OPTIMAL EXCHANGE RATE FLEXIBILITY IN AN ECONOMY WITH INTERSECTORAL RIGIDITIES AND NONTRADED GOODS

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ABSTRACT

This paper develops a two-sector imperfect information stochastic model that can be used to examine the stabilizing features of fixed versus flexible exchange rates. The analysis makes several points. We show that if the monetary authority possesses superior information, a flexible exchange rate will stabilize output in both the tradeable and non-tradeable sectors. However, if the monetary authority does not possess superior information, the optimal regime will depend on the relative magnitudes of domestic versus foreign aggregate shocks, and on the importance of sector-specific variability. A fixed exchange rate rule will minimize the deviation of output from its full information level in tradeables, but will tend to increase the output gap in non-tradeables. In general, we find that the optimal regime implies neither a completely fixed nor a completely flexible exchange rate.

"...supposing that the Common Market countries proceed with their plans for economic union, should these countries allow each national currency to fluctuate, or would a single currency area be preferable?"

R. Mundell, "A Theory of Optimum Currency Areas", 1961.

1 Introduction

It is perhaps surprising that Mundell's question should be as relevant today as it was 30 years ago. But the choice of an optimal exchange rate regime in an open economy has remained the topic of an ongoing, and unresolved, debate for well over three decades. Since the original articles by Mundell (1961) and McKinnon (1963), the issue of what constitutes an optimal currency area has been at the core of this debate. With progress accelerating towards a European Monetary Union (EMU), this old strand of the literature has been revisited, and the arguments first put forth by Mundell and McKinnon have been taken up by both proponents and adversaries of the move towards a single currency.

Traditionally, the concept of an optimal currency area applied only to very small and highly open economics. According to the earlier authors (Mundell, 1961; McKinnon, 1963), the key characteristics of an area over which it was optimal to have a single currency (or alternatively, a credibly fixed exchange rate) included: (a) symmetry of shocks to different regions; (b) relative price flexibility; and, most importantly, (c) high internal geographical and inter-sectoral factor mobility. Where shocks were highly asymmetric, prices sticky or factor mobility lacking, flexible exchange rates were needed to ensure smooth achievement of external and internal balance.

The more recent literature on the relative merits of fixed versus flexible exchange rates shifted attention away from the role of mobility and symmetry, and focused instead on the *rules versus discretion* debate [Barro and Gordon (1983)], and on the time-inconsistency problem associated with discretionary policy-making. Within this framework, the desirability of a fixed exchange rate stemmed from the need to tie the hands of the policy maker, hence increasing the credibility of announced policies [Giavazzi and Pagano (1988)]. This strain of the literature revolved, therefore, around the credibility gains associated with anchoring the exchange rate to an external target.

Although these two lines of thought are by no means inconsistent, they have often been used to defend opposing positions. In this paper, we analyze the choice of an optimal exchange rate regime within an analytical framework that can integrate both types of arguments. In the Mundell and McKinnon vein, our model highlights the role of informational rigidities and sectoral asymmetry of shocks in determining the choice of an exchange rate rule. The paper also links to the credibility literature by examining the fixed exchange rate rule as a mechanism that allows domestic agents to import the better information structure, and hence, superior credibility, of foreign policy makers. In this sense, our arguments parallel those put forth in Giavazzi and Pagano (1988), or Melitz (1988), although we do not consider the inflationary bias problem.

In many regards, our paper represents a return to the earlier tradition of examining the optimality of a given exchange rate regime from the perspective of stabilizing output [as reflected in the papers by Fischer (1977), Gray (1976), or Flood and Marion (1982)]. Building on the *new classical* closed-economy models presented in Lucas (1972 and 1973) and Barro (1976), we develop a simple open-economy version that allows us to study the stabilizing features of alternative monetary policy rules, which are linked in turn to particular exchange rate regimes.

An important element of our strategy lies in the introduction of two sectors –tradeables and a non-tradeables– into our domestic country model. Beyond its analytical appeal, a two-sector approach is justified empirically by the importance of the nontradeable sector in many economies, and by its fundamental role in governing the behavior of the real exchange rate. Many analysts have argued, for example, that the September 1992 exchange rate crisis in the ERM was linked to the unsustainable real appreciation of certain currencies, namely the Italian lira, the Spanish peseta and, to a less extent, the British pound. This real appreciation, at least in the Italian and Spanish case, was rooted in the behavior of the non-tradeable sector [De Gregorio, Giovanninni and Krueger, 1993]. Moreover, by adopting a two-sector model, our analysis serves to link the stabilization literature with the long tradition of two-sector models in international economics.

This two-sector approach allows us to emphasize the role of inter-sectoral rigidities and asymmetry of shocks in determining the optimal choice of an exchange rate regime, and serves to link the paper to the strand of existing literature in the Mundell-McKinnon vein. In this sense, the paper provides a strong analytical neoclassical framework to the discussion of the role of asymmetry, which in our model is rooted in the existence of informational rigidities between sectors.

An interesting implication of our two-sector model is that, depending on the exchange rate rule adopted by policy-makers, the domestic information set of participants in tradeables and non-tradeables may differ. This, in turn, implies that rules which may stabilize output in one sector will fail to do so in another. The introduction of a non-tradeable sector in our asymmetric information model hence adds substantial richness to the results, and leads us to qualify the standard policy prescriptions regarding the advantages of fixed versus flexible rates.

The analysis makes several general points. First, we show that contrary to what has been generally accepted since Mussa (1981), if the monetary authority possesses better information on the economy than private agents, a flexible exchange rate will be preferable since it will stabilize output in both the tradeable and non-tradeable sectors. However, in the more realistic case in which the monetary authority does not possess superior information, the optimal regime will depend on the relative magnitudes of domestic versus foreign aggregate shocks, and on the importance of sector-specific shocks. Furthermore, it will also depend on the weight attached to the tradeable versus the non-tradeable sectors in the policy-maker's objective function. In particular, we find that while a fixed exchange rate rule will minimize the deviation of output from its full information level in tradeables, it will not minimize the output gap in non-tradeables. Rather, this gap will be increased under fixed rates (except in the case where domestic aggregate disturbances far outweigh foreign aggregate disturbances). Thus, as in Mckinnon (1963) but unlike Frenkel and Aizenman (1982), we find that a fixed-exchange rate regime is more advisable in more open economies.

In general, we find that, for most economies, the optimal exchange rate rule is a mixed one –ie. a regime somewhere in between perfectly fixed and perfectly flexible exchange rates. This result provides a rational for exchange rate agreements such as the wide-band regime now in force in the ERM.

The rest of the paper is organized as follows. Section 2 presents the basic two-sector imperfect information model. Section 3 discusses the stabilization properties of a flexible exchange rate rule. Section 4 analyzes the fixed exchange rate case. Section 5 compares the outcomes under both regimes. Section 6 considers the possibility of introducing mixed exchange rate rules (neither perfectly fixed nor perfectly flexible). Finally, Section 7 concludes.

2 The Economy

Our model is essentially a two country version of the Lucas (1973) and Barro (1976) island models. We assume that there is a single nondurable commodity produced in two different countries: foreign and domestic. The foreign country is a large open economy producing the commodity in a single sector. The domestic country is a small open economy that produces the commodity in two sectors (T and N). Sector T (tradeables) is open to the rest of the world in the sense that foreign agents can trade in that sector, and that supply and demand are affected by worldwide shocks. In contrast, only domestic agents are allowed to trade in sector N (nontradeables), where supply and demand are not subject to foreign shocks[1].

