S}_t + \widehat{C}_t^* \tag{9}$$

$$\widehat{C}_t^{H^*} = -\eta(\widehat{P}_t^{H^*} - \widehat{P}_t^*) + \widehat{C}_t^* = \eta(1-\gamma^*)\widehat{S}_t + \widehat{C}_t^* \tag{10}$$

where $\eta \geq 1$ is the elasticity of substitution between home and foreign goods.

2.1.3 Intertemporal consumption choice

The optimal intertemporal consumption allocation for the Home consumer must satisfy in equilibrium a typical Euler equation:

$$\widehat{C}_t = E_t\{\widehat{C}_{t+1}\} - \frac{1}{\sigma}\widehat{rr}_t \tag{11}$$

where $\widehat{rr}_t \equiv \{\widehat{i}_t - E_t\widehat{\pi}_{t+1}\}$ is the CPI-based real interest rate. By substituting (5) in (11), it yields

$$\widehat{C}_t = E_t\{\widehat{C}_{t+1}\} - \frac{1}{\sigma}(\widehat{i}_t - E_t\{\widehat{\pi}_{t+1}^H\}) + \frac{\gamma}{\sigma}E_t\{\Delta\widehat{S}_{t+1}\} \tag{12}$$

2.1.4 Labor Supply

The consumer's intratemporal trade-off between consumption and leisure is expressed by the following optimality condition:

$$V_n(N_t) = U_c(C_t)\frac{W_t}{P_t} \tag{13}$$

where W is the nominal wage, $U_c(C)$ is the marginal utility of consumption and $V_n(N)$ is the marginal disutility of work effort.

2.1.5 Risk Sharing

The existence of complete markets for nominal state contingent securities has implications for consumption risk sharing. Formally the marginal utilities of consumption must be equalized across economies in equilibrium. A simple certainty equivalence implication of this is:

$$U_c(C_t) = \varkappa U_c(C_t^*){q_t}^{-1} \tag{14}$$

where $\varkappa$ is a constant that depends on the initial conditions. By log-linearizing we have:

$$\widehat{C}_t - \widehat{C}_t^* = \frac{1}{\sigma}\widehat{q}_t = \frac{(1-(\gamma+\gamma^*))}{\sigma}\widehat{S}_t \tag{15}$$

where $\sigma \equiv -\frac{U_c(\overline{C})}{U_{cc}(\overline{C})\overline{C}}$ is the intertemporal elasticity of substitution in consumption.

2.2 Aggregate Supply

In the market of the domestic goods, there is a continuum of monopolistically competitive firms (owned by consumers), indexed by $i \in [0,1]$. They operate a CRS technology: $Y_t(i) = Z_t N_t(i)$, where Z is a total factor productivity shifter. Cost minimization leads to the following efficiency condition for the choice of labor input :

$$\frac{MC_t(i)}{P_t^H} = \frac{1}{Z_t}\frac{W_t}{P_t^H} \tag{16}$$

where MC indicates the nominal marginal cost.

2.2.1 The Open Economy Phillips Curve

Domestic firms are allowed to reset their price according to a stochastic time-dependent rule, which implies receiving a price signal at a constant random rate ϕ, as in Calvo (1983). As in Gali-Monacelli (2000) the resulting aggregate supply equation reads:

$$\widehat{\pi}_t^H = \beta \; E_t \widehat{\pi}_{t+1}^H + \lambda \widehat{\mu}_t \tag{17}$$

where $\widehat{\mu}_t$ denotes percent deviations of the real marginal cost from its steady state value and $\lambda \equiv [\frac{(1-\phi)(1-\beta\phi)}{\phi}]$. This is what in the literature is typically defined as New Keynesian Phillips curve. What the open economy dimension adds to it is the specification for the real marginal cost μ_t in equilibrium. The equilibrium in the labor market can be obtained by combining (13) and (16):

$$\frac{V_n(N_t)}{U_c(C_t)} \frac{P_t}{P_t^H} \frac{1}{Z_t} = \mu_t$$

Log-linearizing one obtains:

$$\widehat{\mu}_t = \tau \widehat{Y}_t + \gamma \widehat{S}_t + \sigma \widehat{C}_t - (1+\tau)\widehat{Z}_t \tag{18}$$

given that $(\widehat{P}_t - \widehat{P}_t^H) = \gamma(\widehat{P}_t^F - \widehat{P}_t^H) = \gamma \widehat{S}_t$, and where $\tau \equiv \frac{V_{nn}(\overline{N})\overline{N}}{V_n(N)}$. Equation (18) shows that the real marginal cost depends on the dynamics of the terms of trade if and only if $\gamma > 0$.

2.3 Equilibrium

Equilibrium in the domestic goods market implies:

$$\begin{aligned} \widehat{Y}_t &= (1-\gamma)\widehat{C}_t^H + \gamma \widehat{C}_t^{H*} \\ &= (1-\gamma)\widehat{C}_t + \gamma \widehat{C}_t^* + \gamma\{(\widehat{C}_t^{H*} - \widehat{C}_t^*) - (\widehat{C}_t^F - \widehat{C}_t)\} \end{aligned}$$

By using (7)-(10) it yields:

$$\widehat{Y}_t = (1-\gamma)\widehat{C}_t + \gamma \widehat{C}_t^* + 2\gamma\eta(1-\gamma)\widehat{S}_t \tag{19}$$

Finally substituting (14) it obtains:

$$\widehat{Y}_t = \widehat{C}_t + \gamma \chi \widehat{S}_t \tag{20}$$

where $\chi \equiv \frac{1}{\sigma}[2\eta(1-\gamma)\sigma - (1-(\gamma+\gamma^*))]$.

Real marginal cost and the terms of trade Substituting (20) in (18) we can write:

$$\widehat{\mu}_t = (\tau + \sigma)\widehat{C}_t + \gamma(1 + \tau\chi)\widehat{S}_t - (1 + \tau)\widehat{Z}_t \tag{21}$$

which implies an empirically plausible positive correlation between the terms of trade and the real marginal cost.

