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THE CASE OF FIXED EXCHANGE RATES

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ABSTRACT

The impact of aggregate nominal and real shocks on the variance of relative prices is studied in the case of an open economy with fixed exchange rates where agents have limited information about aggregate shocks and the price level. In the first part of the paper it is shown that the limited information problem causes an excess variance of relative prices. Increasing the variance of all aggregate shocks lowers the quality of the information conveyed by the domestic price level. The second part of the paper compares fixed and flexible exchange rate regimes under a variance of relative prices criterion. Conditions for the superiority of either regime are identified.

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Introduction

In a world where agents have limited information only about the current price level, relative price movements can be severely distorted by purely nominal aggregate shocks to the economy. This type of monetary non-neutrality has been investigated in a number of studies during the last years. The literature has focused on the impact of domestic aggregate money supply shocks on the variance of relative prices in a closed economy.[1/] It has been shown first, that in a closed economy of the Lucas-Barro type, where rational agents suffer from aggregate - relative confusion, relative price risk - defined as the conditional variance of relative price changes - depends positively on the conditional variance of aggregate nominal and real shocks. More specifically, the limited information problem causes an excess of relative price risk over its full information level. This implies that an increase in the variance of domestic monetary shocks worsens the quality of the information about relative scarcities conveyed by the price system.

The analysis has recently been extended to the open economy with flexible exchange rates by Neumann and von Hagen (1987). The open economy brings in two important modifications of the conventional Lucas-Barro model. First, it is exposed to aggregate real and nominal shocks from outside, which emerge as further sources of relative price risk. Secondly, the information structure of the economy is richer, as agents observe the current exchange rate. Being determined on a centralized, competitive market for foreign currency, the exchange rate acts as a global source of information which aggregates local information and local expectations over all markets. It has been shown that in the open economy with flexible exchange rates relative price risk remains dependent on the variance of domestic monetary shocks and, in addition, that the excess of relative price risk over its full information level responds positively to changes in the variance of external shocks.

The present paper considers relative price risk in an open economy with fixed exchange rates. Domestic monetary policy now becomes fully endogenous and has to respond to external shocks in order to preserve a given exchange rate target. Furthermore, with a fixed exchange rate, agents loose the common source of information available in the flexible rates case. To keep the information structure of the economy under fixed rates nevertheless comparable to the economy under flexible exchange rates, we introduce a new global source of information, similar to the specifications of King (1981) and Kimbrough (1984). Agents are assumed to have a jammed observation of the central bank's intervention on the foreign exchange market. With this assumption, the main difference between the two exchange rate regimes is that under fixed exchange rates there are no autonomous domestic monetary shocks to the economy, while the obligation to intervene on the foreign exchange market creates a further channel by which external shocks are transmitted into the domestic economy. The paper shows that this, again, may cause an excess of relative price risk over its full information level due to limited information about foreign exchange interventions. Thus, pegging the exchange rate does not necessarily reduce the level of relative price risk even though it eliminates one of its sources. However, some conditions will be shown under which flexible exchange rates are preferable to fixed rates from the point of view of relative price risk.

The paper proceeds as follows. Section II presents the model and its solution. Section III develops the dependency of relative price risk on the conditional variances of aggregate shocks. A comparison of flexible and fixed exchange rates is presented in section IV. The main results and conclusions are summarized in the final section.

II. The Model

The model underlying our analysis is presented in Table 1. It is an extended version of the multi-markets equilibrium model proposed by Lucas (1973) and Barro (1976). The economy is composed of a large number of small and spatially separated markets on each of which a commodity y is traded. Agents are distributed randomly across markets, and there is no direct communication between different markets during each period. All agents are assumed, however, to have the same amount of past information at the outset of each period. We denote all expectations based on past information by the operator E_{t-1} and all expectations based on current, market specific information by $E_{i,t}$.