Agents can visit any one of the markets in a single period. However, they can only visit

[1]The point of this setup is to ensure that informational flows are superior in the foreign economy. The one versus two-sector modelling can be interpreted, in a way, as a proxy for the domestic economy having more barriers to competition or other sources of informational inefficiencies.

one per period. In each market, participants have information about all aggregate domestic and international variables with a one period lag, except for the exchange rate which is known contemporaneously. They also know the current price of the market in which they participate. These assumptions are meant to proxy for the existence of information costs (or other type of adjusment costs) associated with intersectoral and international trade.

We assume that arbitrage insures that the ex-ante distribution of the different prices is the same in all three markets. This means that (log) relative prices are expected to be zero in all markets. Therefore, the price of foreign output converted into domestic currency is expected equal to that of domestic output. Consequently, the *real exchange rate* is a white–noise variable.

In each economy, there is a public sector which transfers fiat money in every period to all nationals. Money is the only store of value in this economy. Domestic agents are free to spend the money issued by the domestic government in any foreign or domestic sector. Similarly, foreign agents can freely spend the money transferred to them by the foreign authority in the foreign sector or in the domestic traddeable sector. Foreign trade takes place whenever a foreign (domestic) agent decides to spend his real balances in a domestic (foreign) sector. This decision, however, must be taken one period in advance.

Our *island model* assumptions allow factors to move across sectors and countries. Again, factor mobility must be decided one period in advance and the decision cannot be reverted within a single period of time.

2.1 The Foreign Economy

As in the islands models of Lucas (1973) and Barro (1976) island models, we specify supply and demand equations in the foreign economy as a (log) linear function of domestic wealth and of the current price relative to the expected next-period price. We assume that the domestic economy is small enough to have a negligible impact on the demand of the foreign country.

Supply and demand in the foreign economy are subject to additive real shocks that are assumed to be infinitely persistent. The supply and demand functions have the form:

$$\begin{aligned}
\tilde{Y}_t^s &= \tilde{\alpha}^s \left(\tilde{P}_t - E\tilde{P}_{t+1}|\tilde{I}_t\right) + \tilde{v}_t^s \\
\tilde{Y}_t^d &= \tilde{\alpha}^d \left(\tilde{P}_t - E\tilde{P}_{t+1}|\tilde{I}_t\right) + \tilde{\beta}\left(\tilde{M}_t + E\ \Delta\tilde{M}_{t+1}|\tilde{I}_t - E\tilde{P}_{t+1}|\tilde{I}_t\right) + \tilde{v}_t^d,
\end{aligned}$$

where superscripts s and d indicate supply and demand respectively, and $\tilde{}$ refers to variables of the foreign economy. P_t, M_t, Y_t and v_t are prices, money, output and the real shock respectively. I_t denotes agents' information set.

In the above specification we have used the sum of currently available money plus the expected next-period money transfer as a proxy for wealth. We have also assumed, without loss of generality, that there is no wealth effect on output supply and that there are zero-intercepts in the supply and demand equations. The latter just implies a particular normalization of the units in which output is measured.

We define the excess demand shock as $\tilde{v}_t \equiv \tilde{v}_t^d - \tilde{v}_t^s$ and assume that it follows the integrated process:

$$\tilde{v}_t = \tilde{v}_{t-1} + \tilde{u}_t,$$

where $\tilde{u}_t$ is *i.i.d.* and normally distributed with zero-mean and variance $\sigma_{\tilde{u}}^2$.

We can write the market clearing price for the foreign sector as

$$\alpha\tilde{P}_t = (\tilde{\alpha} - \tilde{\beta})E\tilde{P}_{t+1}|\tilde{I}_t + \tilde{\beta}(\tilde{M}_t + E\Delta\tilde{M}_{t+1}|\tilde{I}_t) + \tilde{v}_t, \tag{1}$$

where $\alpha \equiv \tilde{\alpha}^s - \tilde{\alpha}^d$ is the excess supply price elasticity.

Now, in order to solve for $\tilde{P}_t$, we have to assume an exogenous process for the money supply. For simplicity, we assume that money in the foreign country is generated by a random walk process:

$$\tilde{M}_t = \tilde{M}_{t-1} + \tilde{m}_t,$$

where $\tilde{m}_t$ is $i.i.d$ and normally distributed with zero-mean and variance $\sigma^2_{\tilde{m}}$. $\tilde{m}_t$ is also independent of $\tilde{u}_t$.

This assumption implies the following solution for the stochastic difference equation (1):

$$\tilde{P}_t = \tilde{M}_t + \frac{1}{\tilde{\beta}}\tilde{v}_t. \tag{2}$$

This solution is independent of the information structure assumed for agents of the foreign country. Since there is only one sector in that economy ,there is no possible confusion between aggregate and sectoral shocks and, therefore, equilibrium prices and output for the imperfect information economy are equivalent to those of a perfect information economy.

This conclusion would be different if we had assumed a multisector economy for the foreign country. In that case, equilibrium prices and output would depend on the relation between relative and aggregate shocks. But, since we assumed that the domestic economy is small relative to the foreign economy, we would still find no influence of the domestic variables or the exchange rate on foreign prices and output. Given that we are interested in anayzing output gaps associated with the different exchange rate regimes in the small domestic economy, our single foreign sector assumption seems to be convenient.

2.2 The Domestic Economy

The non-tradeables sector (N) of the domestic economy is modeled in the same way as the foreign sector. Thus, demand and supply depend on domestic wealth, and on current prices relative to future expected prices. However, supply and demand depend also on a sector-specific relative shock $(\epsilon_t(N))$:

$$
\begin{aligned}
N_t^s &= \alpha^s \left(P_t(N) - EP_{t+1}|I_t(N)\right) + v_t{}^s + \epsilon_t^s(N) && (3)\\
N_t^d &= \alpha^d \left(P_t(N) - EP_{t+1}|I_t(N)\right) + \beta \left(M_t + E\Delta M_{t+1}|I_t(N) - EP_{t+1}|I_t(N)\right) \\
&+ \; v_t^d + \epsilon_t^d(N), && (4)
\end{aligned}
$$

where N_t is output in the domestic nontradeables sector, $v_t \equiv v_t^d - v_t^s$ is the domestic aggregate excess demand shock and $\epsilon_t(N) \equiv \epsilon_t^d(N) - \epsilon_t^s(N)$ is the sectoral excess demand shock.

The tradeables sector (T) incorporates two differences with respect to the non-tradeables sector. First, since foreign agents have access to that sector, output demand depends also on foreign wealth. Second, in addition to a domestic aggregate shock and a sectoral shock, output demand and supply are affected by the international (foreign) shock:

$$
\begin{aligned}
T_t^s &= \alpha^s \left(P_t(T) - EP_{t+1}|I_t(T)\right) + v_t{}^s + \epsilon_t^s(T) + \tilde{v}_t{}^s && (5)\\
T_t^d &= \alpha^d \left(P_t(T) - EP_{t+1}|I_t(T)\right) + \beta \left(M_t + E\Delta M_{t+1}|I_t(T) - EP_{t+1}|I_t(T)\right) \\
&+ \; \gamma \left(\tilde{M}_t + E\Delta\tilde{M}_{t+1}|I_t(T) - E\tilde{P}_{t+1}|I_t(T)\right) + v_t^d + \epsilon_t^d(T) + \tilde{v}_t{}^d, && (6)
\end{aligned}
$$

where γ is the foreign wealth elasticity of domestic demand. For simplicity, we assume that this elasticity is equal to the wealth elasticity in the foreign country (i.e. $\gamma = \tilde{\beta}$)[2].

As for the foreign economy, we assume that the domestic excess demand shock follows the random walk process $v_t = v_{t-1} + u_t$ where u_t is an *i.i.d* normal random variable with zero mean and variance σ_u^2. The sectoral shocks are *i.i.d.* normal random variables with zero mean and variance σ_ϵ^2 and satisfy $\epsilon_t(N) = -\epsilon_t(T)$.