2.4 The New International Economic System

We are now ready to rewrite the world-economy model in a more compact way. Equilibrium equations for Home read:

$$\widehat{C}_t = E_t\{\widehat{C}_{t+1}\} - \frac{1}{\sigma}(\widehat{i}_t - E_t\{\widehat{\pi}^H_{t+1}\}) + \frac{\gamma}{\sigma}E_t\{\Delta\widehat{S}_{t+1}\} \tag{22}$$

$$\widehat{\pi}^H_t = \beta\ E_t\widehat{\pi}^H_{t+1} + \lambda\widehat{\mu}_t \tag{23}$$

$$\widehat{\mu}_t = (\tau + \sigma)\widehat{C}_t + \gamma(1 + \tau\chi)\widehat{S}_t - (1 + \tau)\widehat{Z}_t \tag{24}$$

The corresponding equations for Foreign:

$$\widehat{C}^*_t = E_t\{\widehat{C}^*_{t+1}\} - \frac{1}{\sigma}(\widehat{i}^*_t - E_t\{\widehat{\pi}^{F^*}_{t+1}\}) - \frac{\gamma^*}{\sigma}E_t\{\Delta\widehat{S}_{t+1}\} \tag{25}$$

$$\widehat{\pi}^{F^*}_t = \beta\ E_t\{\widehat{\pi}^{F^*}_{t+1}\} + \lambda\widehat{\mu}^*_t \tag{26}$$

$$\widehat{\mu}^*_t = (\tau + \sigma)\widehat{C}^*_t - \gamma^*(1 + \tau\chi^*)\widehat{S}_t - (1 + \tau)\widehat{Z}^*_t \tag{27}$$

A real version of the uncovered interest parity implies:

$$\widehat{i}_t - E_t\{\widehat{\pi}^H_{t+1}\} = \widehat{i}^*_t - E_t\{\widehat{\pi}^{F^*}_{t+1}\} + E_t\{\Delta\widehat{S}_{t+1}\} \tag{28}$$

The driving forces are assumed to follow:

$$\begin{bmatrix} \widehat{Z}_t \\ \widehat{Z}^*_t \end{bmatrix} = \begin{bmatrix} \rho & 0 \\ 0 & \rho^* \end{bmatrix} \begin{bmatrix} \widehat{Z}_{t-1} \\ \widehat{Z}^*_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_t \\ \varepsilon^*_{t-1} \end{bmatrix} \tag{29}$$

with $E_t\{\varepsilon_t\varepsilon_t^{*\prime}\} = \begin{bmatrix} \sigma_\varepsilon^2 & \theta \\ \theta & \sigma_{\varepsilon^*}^2 \end{bmatrix}$.

Equations (22) through (29) are sufficient to characterize the equilibrium in the world economy for the system of variables $\{\widehat{C}, \widehat{\pi}^H, \widehat{\mu}, \widehat{C}^*, \widehat{\pi}^{F^*}, \widehat{\mu}^*, \widehat{S}\}$ for given processes of Z, Z^*. What remains to be added is the specification of the monetary policy rule for each country.

2.5 Monetary Policy Arrangements

We will consider four varieties of *symmetric* international monetary arrangements: 1) *Price Stability (PS);* 2) *Taylor-type rule (TAYL);* 3) *Fixed Exchange Rates (FIX)*; 3) *Managed Exchange Rates (SYMA).*

Under the first two regimes the exchange rate is free to float. In the PS regime the central bank of each country pursues a policy of complete stabilization of the price level in a non-coordinated fashion. In Benigno-Benigno (2000) the conditions under which such an arrangement can be considered a Nash equilibrium are discussed. In the TAYL regime both central banks conduct policy according to a simple Taylor-type rule. In the FIX regime the nominal exchange rate is completely fixed, while the SYMA regime is a hybrid in which some degree of symmetric management of the exchange rate is conducted.

2.5.1 Price level stabilization (PS)

By substituting (22) in (21), after some algebra, we can obtain the following first order stochastic difference equation for the domestic real marginal cost:

$$\begin{aligned} \widehat{\mu}_t &= E_t\{\widehat{\mu}_{t+1}\} - \Omega_1(\widehat{i}_t - E_t\{\widehat{\pi}_{t+1}^H\}) + \gamma\Omega_2(\widehat{i}_t^* - E_t\{\widehat{\pi}_{t+1}^{F^*}\}) \\ &\quad -(1+\tau)(1-\rho)\widehat{Z}_t \end{aligned} \tag{30}$$

where $\Omega_1 \equiv [\gamma(1+\tau\chi) + \frac{(1-\gamma)(\sigma+\tau)}{\sigma}]$, $\Omega_2 \equiv \tau(\chi - \frac{1}{\sigma})$.

We define a policy of price level stabilization as a policy that aims at a full stabilization of the markup[6]. We assume that in this kind of international monetary arrangement both countries pursue this policy in an uncoordinated way. Therefore the following condition must be satisfied:

$$\widehat{\mu}_t = 0 = \widehat{\mu}_t^* \ \forall t \tag{31}$$

[6]For a similar approach see Gali-Monacelli (2000).

An interest rate rule consistent with (31) can be derived from (30):

$$\widehat{i}_t = (\gamma\frac{\Omega_2}{\Omega_1})\widehat{i}_t^* - (\frac{(1+\tau)(1-\rho)}{\Omega_1})\widehat{Z}_t \tag{32}$$

and similarly for Foreign:

$$\widehat{i}_t^* = (\gamma^*\frac{\Omega_2^*}{\Omega_1^*})\widehat{i}_t - (\frac{(1+\tau)(1-\rho^*)}{\Omega_1^*})\widehat{Z}_t^* \tag{33}$$

where $\Omega_1^* \equiv [\gamma^*(1+\tau\chi^*) + \frac{(1-\gamma^*)(\sigma+\tau)}{\sigma}]$, $\Omega_2^* \equiv \tau(\chi^* - \frac{1}{\sigma})$.

Both (32) and 33 are derived given that ex-post $\widehat{\pi}_t^H = \widehat{\pi}_t^{F^*} = 0$ must hold in equilibrium. The form of the above rules deserves some comments. Two components can be identified. The first one is the counter-cyclical component of monetary policy in response to productivity shocks, a feature that already identifies per se the optimal policy in a closed economy[7]. The second element is the novelty due to the open economy interaction, given the effects that the terms of trade, under nominal price rigidity, exercise on aggregate demand and therefore on inflation. Notice that both (32) and (33) imply a positive correlation of interest rates across countries, a feature in line with the empirical evidence for industrialized countries. Notice also that the interaction terms $(\gamma\frac{\Omega_2}{\Omega_1})\widehat{i}_t^*$ and $(\gamma^*\frac{\Omega_2^*}{\Omega_1^*})\widehat{i}_t$ disappear as $\gamma \to 0$ and $\gamma* \to 0$, i.e., when both economies become closed.

2.5.2 A Battery of Regimes: Taylor Rules, Exchange Rate Management, Fixed Exchange Rates.

As in Monacelli (2000), we can rationalize the alternative regimes in terms of an open economy extension of a simple Taylor rule:

$$\widehat{i}_t = b_\pi\widehat{\pi}_t^H + b_y\widehat{Y}_t + \frac{b_e}{1-b_e}\widehat{e}_t \tag{34}$$

$$\widehat{i}_t^* = b_\pi\widehat{\pi}_t^{F^*} + b_y\widehat{Y}_t^* - \frac{b_e}{1-b_e}\widehat{e}_t \tag{35}$$

where $0 \leq b_e \leq 1$. Here we have assumed for simplicity that the weights b_π, b_y, b_e are equalized across countries. Notice that for different values of b_e this policy rule nests a simple Taylor rule ($b_e = 0$), a regime of managed exchange rates $b_e \in (0,1)$, and a regime of (symmetric) fixed exchange rates ($b_e \to 1$)

[7]See Ireland (1998).

2.6 Parametrization

I will perform comparative simulations across alternative rules. The model is parametrized as follows. The period utility is $U(C_t, N_t) = U(C_t) - V(N_t) = \frac{1}{1-\sigma}C_t^{1-\sigma} - \frac{1}{1+\tau}N_t^{1+\tau}$. I set the discount rate $\beta = 0.99$ and the elasticity of labor supply $\tau = 1$. The share of imported goods $\gamma = \gamma^*$ is set to 0.4. The elasticity of substitution between home and foreign consumption is $\eta = 1.5$. The probability of price non-adjustment ϕ is equal to 0.75, which implies that the average frequency of price adjustment is four quarters. As to the monetary policy rule parameters, we set as benchmark $b_\pi = 0$ and $b_y = 0$. The reason for setting $b_y = 0$ is twofold. On the one hand, monetary policy responding to detrended output as opposed to the output gap, as in the original Taylor rule (Taylor 1993), would imply an inefficient behavior of policy. On the other, the output gap is an unobservable variable and the central bank does not feature any trade off between inflation and output gap stabilization in the present model. The choice of the parameter b_e under the SYMA regime is discussed in the next section. The standard deviation of each shock is normalized to 1. The persistence of each stochastic process is set to $\rho^z = \rho^{z^*} = 0.9$.

3 Exchange Rate Dynamics and Policy Rules

I first investigate the following question: Are the dynamic properties of the nominal exchange rate sensitive to the type of international monetary policy arrangement chosen ? *Figure 1* compares across rules the impulse response of the nominal exchange to a domestic positive productivity shock . The PS regime is kept as a benchmark. Some interesting observations are in order. Notice first that under the TAYL regime ($b_e = 0$) the exchange rate displays non stationarity. In all other cases the exchange rate is stationary, although its response is more muted the higher is b_e, which parametrizes the degree of exchange rate management. The behavior under the TAYL regime is even more striking when compared to the PS case. In this latter case both countries seek to stabilize the price level as opposed to the Taylor rule case in which the mutual goal is the one of stabilizing the inflation rate. In order to choose a parametrization for the SYMA regime I therefore compute the lower bound of b_e that induces stationarity in the exchange rate. All other parameters being equal it is found that this lower bound is $b_e = 0.018$. Henceforth this value of b_e will pin down the definition of a managed exchange rate regime. Notice further that under the PS regime a depreciation is observed, while in the other cases the exchange rate depreciates first and then appreciates, with a magnitude and persistence that is inversely related to b_e.

Table 1 compares the volatility of the nominal exchange rate in the three regimes. Although the SYMA regime allows a dampening of the volatility of the nominal exchange rate this remains high in absolute terms. In *Figure 2* I therefore let the degree of exchange rate management (b_e) vary between 0.018 and ≈ 1 and measure the impact on the volatility of the exchange rate. The effect is quantitatively large. To attain the volatility of the exchange rate that is consistent with the PS regime a value $b_e = 0.028$ is necessary, which implies that a 1% depreciation of the nominal exchange rate should be followed by a $\frac{b_e}{1-b_e} \approx .03\%$ rise in the interest rate (in both countries) to achieve the degree of exchange rate flexibility consistent with full price stability.

3.0.1 Policy Response, Output and Inflation Dynamics.

In *Figure 3*, the impulse responses of the nominal interest rate describe the different behavior of monetary policy across regimes. In the PS regime, in line with equation (32), the domestic authorities respond by lowering interest rates. Qualitatively the same response is displayed in all the other regimes, but in all cases the magnitude of the policy loosening is much larger than the one required by a goal of pure stabilization of the price level. The largest reaction is observed in the TAYL case. Despite this the largest output expansion takes place under the PS regime. This is consistent with the behavior of consumption and the terms of trade also reported in the figure. Consumption is more reactive under the PS regime because of a larger fall in real interest rates. The same is true for the terms of trade, whose depreciation is much larger under a regime of full price stability. The combination of these two effects lead to a larger expansion in real activity under the PS regime. Notice that the FIX regime induces a hump-shaped response of the terms of trade, consistent with the necessity of compensating for the much more muted behavior of the nominal exchange rate. This dynamics is reflected in a similar adjustment in output.

Furthermore, the positive productivity shock induces a fall in the real marginal cost and therefore in inflation. Under the PS regime zero inflation is achieved by construction. Yet the quantitative dynamics of inflation differs substantially across rules. Under the TAYL regime the deflationary effect is much larger (and this triggers the larger response of policy). As a general conclusion all regimes seem to imply an excessively large volatility of inflation relatively to the PS benchmark.