Equating demand and supply in sector N reveals that the market clearing price must

[2]Notice that since we have assumed ex-ante arbitrage, expected next period prices must be equal in all three sectors when converted into the same currency. That is why the real exchange rate does not appear directly in equation (6).

satisfy:

$$\alpha P_t(N) = (\alpha - \beta)EP_{t+1}|I_t(N) + \beta(M_t + E\Delta M_{t+1}|I_t(N)) + v_t + \epsilon_t(N). \qquad (7)$$

Similarly, for sector T:

$$\alpha P_t(T) = (\alpha - \beta)EP_{t+1}|I_t(T) + \beta(M_t + E\Delta M_{t+1}|I_t(T)) + v_t + \epsilon_t(T). \qquad (8)$$

No foreign variable appears in equations (7) and (8). Prices and output can be affected by foreign variables only if those variables help to forecast future money balances.

2.3 The Exchange Rate

Since we have assumed that expected future (log) relative prices are zero in all markets, Purchasing Power Parity must hold ex-ante. Therefore, we can define the exchange rate (e_t) in the economy as the domestic price of the tradeables sector relative to the foreign price (as in most of the two-sector monetary models): $e(t) \equiv P_t(T) - \tilde{P}_t$.

This definition of the exchange rate implies that PPP verifies also ex-post for tradeable goods. In principle, since instantaneous arbitrage is not possible, there is no reason to believe that PPP holds period by period. Since we are interested in analyzing the effects of monetary policy rules implied by different exchange rate regimes, this definition of the exchange rate seems to be not only practical, but also reasonable. As long as PPP holds ex-ante, the (fixed exchange rate) money rule that attempts to estabilise $P_t(T) - \tilde{P}_t$ can be realistically reinterpreted as an exchange rate policy that targets a specific parity but permits stationary deviations around it.

The implementation of a fixed exchange rate money rule requires that monetary authorities be able to react instantaneously to incipient deviations of the prevailing exchange rate. Our assumptions allow us to model this behavior in a rather simple way. Instead of complicating considerably the model by considering simultaneously the currency markets and the good markets, we just need to assume that there exists an international agency that continuously provides world-wide relative prices of the tradeable good.

Flexible and fixed exchange rate regimes will only differ in that they imply different money rules. Under a flexible rule, money follows an exogenous stochastic process (as in the foreign economy); under a fixed regime, money follows an endogenous process such that the expression $(P_t(T) = \tilde{P}_t)$ becomes a solution of equation (8).

3 Flexible Exchange Rates

We begin by examining the flexible exchange rate case. First, we obtain expressions for equilibrium output and prices under perfect information. We then analyze the imperfect information case.

Throughout the section, we assume for simplicity that the money supply follows an exogenous process similar to that of the foreign money supply:

$$M_t = M_{t-1} + m_t, \tag{9}$$

where m_t is $i.i.d$, $N(0, \sigma_m^2)$ and independent of u_t and $\varsigma_t(T)$.

3.1 Perfect Current Information

Suppose agents know all aggregate and sectoral variables contemporaneously. Then, for all agents: $E_t M_{t+1} = M_t$. Using the method of undetermined coefficients we find that from equations (7) and (8) equilibrium sectoral prices are then given by:

$$P_t(N) = M_t + \frac{1}{\beta} v_t + \frac{1}{\alpha} \epsilon_t(N) \tag{10}$$

and

$$P_t(T) = M_t + \frac{1}{\beta}v_t + \frac{1}{\alpha}\epsilon_t(T) \tag{11}$$

Using expressions (10) and (11) and defining the aggregate domestic price (P_t) as a simple geometric average of the sectoral prices, we obtain that aggregate prices resemble those found for the foreign economy. Similarly, we also obtain that relative prices satisfy $E_t(P_{t+1}(N) - P_{t+1}(T)) = 0$, as is required by our no-arbitrage assumption.

Calculating expected next period prices and substituting them into the supply equations (5) and (3) yields the following expressions for the equilibrium levels of output:

$$N_t^F = \frac{\alpha^s}{\alpha}\epsilon_t(N) + v_t^s + \epsilon_t^s(N) \tag{12}$$

and

$$T_t^F = \frac{\alpha^s}{\alpha}\epsilon_t(T) + v_t^s + \tilde{v}_t^s + \epsilon_t^s(T), \tag{13}$$

where superscript F stands for full information outcome. Not surprisingly, under full information, money and the exchange rate have no effect on equilibrium output. Finally, comparing equations (2) and (11) we find that under perfect information, the exchange rate follows an integrated process:

$$e_t \equiv P_t(T) - \tilde{P}_t = e_{t-1} + \omega_t$$

where $\omega_t = m_t - \tilde{m}_t + \frac{1}{\beta}u_t - \frac{1}{\beta}\tilde{u}_t + \frac{1}{\alpha}(\epsilon_t(T) - \epsilon_{t-1}(T))$

3.2 Imperfect Current Information

Assume now that agents have current information only on the exchange rate and on the price of the sector where they are located. Since money follows an exogenous process which does not depend on international data, a natural guess for the equilibrium price of sector N is:

$$P_t(N) = C_1 M_{t-1} + C_2 m_t + C_3 v_{t-1} + C_4 u_t + C_5 \epsilon_t(N). \tag{14}$$

According to equation (7), this proposed solution implies that by observing the current price, agents who are trading in sector N are able to infer a linear combination of the aggregate real and nominal shocks, and the sectoral shock. By projecting each of those shocks on that linear combination and the lagged macro-variables, they form the best linear predictors of the shocks. Using those linear predictors when calculating $EP_{t+1}|I_t(N)$ and $EM_{t+1}|I_t(N)$ in equation (7), and relying on the method of undetermined coeficients we find that:

$$\begin{aligned} P_t(N) &= M_{t-1} + \left[\theta_m + \theta_u + \frac{\beta}{\alpha}(1 - \theta_m - \theta_u)\right]\left[m_t + \frac{1}{\beta}(u_t + \epsilon_t(N))\right] + \epsilon_t(N) \\ &+ \frac{1}{\beta} v_{t-1}, \end{aligned} \tag{15}$$

where

$$\theta_m = \frac{\beta^2 \sigma_m^2}{\beta^2 \sigma_m^2 + \sigma_u^2 + \sigma_\epsilon^2}$$

and

$$\theta_u = \frac{\sigma_u^2}{\beta^2 \sigma_m^2 + \sigma_u^2 + \sigma_\epsilon^2}.$$

Similarly, the equilibrium price for sector T is

$$\begin{aligned} P_t(T) &= M_{t-1} + \left[\theta_m + \theta_u + \frac{\beta}{\alpha}(1 - \theta_m - \theta_u)\right]\left[m_t + \frac{1}{\beta}(u_t + \epsilon_t(T))\right] + \epsilon_t(T) \\ &+ \frac{1}{\beta} v_{t-1}. \end{aligned} \tag{16}$$

Substituting expressions (15) and (16) into the supply equations (3) and (5), and substracting equations (12) and (13) respectively, yields an expression for the deviations of output from its full information level in each sector:

$$N_t - N_t^F = \frac{\alpha^s \beta}{\alpha}(1-\theta_m-\theta_u)(m_t+\frac{1}{\beta}u_t) - \frac{\alpha^s}{\alpha}(\theta_m+\theta_u)\epsilon_t(N) \tag{17}$$

$$T_t - T_t^F = \frac{\alpha^s \beta}{\alpha}(1-\theta_m-\theta_u)(m_t+\frac{1}{\beta}u_t) - \frac{\alpha^s}{\alpha}(\theta_m+\theta_u)\epsilon_t(T). \tag{18}$$

As in the standard closed-economy island models, we find that unexpected money growth has a real effect in both sectors and that, therefore, the Phillips curve has a finite slope. This result arises from agents' confusion between the aggregate shock $(m_t + \frac{1}{\beta}u_t)$ and the sector-specific shocks ϵ_t. The slope of the Phillips curve, $(1-\theta_m-\theta_u)$, is given by the proportion of total aggregate uncertainty that is due to sectoral shocks.

The exogenous money rule we have assumed implies that the slope of the Phillips curve for both sectors is independent of the foreign variables and the exchange rate. This is so because those foreign variable add no information that could be used in forecasting money and prices. We can also show, by comparing expression (2) and (16), that as in the full information case the exchange rate follows an integrated process.

3.3 Monetary Authority has Superior Information

As in the standard closed economy Barro model, assuming that the authority has superior information about the aggregate variables implies that, by following an autonomous money rule, the policy-maker is able to lead the economy to its full information equilibrium.

To see this, assume that the monetary authority is able to observe contemporaneouly the aggregate real domestic shock v_t. Then consider the contemporaneous feedback rule:

$$\Delta M_t = m_t - \frac{1}{\beta}u_t. \tag{19}$$

One can show that by using this money rule, the monetary authority is minimizing the variance of the aggregate shocks in this economy for any given value of σ_m^2. Furthermore, if the authority is able to control m_t by setting $\sigma_m^2 = 0$, he can push aggregate variability to zero, eliminating any possible confusion between aggregate and sectoral shocks $((1 - \theta_m - \theta_u = 0))$. In this case, from equations (17) and (18) we can see that equilibrium output corresponds to that obtained under full current information.

The equilibrium price for sector T is in this case given by:

$$P_t(T) = M + \frac{1}{\beta}(v_{t-1} + \epsilon_t(T)). \tag{20}$$

We can now calculate the equilibrium level for the exchange rate when policy makers have perfect contemporaneous aggregate information and follow the optimal money rule. Combining the expression for equilibrium prices in the foreign sector (equation (2)) and that for sector T (equation (20)) implies that the exchange rate is time variant and follows an integrated process.

In this simple economy, if monetary authorities possess full current information about aggregate variables, it is optimal to set a monetary policy that implies flexible exchange rates. This is because a better informed policymaker can eliminate the confusion between sectoral and aggregate shocks by setting a money rule which is independent of foreign variables.

This result contrasts with the ideas proposed by Mussa (1981), who claims that a fixed exchange rate regime is superior to a flexible one when policy makers are better informed than private agents about the value of the *fundamental* exchange rate. In our set–up, deviations from *fundamentals* are always transitory and independent of the exchange rate regime in force. Instead, the output gap is caused by agents's confusion between sectoral and aggregate uncertainty. Policy makers who posses better aggregate information can solve that confussion only by implementing an autonomus money rule which incoporates such information. That monetary autonomy is incompatible with fixed exchange rates.

In any case, the assumption that the monetary authorities possess superior information is not too appealing. It is, hence, more interesting to continue analysing the case in which monetary authorities posses the same aggregate information as private agents. We will study now the fixed exchange rate case.

4 Fixed exchange rates

Under a credible fixed–exchange rate regime, the money supply in the domestic economy must follow an endogenous process that sets the equilibrium price of the domestic tradeable sector equal to that of the foreign sector [3]. Thus we require $\tilde{M}_t + \frac{1}{\beta}\tilde{v}_t$ to be the solution of the stochastic difference equation (8).

Using again the method of undetermined coefficients we find that $\tilde{P}_t = P_t(T)$ is the solution to equation (8) when the money supply satifies the condition:

$$M_t + E\Delta M_{t+1}|I_t(T) = \tilde{P}_t - \frac{1}{\beta}(v_t + \epsilon_t(T)), \tag{21}$$

where $\tilde{P}_t$ is defined by expresion (2).

Condition (21) implies that the domestic money supply follows the process:

$$M_t = \tilde{P}_t - \frac{1}{\beta}(v_t + \epsilon_t(T) + \epsilon_{t-1}(T)). \tag{22}$$

The money rule is equivalent to a contemporaneous feedback rule where money growth depends on foreign shocks, the domestic real aggregate shock and the sectoral shock in tradeables. Since the monetary authority only obtains information about the relevant variables with one period lag –except for the exchange rate, which is known contemporaneously–, that money rule is not directly implementable. By reacting to deviations of the exchange rate from its target,

[3]Through this discussion we are assuming without loss of generality that the the fixed exchange rate is equal to 1.

however, the monetary authority is indirectly implementing the rule expressed by equation (22).

We are now ready to obtain equilibrium output and prices for the domestic economy.

4.1 The Tradeables Sector

We have already seen that the equilibrium price is

$$P_t(T) = \tilde{P}_t = \tilde{M}_t + \frac{1}{\beta}\tilde{v}_t. \tag{23}$$

Then

$$EP_{t+1}|I_t(T) = E\tilde{P}_{t+1}|I_t(T) = \tilde{P}_t(T) = P_t(T), \tag{24}$$

which implies that, from the specification of the output supply equation, output is equal to

$$T_t = v_t^s + \tilde{v}_t^s + \epsilon_t^s(T). \tag{25}$$

This is equivalent to the full information solution when money follows the stochastic process (22)[4].

By making the domestic price equal to the foreign one, agents are are able to use the better predictability of the latter. Thus, the fixed exchange rate regime is able to stabilize the tradeable sector completely by allowing agents participating in sector T to import the same information that makes the foreign economy able to attain the full information equilibrium. Although this result is grounded in a different rationale, it resembles that put forth by Giavazzi and Pagano (1988) and other recent literature on the European Exchange Rate Mechanism.

[4]Notice that the full information solution is different to that corresponding to the random walk money rule. However the difference does not depend on money growth and has zero mean. Therefore that discrepancy is irrelevant for the purpose of this paper.

4.2 The Non-Tradeables Sector

Substituting the money rule (22) into equation (7) and using once again the method of undetermined coefficients, we find that the solution for the equilibrium price of sector N is:

$$\begin{aligned} P_t(N) &= \tilde{M}_{t-1} + \left[\frac{\alpha-\beta}{\alpha}(1-\theta_{\tilde{m}}-\theta_{\tilde{u}}) + \frac{\beta}{\alpha}\right]\left[\tilde{m}_t + \frac{1}{\tilde{\beta}}\tilde{u}_t + \frac{1}{\beta}(\epsilon_t(N)-\epsilon_t(T))\right] \\ &+ \frac{1}{\tilde{\beta}}\tilde{v}_{t-1} \end{aligned} \tag{26}$$

and that equilibrium output is given by:

$$\begin{aligned} N_t &= \frac{\alpha^s\beta}{\alpha}(1-\theta_{\tilde{m}}-\theta_{\tilde{u}})\left[\tilde{m}_t + \frac{1}{\tilde{\beta}}\tilde{u}_t + \frac{1}{\beta}(\epsilon_t(N)-\epsilon_t(T))\right] \\ &+ v_t^s + \epsilon_t^s(N), \end{aligned} \tag{27}$$

where

$$\theta_{\tilde{m}} = \frac{\tilde{\beta}^2\sigma_{\tilde{m}}^2}{\tilde{\beta}^2\sigma_{\tilde{m}}^2 + \sigma_{\tilde{u}}^2 + 4(\frac{\tilde{\beta}}{\beta})^2\sigma_\epsilon^2}$$

and

$$\theta_{\tilde{u}} = \frac{\sigma_{\tilde{u}}^2}{\tilde{\beta}^2\sigma_{\tilde{m}}^2 + \sigma_{\tilde{u}}^2 + 4(\frac{\tilde{\beta}}{\beta})^2\sigma_\epsilon^2}.$$

Those results indicate that although the fixed exchange rate regime is able to stabilize sector T, the equilibrium level of output for the nontradeable sector is not equal to the full information solution. We obtain a Phillips curve relation in sector N, which arises because agents cannot completely separate unanticipated price movements into relative and absolute components.