3.1 Macroeconomic Stability and Monetary Arrangements

In *Table 2* a quantitative evaluation of the relative performance of the different rules in terms of macroeconomic stability is provided. Second moments for selected variables are reported. Several interesting aspects are worth emphasizing. Notice, first, that eliminating the unit root feature in the exchange rate behavior (under the SYMA regime) has virtually no effect on the equilibrium allocation of all the variables. The only noticeable effect is on interest rate volatility. If, on the one hand, the TAYL regime seems to approximate the price stability benchmark better this happens at the cost of a larger instability in interest rates. A striking feature of the PS regime is that interest rate volatility is minimized. Along this line of argument, notice that limiting exchange rate flexibility seems desirable to the extent that allows to dampen the volatility of interest rates. A regime of fixed exchange rates, in fact, is the one that delivers the best performance on this dimension. The same FIX regime delivers the lowest value of CPI inflation volatility, but notice that this is not in line with the PS benchmark, which requires sizable CPI inflation variability.

3.2 International Transmission

In this section I proceed by analyzing how the international transmission of shocks works in our model. In *Figure 4* impulse responses of Foreign variables to the same uncorrelated Home productivity shock are reported. Few considerations are in order. First, notice the response of the policy authority. Under the PS regime interest rates fall slightly in Foreign in accordance with the interaction term from equation (33). The loosening of policy is however much larger under the SYMA and FIX regimes, and mimics closely the behavior of the interest rate in Home. The response of Foreign output also differs across rules. The TAYL regime mimics quite closely the PS regime, in that they both imply a clear negative transmission (a recession in Foreign with respect to the boom in Home). On the other hand, the international transmission differs when exchange rate flexibility is limited.

Under the SYMA regime the fall in output is dampened, while under the FIX regime foreign output even experiences a boom at first. This effect is larger the higher is the dampening of the exchange rate response. The reason lies in the fact that a more muted flexibility of the exchange rate limits the appreciation of the terms of trade, which is detrimental for aggregate demand in Foreign. In other words, the monetary policy regime works in the direction of dampening the expenditure switching effect that governs the transmission of shocks across countries. The initial expansion, though, is followed by a recession. One is left wondering, then, what is the implied reduced form sign of the cross-country correlation of output implied by the model.

Cross-country correlations *Table 3* reports selected international correlations implied by our model (conditional on uncorrelated shocks). Let's consider the cross-country correlation of interest rates, a measure of the degree of international coordination of policy. It is interesting to notice that the PS regime is able to produce a positive cross-country correlation of the policy stance without any explicit mandate for the stabilization of the exchange rate being specified in the policy rule of either country. This result can be also attained in the TAYL regime, even though in both cases the policy authority of each country has a concern only for the stabilization of domestic variables. When the goal of stabilizing the exchange rate becomes explicit, as in the SYMA and FIX regime, the correlation of interest rates increases with the degree of exchange rate management, reaching a value of roughly one in a regime of fixed exchange rates. Next, consider the sign of the cross-country correlation of output. In all cases this sign is negative, in sharp contrast with the empirical evidence. The key factor determining this sign is the expenditure switching effect, which diverts foreign demand towards the relatively less expensive domestic goods. Limiting exchange rate flexibility improves the performance of the model on this front. In fact it introduces a positive transmission mechanism working through the stronger coordination of monetary policy. Yet even in the case where this mechanism displays its effects more sharply (the FIX regime) the cross-country output correlation does not improve beyond a value of roughly zero.

4 Conclusions

The New International Macroeconomics is searching for a set of tools to better comprehend the structure of the new Euro-Dollar monetary policy arrangement. This paper aims at providing a contribution in that direction. A rich but tractable framework is proposed for the analysis of alternative international monetary policy arrangements in the form of alternative monetary policy rules. Several results emerge. First, it is found that a simple symmetric Taylor-type rule, which implies trying to stabilize the inflation rate as opposed to the price level, delivers excess volatility in the exchange rate. It is shown that a simple extension of this rule to include a partial feed-back from the exchange rate is able to restore stationarity in the exchange rate for very low values of the feed-back parameter.

Second, a Taylor-type rule featuring only an aggressive response to the deviations of inflation from the target seems to approximate fairly well the full price stability benchmark. This is obtained, though, at the cost of a much higher instability in nominal interest rates. Minimizing the volatility of nominal interest rates emerges as a striking feature of the price stability benchmark regime. This result suggests that welfare measures penalizing excess volatility of interest rates would rank the Taylor-type rule in a relatively poor way.

Finally, the model delivers positive cross-country correlation of interest rates in all cases Interestingly such positive correlation is a feature of the full price stability outcome under purely flexible exchange rates. On the other hand, the model always predicts a negative cross-country correlation of output. In all cases the expenditure switching mechanism that lies at the heart of the international transmission of shocks needs to be amended in order to improve the empirical performance of the model.

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Table 1

Volatility of the Exchange Rate and Monetary Regime

	stdev(e)
PS	2.61
TAYL	*unbound.*
SYMA	3.44
FIX	0.0

Table 2

Macroeconomic Stability and Monetary Regime

st.dev in %	***PS***	**TAYL**	**SYMA**	**FIX**
Home Output	2.52	2.31	2.26	2.09
Home Consumption	1.64	1.48	1.48	1.48
Home Inflation	0.0	0.31	0.3	0.32
Home CPI Inflation	0.46	0.49	0.44	0.24
Terms of Trade	2.61	2.61	2.32	2.02
Home Interest Rate	0.2	0.47	0.44	0.36

Table 3

Cross-country Correlations

	PS	***TAYL***	**SYMA**	**FIX**
*Corr(i,i**	0.21	0.19	0.38	1
Corr(Y,	-0.175	-0.19	-0.15	-0.02