However, there are two differences between this result and that obtained with flexible rates. First, the relevant aggregate variability is that of the foreign economy. Second, asumming that $\tilde{\beta} \simeq \beta$, the impact of the sector specific variability on total uncertainty is about 4 times higher than under flexible exchange rates. This effect is caused by the endogenous process followed by the domestic money supply which incorporates the response to the relative shocks and that adds up to the direct effect of these shocks on total uncertainty.

In the next section we compare the output gap for this sector under the flexible and the fixed exchange rate regimes.

5 Comparing Exchange Rate Regimes

The usual way to compare the stabilizing properties of each exchange-rate regime is by evaluating the squared deviation of output from its full information level.

For the flexible exchange rate regime, this calculation yields:

$$E(N_t - N_t^F)^2 = E(T_t - T_t^F)^2 = \left(\frac{\alpha^s}{\alpha}\right)^2 \frac{\sigma_A^2 \sigma_\epsilon^2}{\sigma_A^2 + \sigma_\epsilon^2} \tag{28}$$

where

$$\sigma_A^2 = \beta^2 \sigma_m^2 + \sigma_u^2 \tag{29}$$

Similarly, for the fixed exchange rate regime, we find that:

$$E(N_t - N_t^F)^2 = \left(\frac{\alpha^s}{\alpha}\right)^2 \frac{4\sigma_{\tilde{A}}^2 \sigma_\epsilon^2}{\sigma_{\tilde{A}}^2 + 4\left(\frac{\tilde{\beta}}{\beta}\right)^2 \sigma_\epsilon^2}, \tag{30}$$

where

$$\sigma_{\tilde{A}}^2 = \tilde{\beta}^2 \sigma_{\tilde{m}}^2 + \sigma_{\tilde{u}}^2 \tag{31}$$

and

$$E(T_t - T_t^F)^2 = 0. \tag{32}$$

These results suggest that, while the fixed exchange rate regime eliminates the output gap for the tradeables sector, it can increase the output gap for the non-tradeables sector. Assuming that $\tilde{\beta} \simeq \beta$, the difference between the output gap for nontradeables under flexible and fixed exchange rates depends on the magnitude of the sectoral shifts, and of the domestic and foreign aggregate shocks. Under the fixed exchange rate regime, the relevant aggregate shock is the foreign shock; under the flexible exchange rate regime it is the domestic one that is relevant. On the other hand, the impact of the sectoral shock on total uncertainty is four times higher under fixed exchange rates that under free floating. Therefore, if $\sigma^2_{\tilde{A}}$ is not much smaller than σ^2_A, the fixed exchange rate regime will introduce a larger output gap in the nontradeables sector than the flexible one. The reason for this is that the domestic money supply incorporates responses to the relative shocks, which increase the unpredictability of future money supply and prices in sector N. The additional uncertainty decreases the ability of agents in sector N to distinguish between sectoral and aggregate shocks and, therefore, increases the deviation of output from its full information level.

Hence, if aggregate real variability is not much larger in the domestic than in the foreign country, and if the nontradeable sector is relatively important in the economy, the fixed exchange rate regime has poor stabilizing properties. In this case, policies oriented to decrease domestic nominal volatility under flexible exchange rates are superior. Conversely, in highly open economies with unstable real sectors, a fixed exchange rate regime is particularly useful for stabilizing production.

However, extreme exchange rate rules (perfectly fixed or perfectly flexible) need not be the only solution. Perhaps, some kind of mixed exchange rate rule could improve, under some circumstances, the stabilizing properties of either extreme regime. This will be analyzed in the next section.

6 Mixed Exchange-Rate Rules

We model intermediate exchange rate regimes as the processes resulting from allowing the domestic central bank to decide in each period whether to follow a fixed exchange rate policy that implies an endogenous money rule, or to employ an autonomous money rule that implies a flexible exchange rate. We assume, for simplicity, that this decision is taken based on exogenous probabilities.

Assume that at every period, with probability p, the monetary authority surrenders its autonomy and follows a fixed exchange rate policy. With probability $(1-p)$ the monetary policy follows the simple process $M_t = M_{t-1} + m_t$. Since we focus on the case in which monetary authorities do not posses superior aggregate information, other conceivable autonomous money rules would not produce different results.

In a particular market J ($J = N, T$), agents' expectations about the current value of money supply are given by:

$$E(M_t|I_t(J)) = (1-p)E(M_{t-1} + m_t|I_t(J)) + pE(\tilde{P}_t - \frac{1}{\beta}(v_t + \epsilon_t(T) + \epsilon_{t-1}(T))|I_t(J)).$$

Therefore, p $(0 \leq p \leq 1)$ can be interpreted as a measure of the degree of credibility of the fixed exchange-rate regime. Alternatively, $1-p$ can be interpreted as a measure of the degree of exchange rate flexibility that the monetary authority is willing to accept.

In the appendix, we show that the deviation of output from its full information level in the tradeables sector under a mixed rule is given by:

$$T_t - T_t^F = (1-p)\frac{\alpha^s}{\alpha}\{(1-\theta_m-\theta_u)(\beta m_t + u_t) - (\theta_m + \theta_u)\epsilon_t(T)\}. \tag{33}$$

Since agents who trade in sector T know the equilibrium price in the foreign country there is no possible confussion between domestic and foreign shocks. Thus, the information gap in this sector is caused completely by the confusion between domestic aggregate and sectoral shocks, which arises when there exists a positive degree of autonomy in the domestic monetary policy. Consequently, for this mixed money rule with $p \neq 1$, the slope of the Phillips curve is not zero, but only domestic unexpected money growth affects output.

The expected squared deviation of output in the tradeables sector is:

$$E(T_t - T_t^F)^2 = (1-p)^2 \left(\frac{\alpha^s}{\alpha}\right)^2 \frac{\sigma_\epsilon^2 \sigma_A^2}{\sigma_A^2 + \sigma_\epsilon^2}. \tag{34}$$

The output gap for the mixed rule is, not surprisingly, a monotonic function of the exchange-rate flexibility parameter p. The closer the rule is to that of a fixed exchange rate ($p \simeq 1$), the closer the equilibrium output is to the full information solution. Conversely, the higher the degree of monetary autonomy, the more important the confusion between aggregate and sectoral shocks and, consequently, the higher the output gap.

In the appendix, we also show that under the mixed rule, the deviation of output from its full information level in non-tradeables is:

$$\begin{aligned} N_t - N_t^F &= \frac{\alpha^s}{\alpha}\left\{(1-H)[(1-p)(\beta m_t + u_t) + p\left(\frac{\beta}{\tilde{\beta}}\right)(\tilde{\beta}\tilde{m}_t + \tilde{u}_t)]\right. \\ &- \left.(1+p)H\epsilon_t(N)\right\}, \end{aligned} \tag{35}$$

where

$$1 - H = \frac{(1+p)^2\sigma_\epsilon^2}{(1-p)^2\sigma_A^2 + p^2\sigma_{\tilde{A}}^2\left(\frac{\beta}{\tilde{\beta}}\right)^2 + (1+p)^2\sigma_\epsilon^2}. \tag{36}$$

In the nontradeables sector, the mixed rule increases the sources of uncertainty by including foreign and domestic contemporaneous shocks in the money rule. Agents are unable to distinguish between aggregate domestic and foreign shocks, and between aggregate and sector specific shocks. As long as the slope of the Phillips curve is the proportion of total aggregate uncertainty due to sector specific shocks, both domestic and foreign money shocks will have effects on output in the nontradeables sector.

In order to analyze the stabilizing properties of the mixed exchange-rate rule for the nontradeable sector, we compute the squared expected deviation of output:

$$E(N_t - N_t^F)^2 = \left(\frac{\alpha^s}{\alpha}\right)^2 \frac{(1+p)^2\sigma_\epsilon^2\left[(1-p)^2\sigma_A^2 + p^2\sigma_{\hat{A}}^2\right]}{(1-p)^2\sigma_A^2 + p^2\sigma_{\hat{A}}^2 + (1+p)^2\sigma_\epsilon^2}. \tag{37}$$

Simple inspection of equation (37) shows that a higher p (lower exchange-rate flexibility) increases the weight attached to both sector-specific and foreign aggregate uncertainty, while reducing the weight of aggregate domestic variability. If $\sigma_{\hat{A}}^2$ is large enough relative to σ_A^2, an increase in p will increase both sector-specific and aggregate variability. Therefore, total variability will be unambigously higher and the output gap will be larger.

If domestic aggregate variability is larger than foreign aggregate variability, as the money rule moves closer to a fixed exchange rate regime (as p goes to 1), we observe two different counteracting effects. On the one hand, a higher p implies a higher response to sector specific shocks, and hence an increase in sectoral variability. On the other, a higher p increases the weight attached to the foreign shock component of aggregate variability, while reducing the importance of the domestic part . The net effect on total variability will depend on the relative magnitudes of the aggregate shocks (both domestic and foreign) and of the sector-specific shocks, as well as on the initial value for p. Therefore, in general, the effect of tightening the exchange rate regime on the output gap will be parameter-specific.

The determinants of the output gap are illustrated in figures 1a and 1b, which present the output gap in the nontradeables sector as a function of the exchange-rate flexibility parameter (p), for different values of the foreign aggregate and the sector-specific variability parameters relative to domestic aggregate variability. The graphs show that, for high values of $\sigma_{\hat{A}}^2$ relative to σ_A^2, the output gap in non-tradeables is an increasing function of p. In this case, the optimal regime is one characterized by completely flexible exchange rates ($p = 0$). However, for small values of the foreign shock variance, the fixed exhange rate regime ($p = 1$) leads to an output gap which is smaller than that resulting under a flexible exchange rate regime. Moreover, if the variance of the foreign shocks is smaller than the variance of aggregate domestic shocks, the output gap is S-shaped (for small sectoral variances as in figure 1.a) or U-shaped (for high sectoral variances as in figure 1.b).

The total output gap is the sum of the gap in tradeables and the gap in nontradeables. A fixed exchange rate will minimize this gap for tradeables, but at the expense of likely increasing the deviation from full information output in nontradeables. The optimal degree of flexibility (the optimal p) will depend on: (a) the parameters of the model -specifically on the relative magnitudes of foreign versus domestic aggregate shocks, and of sector-specific versus aggregate variance; and (b) on the weight given to each sector within the policymaker's objective function.

Figures 2a and 2b illustrate the total output gap for different values of foreign aggregate variability under the realistic assumption that each sector is weighted evenly in policymaker's preferences. Those graphs show that the optimal degree of exchange rate flexibility does not correspond to the extreme regime solutions (p=0 or p=1) for a wide range of parameter values. The higher (lower) the foreign aggregate variance and the less (more) stable the anchor country, the closer the optimal regime is to the flexible (fixed) exchange rate solution.

7 Conclusions

This paper has analyzed the stabilizing properties of alternative exchange rate regimes in a two-sector imperfect information model. The results show that in such a setting the best choice of exchange rate rule will generally be a mixed-one -neither a perfectly fixed nor a free floating regime appear optimal.

The two-sector approach is crucial to the results. In our two-sector model, different exchange rate regimes have different implications for the ability of economic agents to forecast the future path of money and prices. In particular, the exchange rate rule affects the information available to market participants in the tradeable and nontradeable sectors. By importing the better predictability of foreign prices, a fixed exchange rate rule allows market participants in tradeables to separate out the effects of aggregate and sector-specific shocks. As a result, we find that a fixed exchange rate rule completely stabilizes output in the tradeable sector. A fixed rate regime, however, does not minimize the output gap in non-tradeables, even in the case where foreign aggregate variance is substantially smaller than domestic aggregate variance. This is because a fixed-exchange rate rule augments the uncertainty facing participants in the nontradeables market, by magnifying the impact of relative shifts and accentuating agents' confusion.

In general, we find that the optimal degree of exchange rate flexibility depends on specific parameter values, and in particular, on the relative sizes of domestic versus foreign disturbances, and of sector-specific versus aggregate variances. While this parameter-specificity may reduce somewhat the appeal of the results, it is nevertheless quite common to the whole literature that analyzes the relative merits of fixed versus flexible regimes [see, for example, Flood (1979)], and is to be expected given the complexity of the model.

On the whole, our conclusions suggest that economies with a relatively large component of industries closed to international competition (or subject to intersectoral rigidities) are more likely to prefer exchange rate regimes that involve some degree of exchange rate flexibility. Nevertheless, if those economies suffer from a relatively high level of aggregate variability, free floating is not the optimal regime as they would prefer to adopt money rules which limit exchange rate fluctuations.

APPENDIX

DERIVATION OF EQUILIBRIUM PRICES AND OUTPUT UNDER THE MIXED EXCHANGE-RATE REGIME

1) THE TRADEABLES SECTOR

Under the mixed regime, money supply in period t can be written as

$$M_t = pM_t^{fx} + (1-p)M_t^{fl}, \tag{38}$$

where M_t^{fl} and M_t^{fx} are the realizations of the money supply processes corresponding to the flexible exchange rate regime (defined inequation 9) and the free floating regime (defined in equation 22) respectively. Expected money growth under process (22) is:

$$E\Delta M_{t+1} = p\frac{1}{\beta}\epsilon_{t-1}(T) \tag{39}$$

Then, according to equation (8), equilibrium prices must satisfy:

$$\alpha P_t(T) = (\alpha-\beta)EP_{t+1}|I_t(T) + \beta\left[pM_t^{fx} + (1-p)M_t^{fl} + p\frac{1}{\beta}\epsilon_{t-1}(T)\right] + v_t + \epsilon_t(T). \tag{40}$$

Now, guess the solution

$$P_t(T) = pP_t^{fx}(T) + (1-p)P_t^{fl}(T), \tag{41}$$

where $P_t^{fx}(T)$ and $P_t^{fl}(T)$ are the equilibrium prices corresponding to the pure fixed and flexible exchange rate regimes respectively. Those equilibrium prices are defined by equations (16) and (23). Then, substituing (41) into (40) yields

$$\alpha\ \left[pP_t^{fx}(T) + (1-p)P_t^{fl}(T)\right] = (\alpha-\beta)\left[pP_t^{fx}(T) + (1-p)EP_{t+1}^{fl}|I_t(T)\right]$$

$$+ \quad \beta\left[pM_t^{fx} + (1-p)M_t^{fl} + p\frac{1}{\beta}\epsilon_{t-1}(T)\right] + v_t + \epsilon_t(T).$$

Arranging terms, it holds that

$$\alpha P_t^{fl}(T) = (\alpha - \beta)EP_{t+1}^{fl}|I_t(T) + \beta M_t^{fl} + v_t + \epsilon_t(T),$$

which is consitent with equation (7). Therefore, the equilibrium price for sector T is given by expression (41).

Now, from expressions (5) and (41), it is immediate to see that equilibrium output is given by

$$T_t = pT_t^{fx} + (1-p)T_t^{fl},$$

where T_t^{fx} and T_t^{fl} are the quilibrium output solutions corresponding to the flexible and the fixed exchange rate regimes, respectively.