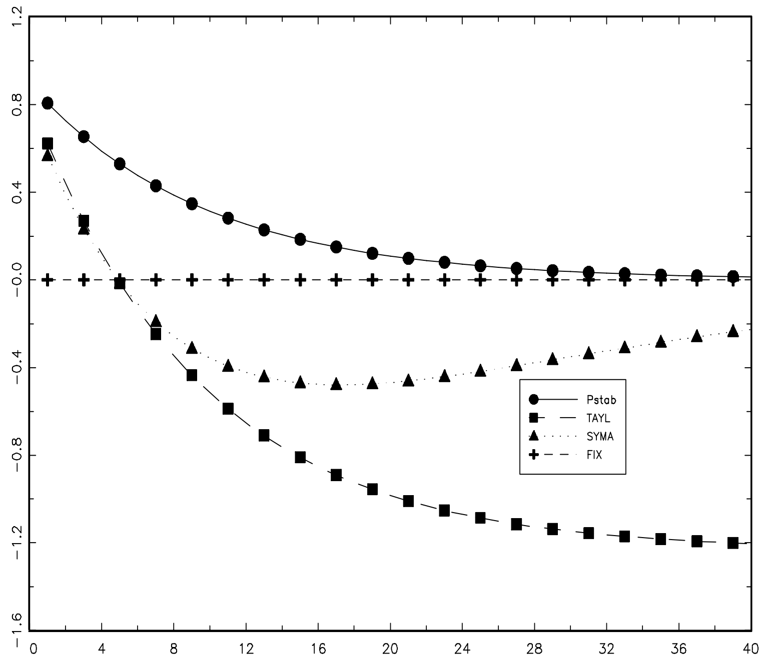

Figure 1: **Nominal Exchange Rate and Monetary Regimes: Impulse Response to a Home Productivity Shock.**

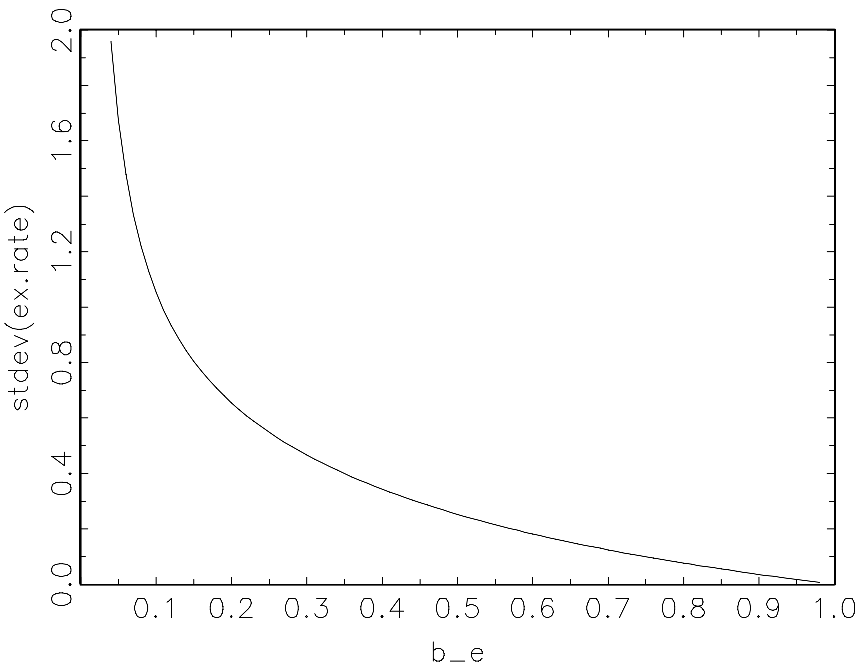

Figure 2: **Nominal Exchange Rate Volatility and Degree of Exchange Rate Management** (b_e).

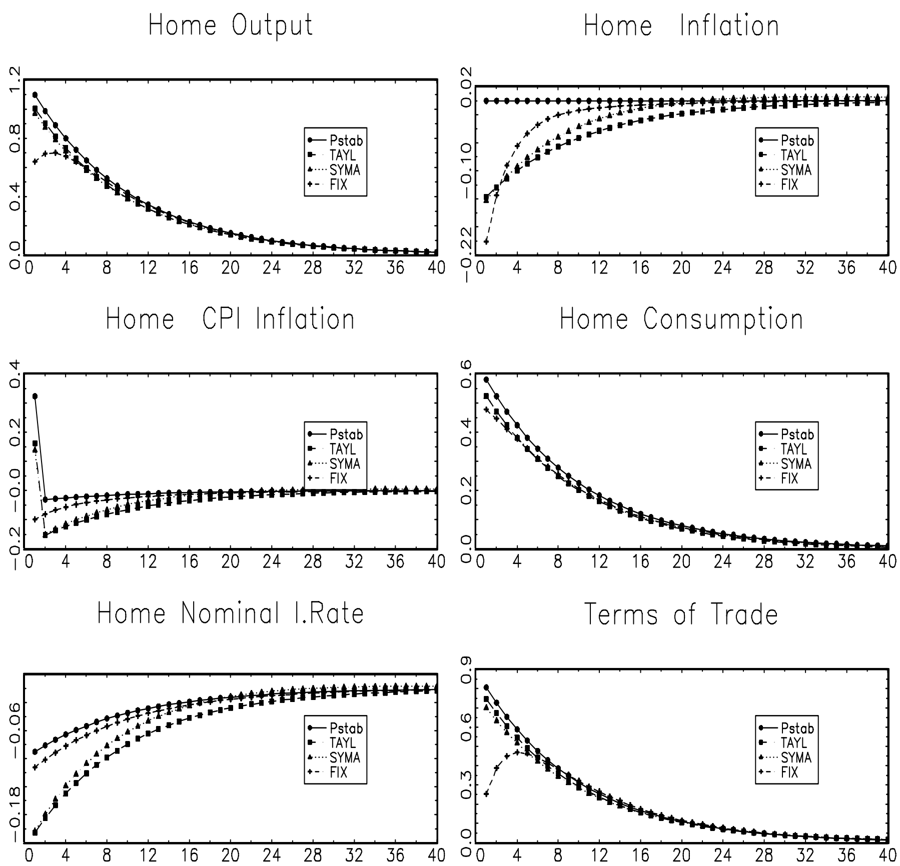

Figure 3: **Impulse Responses to a Home Productivity Shock under Alternative Monetary Regimes**

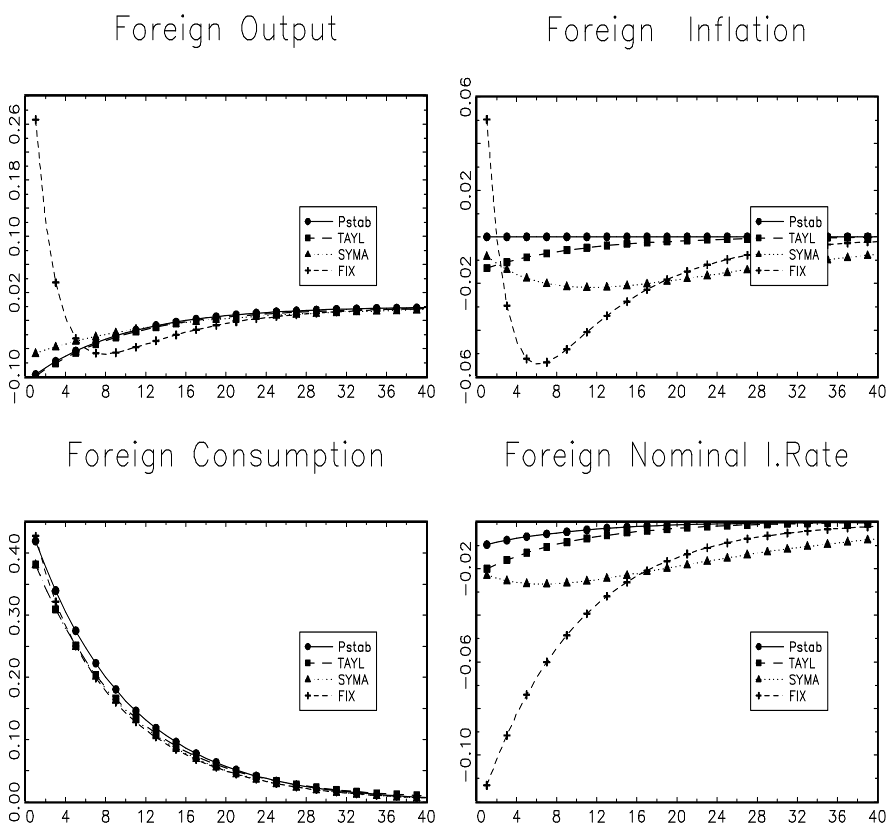

Figure 4: **Impulse Responses of Foreign Variables to a Home Productivity Shock.**

Discussion

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This paper considers several alternative monetary policy arrangements in a two-country model of the dollar-euro relationship. The approach is to derive a specification of equilibrium in terms of a policy rule aimed at price level stabilization under floating rates and then to compare the exchange rate adjustment dynamics in alternative policy regimes against this benchmark. The alternative regimes consist of a modified Taylor rule with floating rates, fixed exchange rates, and managed rates. The paper's main conclusion is that limiting exchange-rate flexibility is a means of enhancing the performance of monetary policy regimes.

The two countries are assumed to be symmetric in structure and to follow symmetric policy rules. In each country, imperfectly competitive firms produce a differentiated product, while utility-maximizing consumers switch between the two products in response to variations in the terms of trade. The object of the exercise is to evaluate alternative stabilization policies relative to the benchmark regime whose target is complete price stability. It is important to note that, unlike the conventional Taylor rule, which stabilizes the inflation rate, the current version stabilizes the price level. In addition, the paper's version of the Taylor rule stabilizes output levels rather than the output gap. An exchange-rate term in the rule set-up represents the open-economy dimension and provides feed-back from the exchange rate; the magnitude of the parameter is adjusted to reflect the type of exchange-rate regime.

One of the strengths of the model is the inclusion of micro-economic foundations to underpin consumer and firm behavior. Dynamics based on forward-looking decisions are part of the basic model structure. The behavior of the central bank, however, is not similarly rooted in microeconomic fundamentals. This creates significant problems for the assessment of alternative policy regimes. This shortcoming would not be serious if objective functions for consumers (and producers) were specified to include the welfare costs of high volatilities upon which the evaluation of regime performance is based. As it stands, references to "excessive" volatility cannot answer questions about whose welfare is being impaired by such volatility.

In the absence of welfare criteria with which to evaluate alternative scenarios, the problem is handled by making the full price stability regime the benchmark scenario against which the performance of the other three regimes is assessed. The focus is thus on volatility of nominal and real variables *relative* to their volatility in the benchmark regime. Against this standard, for example, the modified Taylor rule regime is judged to be inferior because it generates "excess" instability in nominal variables and "excess" smoothness in real variables.

The proposed solution to this problem is to impose limits on the mobility of the exchange rate. The model dynamics depend importantly on the specification, including the assumption of imperfect competition and complete state-contingent asset markets. Stabilizing the price level is equivalent to stabilizing the mark-up over marginal cost, so that a positive productivity shock, for example, provokes monetary expansion as the required policy response.

The alternative regimes produce results that are at once similar to and different from the benchmark rule. Some of the differences are mainly quantitative in nature, with larger swings in the exchange rate, for example, while others are qualitatively distinct. An important similarity is that outputs are negatively correlated across countries in all four scenarios. An important difference is that the nominal exchange rate appreciates in the alternative scenarios, while depreciating in the benchmark case. Still, the real rate depreciates in all cases. The benchmark regime generates large variations in real variables - output, consumption, exchange rate, and terms of trade, while the others cause nominal variables to vary more.

Nominal rigidities, which are introduced into the model in order to mimic the "new international macroeconomics" framework, are specified as a restriction on price setting by firms. Price setting occurs according to a Calvo-type of stochastic, time-dependent rule, which in this model causes price signals to arrive every four quarters. Nominal wages are not subject to rigidities.

The price rigidity applies to the good produced in each country, while price adjustments in trade have no rigidities and occur instantaneously. Thus, movements in exchange rates are passed through fully and without lags and the law of one price holds. This is an important means of introducing variations in the terms of trade, which play a key role in this model.

The presence of nominal rigidities usually raises questions about agents' expectations with respect to the dissolution of rigidities in the long run. In this model, the problem could be handled by allowing expected dissolution of nominal rigidities to be incorporated in the price-expectations term in equation 17, the so-called New Keynesian Phillips curve. This is not done, however. Furthermore, the unwinding of rigidities doubtless affects the adjustment path. It would be useful for the reader to know the extent to which the plotted impulse responses reflect such effects.

As noted, the terms of trade represent a key feature of the open-economy dimension of this model. On the demand side, they play a crucial role in expenditure switching between home and foreign goods and thus in the transmission of shocks.