Therefore, output deviation from its full information level under the mixed exchange rate regime is

$$\begin{aligned} T_t - T_t^F &= p\left[T_t^{fx} - (T_t^{fx})^F\right] + (1-p)\left[T_t^{fl} - (T_t^{fl})^F\right] = (1-p)\left[T_t^{fl} - (T_t^{fl})^F\right] \\ &= (1-p)\frac{\alpha^s}{\alpha}\left[(1-\theta_m - (\beta m_t + u_t) - (\theta_m + \theta_u)\epsilon_t(T)\right], \end{aligned} \tag{42}$$

where F superscripts stand for full information output.

2) THE NON-TRADEABLES SECTOR

Under the mixed exchange rate regime, equation (7) becomes

$$\alpha P_t(N) = (\alpha - \beta)EP_{t+1}|I_t(N) + \beta\left[pM_t^{fx} + (1-p)M_t^{fl} + p\frac{1}{\beta}\epsilon_{t-1}(T)\right] + v_t + \epsilon_t(N). \tag{43}$$

Using the condition $\epsilon(T) = -\epsilon(N)$, this implies that

$$\begin{aligned}\alpha P_t(N) &= (\alpha-\beta)EP_{t+1}|I_t(N) + \beta p\left[\tilde{M}_t + \frac{1}{\beta}\tilde{v}_t - \frac{1}{\beta}v_t\right] \\ &+ \beta(1-p)(M_{t-1}+m_t) + v_t + \epsilon_t(N)(1+p). \end{aligned} \tag{44}$$

Now, guess the solution

$$\begin{aligned}P_t(N) &= \Pi_1\tilde{M}_{t-1} + \Pi_2\tilde{m}_t + \Pi_3\tilde{v}_{t-1} + \Pi_4\tilde{u}_t \\ &+ \Pi_5 M_{t-1} + \Pi_6 m_t + \Pi_7 v_{t-1} + \Pi_8 u_t + \Pi_9\epsilon_t(N). \end{aligned} \tag{45}$$

Then, the expected future price is

$$\begin{aligned}EP_{t+1}|I_t(N) &= \Pi_1\tilde{M}_{t-1} + \Pi_1 E\tilde{m}_t|I_t(N) + \Pi_3\tilde{v}_{t-1} + \Pi_3 E\tilde{u}_t|I_t(N) \\ &+ \Pi_5 M_{t-1} + \Pi_5 Em_t|I_t(N) + \Pi_7 v_{t-1} + \Pi_7 Eu_t|I_t(N). \end{aligned} \tag{46}$$

Since the sector prices are known at period t, agents observe $G \equiv \Pi_2\tilde{m}_t + \Pi_4\tilde{u}_t + \Pi_6 m_t + \Pi_8 u_t + \Pi_9\epsilon_t(N)$. Therefore,

$$\begin{aligned}E\tilde{m}_t|I_t(N) &= \frac{\Pi_2\sigma_{\tilde{m}}^2}{\Pi_2^2\sigma_{\tilde{m}}^2 + \Pi_4^2\sigma_{\tilde{u}}^2 + \Pi_6^2\sigma_m^2 + \Pi_8^2\sigma_u^2 + \Pi_9^2\sigma_\epsilon^2}\, G \\ E\tilde{u}_t|I_t(N) &= \frac{\Pi_4\sigma_{\tilde{u}}^2}{\Pi_2^2\sigma_{\tilde{m}}^2 + \Pi_4^2\sigma_{\tilde{u}}^2 + \Pi_6^2\sigma_m^2 + \Pi_8^2\sigma_u^2 + \Pi_9^2\sigma_\epsilon^2}\, G \\ Em_t|I_t(N) &= \frac{\Pi_6\sigma_m^2}{\Pi_2^2\sigma_{\tilde{m}}^2 + \Pi_4^2\sigma_{\tilde{u}}^2 + \Pi_6^2\sigma_m^2 + \Pi_8^2\sigma_u^2 + \Pi_9^2\sigma_\epsilon^2}\, G \\ Eu_t|I_t(N) &= \frac{\Pi_8\sigma_u^2}{\Pi_2^2\sigma_{\tilde{m}}^2 + \Pi_4^2\sigma_{\tilde{u}}^2 + \Pi_6^2\sigma_m^2 + \Pi_8^2\sigma_u^2 + \Pi_9^2\sigma_\epsilon^2}\, G \end{aligned} \tag{47}$$

Substituing (47) into (46) and (46) into (45) we can use the method of undetermined coefficients to obtain the following expression for equilibrium prices in sector N:

$$P_t(N) = p(\tilde{M}_{t-1} + \frac{1}{\beta}\tilde{v}_{t-1}) + (1-p)(M_{t-1} + \frac{1}{\beta}v_{t-1})$$

$$
\begin{aligned}
&+ \frac{p}{\alpha}\left[(\alpha-\beta)(1-H)+\beta\right](\tilde{m}_t+\frac{1}{\tilde{\beta}}\tilde{u}_t) \\
&+ \frac{1-p}{\alpha}\left[(\alpha-\beta)(1-H)+\beta\right]\left(m_t+\frac{1}{\beta}u_t\right) \\
&+ \frac{1+p}{\alpha}\left[(\alpha-\beta)(1-H)+\beta\right]\frac{1}{\beta}\epsilon_t(N),
\end{aligned} \tag{48}
$$

where H is defined in expression (36).

This expression implies that the expected next period price level is

$$
EP_{t+1}|I_t(N) = p(1-H)\left[\tilde{m}_t+\frac{1}{\tilde{\beta}}\tilde{u}_t+\frac{1-p}{p}m_t+\frac{1-p}{\beta p}u_t+\frac{1+p}{\beta p}\epsilon_t(N)\right] \tag{49}
$$

Substituing equations (48) and (49) into equation (3) we find that equilibrium output in the non-tradeables sector is

$$
\begin{aligned}
N_t &= \frac{\alpha^s\beta}{\alpha}H\left[p(\tilde{m}_t+\frac{1}{\tilde{\beta}}\tilde{u}_t)+(1-p)(m_t+\frac{1}{\beta}u_t)+(1+p)\frac{1}{\beta}\epsilon_t(N)\right] \\
&+ v_t^s+\epsilon_t^s(N)
\end{aligned} \tag{50}
$$

The full information solution of expression (45) is

$$
P_t(N) = p(\tilde{M}_{t-1}+\tilde{m}_t+\frac{1}{\tilde{\beta}}\tilde{v}_t)+(1-p)(M_{t-1}+m_t+\frac{1}{\beta}v_t)+(1+p)\frac{\epsilon_t(N)}{\beta}, \tag{51}
$$

which implies the following full information solution for output

$$
N_t^F = \frac{\alpha^s}{\beta}(1+p)\epsilon_t(N)+v_t^s+\epsilon_t^s(N). \tag{52}
$$

Therefore, otuput deviation from the full informaton level for the sector of non-tradeables is

$$
\begin{aligned}
N_t - N_t^F &= \frac{\alpha^s}{\alpha}\left\{(1-H)[(1-p)(\beta m_t+u_t)+p\left(\frac{\beta}{\tilde{\beta}}\right)(\tilde{\beta}\tilde{m}_t+\tilde{u}_t)]\right. \\
&- \left.(1+p)H\epsilon_t(N)\right\}.
\end{aligned} \tag{53}
$$