This expenditure-switching feature of the consumption decision is clearly a main cause of the negative correlation between national outputs. Indeed, the model is really more an optimal-exchange model than an open-economy macro model in the more conventional sense. In this model, outputs and output growth have no independent effects on trade. Hence, the only linkage between the outputs of the two countries is through the aforementioned expenditure-switching operations of households. In such a model, output will rise in the country toward whose product world consumption is moving and fall in the other country. Hence the negative correlation between outputs.

On the supply side, the terms of trade enter into the work-leisure decisions of households through the labor-market specification and from there are passed through to marginal cost. Thus, terms-of-trade changes do not affect cost because the prices of imported inputs change, but because the optimizing behavior of worker-households is affected. While this is certainly a legitimate modeling approach, it seems a bit of a stretch if the objective is to explain the stylized facts of U.S.-EU macro-money relations.

The symmetry assumption also raises questions. In the context of U.S.-EU relations, it is probably less the assumption of symmetry in economic structure, although factor markets seem to behave quite differently in the two countries. It would be difficult to assert that wages are equally flexible (or rigid) in the regions. However, extension of the assumption to central bank policies in terms of assignment of identical (fixed) weights to policy targets in reaction functions such as equations (33) and (34) is questionable. In assigning a larger (fixed) parameter value to the inflation goal, the author argues that price goals are more important than output goals. If, instead, the weights were variable over the cycle, then the weight on output in the European reaction function would be allowed to rise with the intensity of the negative output shock arriving from the United States. This would provide an influence tending to reduce the negative correlation between outputs.

In general, the model results seem to depend fairly importantly on the specifics of this and other calibrations. It would be useful if the author could provide something akin to rebustness tests with respect to key parameter values.

I sum, this is certainly a stimulating paper. Macroeconomic modeling has traditionally been accused of arbitrariness, implicit theorizing, and intellectual sloppiness, so that the inclusion of micro foundations goes a long way toward addressing that complaint. This, in spite of the fact that one might want to argue about the specifics of the micro foundations. The comparison of alternative monetary policy regimes is, of course, an extension of the debate over floating vs. fixed exchange-rate regimes, but focusing the debate on the performance of alternative policy rules provides a new and useful perspective. However, the way in which these alternative scenarios are rated and ranked, leaves much to be desired in that it provides no means of assessing the welfare costs of volatility. While these are unquestionably shortcomings of the present version of the model, they are quite capable of being corrected.

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This paper discusses optimal monetary policy arrangements in a two-country optimising model with nominal price rigidities. The model used is a very nice extension of the class of closed-economy "New Neoclassical Synthesis" models discussed in Rotemberg and Woodford (1997) and Clarida, Gali and Gertler (1999). In my comments I will first briefly review the model. Then, I will discuss the author's characterisation of optimal monetary policy. Finally, I will make some comments on the main conclusions of the analysis.

1. A canonical two-country model

I am convinced that the very elegant two-country model used in this paper (which is in turn based on Gali and Monacelli (2000)) will become one of the workhorse models for international macro-economists. For each country the model comprises of two equations which are open-economy extensions of the standard forward-looking IS curve and the New-Keynesian Phillips curve used, for example, in Clarida, Gali and Gertler (1999). A nice feature of the model is that for given parameters it reverts to the canonical closed-economy model.

The open-economy version of the *forward-looking consumption equation* is given by:

$$c_t = E_t\{c_{t+1}\} - \frac{1}{\sigma}\left(i_t - E_t\{\pi_{t+1}^H\}\right) + \frac{\gamma}{\sigma} E_t\{\Delta s_{t+1}\}$$

The main difference with the closed-economy version is that the terms-of-trade enters the consumption equation through its effect on the ex ante real interest rate, which is computed in terms of consumption prices and thus includes imported goods prices.

The open-economy version of the *forward-looking Phillips curve* is given by:

$$\pi_t^H = \beta E_t\{\pi_{t+1}^H\} + \lambda\{(\tau+\sigma)c_t + \gamma(1+\tau\chi)s_t - (1+\tau)z_t\}$$

Here the main difference with respect to the closed economy model is that the terms of trade enters the real marginal cost or the inverse of the mark-up. It is worth noting that the slope of the Phillips curve with respect to output is identical to that in a closed economy. However, the terms of trade effect provides an additional channel for monetary policy.

Note that by using equation (20) of the paper the real marginal cost can also be written in terms of output as:

$$\mu_t = (\tau + \sigma) y_t + \gamma(1 - \sigma\chi) s_t - (1 + \tau) z_t$$

For a given output level, a terms of trade deterioration has thus two offsetting effects on the marginal cost. First, a terms of trade deterioration increases marginal cost because it increases input prices (such as wages which are set with respect to the consumption price index) relative to the output price. Second, a terms-of-trade deterioration leads to an increase in world demand for home goods and crowds out domestic consumption (for given output). This leads to a higher marginal utility of consumption and lower real wages and marginal cost.

It is worth noting that all the results in the paper are based on the assumption that the latter effect outweighs the former. Based on equation (20) of the paper, this will be the case if $\eta\sigma > \frac{1-2\gamma}{2(1-\gamma)}$. In this case, a terms-of-trade deterioration has a positive effect on the flexible price level of output, which can be obtained by setting the real marginal cost equal to one:

$$y_t^f = \frac{\gamma(\sigma\chi - 1)}{\tau + \sigma} s_t + \frac{1 + \tau}{\tau + \sigma} z_t .$$

Note that when $\gamma = 0$ (closed economy), the expression of the flexible price output level reverts to the one derived in Rotemberg and Woodford (1997).

The terms of trade is determined by an *uncovered interest rate parity condition*:

$$i_t - E_t\{\pi_{t+1}^H\} = i_t^* - E_t\{\pi_{t+1}^{F*}\} + E_t\{\Delta s_{t+1}\}$$

Finally, the model is closed by specifying a rule for the monetary policy instrument which is taken to be the nominal short-term interest rate.