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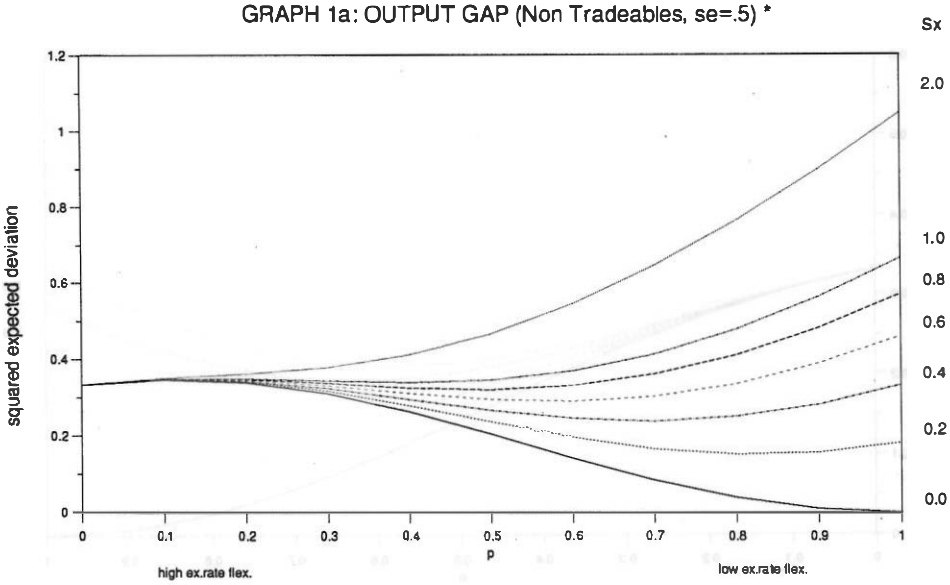
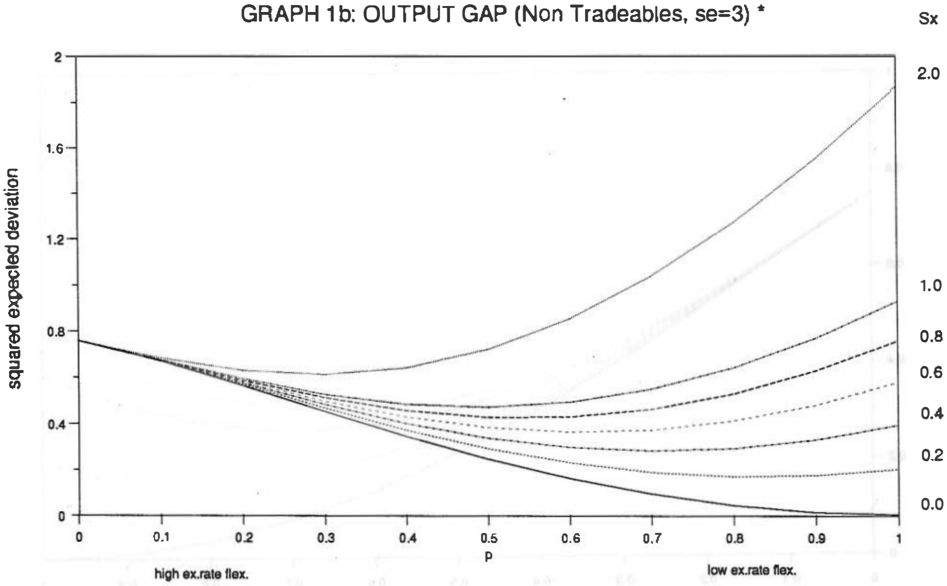
GRAPH 1a: OUTPUT GAP (Non Tradeables, se=.5) *



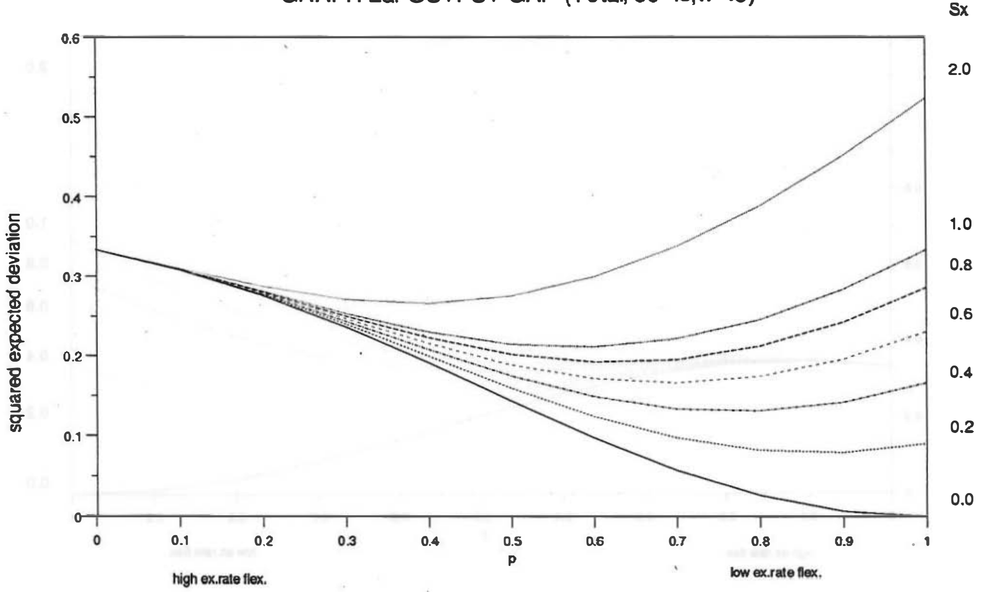
GRAPH 1b: OUTPUT GAP (Non Tradeables, se=3) *



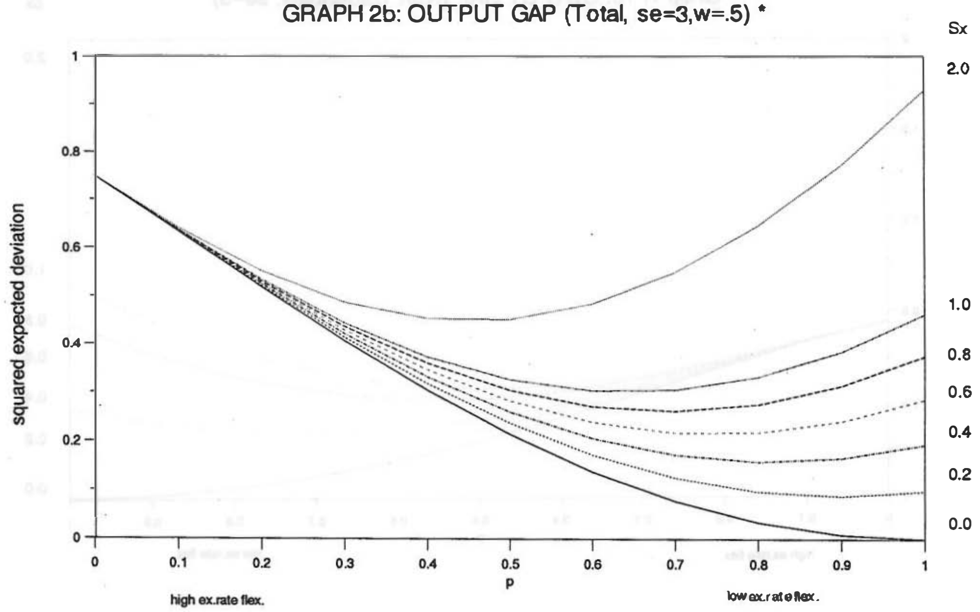
(*) Se: Sectoral variability/Domestic aggregate variability

Sx: Foreign variability/Domestic aggregate variability

GRAPH 2a: OUTPUT GAP (Total, se=.5,w=.5) *



GRAPH 2b: OUTPUT GAP (Total, se=3,w=.5) *



(*) w is the weight of the Tradeables Sector

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