The model is extremely elegant, but at the same time very stylised. There is no persistence at all in the model. Consumption, inflation and the terms of trade are all jump-variables. As its closed-economy counterpart, the model will thus have problems to capture the observed persistence in the empirical data. This can be resolved by introducing habit persistence in the consumption equation and indexation in the Calvo pricing. Moreover, there are no lags in the transmission mechanism of monetary policy: central banks are able to control prices instantaneously. In addition, there is only one source of shocks, productivity shocks, which are assumed to be asymmetric. Finally, there is perfect risk sharing. As a result, wealth redistribution across countries and the current account do not really matter. All these simplifications may of course have an important bearing on the analysis and its conclusions.

2. Optimal monetary policy

The author characterises optimal monetary policy in this framework. As in the closed economy model, optimal monetary policy involves complete stabilisation of the real marginal cost in both countries and a replication of the flexible price equilibrium. The optimal policy rule can be written as:

$$i_t = \gamma \frac{\Omega_2}{\Omega_1} i_t^* - \frac{(1+\tau)(1-\rho)}{\Omega_1} z_t$$

If the condition mentioned above is satisfied, then this policy rule implies a positive correlation between the domestic and foreign interest rate. As in the closed economy case, a negative productivity shock is accompanied by a rise in the interest rate. Optimal monetary policy is countercyclical.

For the parameters used by the author, the response of the domestic interest rate to the foreign interest rate and the domestic productivity shock are respectively given by $\frac{\gamma(1-\gamma)}{2+\gamma(1-\gamma)}$ and $-\frac{2(1-\rho)}{2+\gamma(1-\gamma)}$. The policy response to the foreign interest rate will therefore be the largest when the degree of openness in both economies is 0.5. Similarly, the response to the domestic productivity shock will be smallest when the degree of openness is 0.5. This hump-shaped relationship between the degree of openness and the optimal policy response contrasts with the monotonic relationship found in Gali and Monacelli (2000). The main reason is that in this two-country model foreign monetary policy will react to terms-of-trade movements, the more so, the more open the foreign economy is. Because of the symmetry in the model, an increasing degree of openness of the domestic economy implies that also the foreign economy becomes more open. This endogenous response of foreign monetary policy also explains why the result found in Clarida, Gali and Gertler (2000) that the response to domestic productivity shocks is less strong the greater the degree of openness only holds when the degree of openness is less than 0.5. One implication of this analysis is that in this model the volatility of the exchange rate is likely to be the smallest when $\gamma = 0.5$. In contrast, the degree of exchange rate volatility will be much larger in the case of relatively closed economies like the United States and the euro area. Somewhat more analysis along these lines could be usefully incorporated in the paper.

It is worth noting that the result that price level stability is the outcome under optimal monetary policy is quite particular to this model. More generally, some degree of base level drift is likely to be optimal if there are price level shocks (e.g. due to policy mistakes as in Goodfriend and King, 1997), lags in the transmission mechanism, persistence in inflation (Gaspar and Smets, 2000), or other distortions such as nominal wage rigidities (Erceg, Henderson and Levin (2000)).

In the open-economy context, there is the additional issue that the monetary authorities may be tempted to create surprise deflation in order to push up the terms of trade and thus increase the welfare of the agents in the domestic economy. Beningo and Beningo (2001) show that price stability is a Nash equilibrium only for a particular degree of imperfect competition. In this case, the attempt to push up inflation because of the distortion due to imperfect competition and the socially inefficient level of output is exactly balanced by the open economy attempt to deflate the economy.

3. Results

The main conclusions of the paper are:

1. The exchange rate is non-stationary unless some form of management is undertaken by the respective monetary authorities of the two countries.
2. The Taylor-rule based floating exchange rate regime seems to better approximate the full price stability benchmark, but at the cost of boosting interest rate volatility. In order to limit interest rate volatility, limiting exchange rate flexibility is desirable.

3. In all cases, the model delivers positive cross-country correlations of interest rates but negative cross correlations of output.

Let me make some comments on each of these conclusions.

First, it is not very surprising that the exchange rate becomes stationary when there is a sufficient degree of feedback on the level of the exchange rate. However, I disagree with the statement that some form of exchange rate management is a necessary condition to get stationary exchange rate dynamics. For example, a symmetric policy rule in which the monetary authorities would respond strongly to the domestic price level would also deliver a stable nominal exchange rate. Such a rule can be described as a monetary policy purely geared towards domestic stabilisation objectives. Of course, it would involve an implicit response to the terms of trade because a change in the terms of trade affects the real marginal cost and thus the price level. It would, however, be misleading to describe such a regime as one in which the exchange rate is managed.

Second, the finding that a simple Taylor rule with zero response to output works quite well is also not very surprising given the description of optimal monetary policy. According to the discussion in Section 3.1., this rule appears to be costly in terms of an increased interest rate (and exchange rate) volatility. This is, however, inconsistent with the results presented in Table 2. There are two additional domestically based interest rate rules which would be worth examining. First, it has been argued that a rule in terms of the price level may have beneficial effects in terms of interest rate and inflation volatility compared to the Taylor rule used in the paper for the same reasons as, for example, analysed in Vestin (1999). The fact that under a price level rule a period of inflation needs to be followed by a period of deflation will have a dampening effect on inflation expectations and the current inflation rate. As a result less tightening is necessary. Second, it would also be interesting to explore the benefits of a Taylor rule with a positive response to the properly defined output gap. As discussed before, for the calibrated utility function parameters the flexible-price level of output is given by:

$$y_t^f = \gamma(1-\gamma)(\eta-1)s_t + z_t$$

Such a rule could potentially improve on the simple Taylor rule examined in the paper because it would include a reaction to the terms of trade and the productivity shock that is consistent with the optimal policy response discussed above. Finally, it may also be worth examining the performance of various targeting rules in this model (Svensson (2001)).

One clear drawback of the rules that respond to the nominal exchange rate is that the volatility of the terms of trade is too low. While such an explicit exchange rate response has the advantage of making the nominal exchange rate stationary, the cost is that the equilibrating movements in the terms of trade in response to asymmetric shocks are hindered. This is another reason why it may be more appropriate to respond to the domestic price level if the goal is to obtain a stationary nominal exchange rate.

Third, the model delivers a negative cross-country correlation of output. Strong crowding out effects are a more general feature of this class of models. One obvious way of introducing a positive correlation is to assume that the shocks are correlated. A more interesting approach would be to introduce stronger accelerator effects.

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