The model is linear in logs. A typical commodity market is described by equations (1)-(3). Total demand on a market i consists of local domestic demand $y^d_{i,t}$ and local foreign demand $y^f_{i,t}$. Domestic demand depends positively on perceived real balances, $M_t - E_{i,t}p_t$ and negatively on the perceived relative price of the commodity, $p_{i,t} - E_{i,t}p_t$. Local foreign demand depends negatively on the expected relative commodity price relevant for foreign traders, namely $p_{i,t} + e_t - p^*_{t-1}$. Finally, there is a local excess demand shock $w^d_{i,t}$, which is zero on average across all markets.

Supply on each market is composed of a normal and a transitory component. The main difference between these components is that normal supply is based on expectations as of t-1, while transitory supply depends on current expectations and therefore reacts to current information. Suppliers are assumed to increase output if the perceived relative price of the commodity they produce rises and to cut back supply if the perceived relative price falls. Furthermore, producers on all markets use an imported input in their production processes. Output supply on all markets therefore responds negatively to changes in the relative price of the imported input, $p_t^R - p_{i,t}$. The domestic price of this input is the product of the exogenous world market price p_t^{R*} and the exchange rate e_t. Finally, there is a local supply shock $w_{i,t}^s$, which is zero again on average across the economy. Equation (3) states the equilibrium condition for each market.

The general price level of the domestic economy is defined as a geometric average of all local prices, see equation (7). It is related to the foreign price level p_t^* and the exogenous real exchange rate q_t through the equilibrium on the foreign exchange market, according to equation (4). The foreign exchange market in this economy is a centralized market in the sense that agents from all local markets can trade on this market. The equilibrium on this market is therefore based on information and expectations averaged over all local commodity markets. This will be shown in detail, below. We assume a fixed exchange rate regime, in which the nominal exchange rate is permanently tied to a known target level $\bar{e}$. This implies that the central bank controls the domestic money stock M_t by means of exchange market interventions such that the equilibrium exchange rate equals the target rate. In other words, monetary policy is fully endogenous and depends in particular on the external shocks in the foreign price level, the real exchange rate and the world market price of the imported input. Furthermore, (4) implies that the current innovation in the domestic price level is equal to the sum of the innovations in the foreign price level and the real exchange rate. To close the model, we specify the three aggregate exogenous variables p_t^*, q_t and p_t^{R*} and local excess demand $w_{i,t} = w_{i,t}^d - w_{i,t}^s$ as mutually independent random walks with normal innovations. As usual, local excess demand shocks are assumed to be drawn from a common distribution and to sum up to zero on average.

The model is solved under the assumption of rational expectations. Following the procedure suggested by King (1983), the solution is derived in two steps. First, the semi-reduced form of the local commodity price is computed, treating agents' expectations as state variables. The well-known method of undetermined coefficients is used for this purpose. This step yields a semi-reduced form for the local price $p_{i,t}$ and, using the rule of aggregation and the exchange rate equation, a semi-reduced form for the domestic money supply M_t. Both are reported in table 2. The local commodity price depends on both, on local and - through M - on average perceptions of the domestic price level. These perceptions are expressed in equation (8) as expectations of the current aggregate external shock $\varepsilon_t^Q = \varepsilon_t^q - \varepsilon_t^*$, in addition to the components $\bar{e}$, q_{t-1} and p_{t-1}^*, which are known to all agents from the past. The domestic money supply is decomposed into an expected part $E_{t-1} M_t$, related to the exchange rate target and the previous realizations of p^*, q, and p^{R*}, and an unexpected component ε_t^M. The latter is the current reaction of domestic money supply to the external shocks hitting the economy and to the average of agents' perceptions of these shocks, and it is enforced by the condition of keeping the exchange rate constant. The condition $1-\alpha\lambda\theta_q > 0$ stated in table 2 amounts to the usual assumption that the real balance effect in our economy is dominated by substitution effects on average.

Before we derive the full reduced form of the model, let us specify the information structure of the economy. We assume that agents observe two current signals from which information about the current innovation in the domestic price level can be extracted. One signal is derived from the unexpected variation in the local commodity price, corrected for the effect of the observed shock in the foreign input price, ε_t^{R*}. With the nominal exchange fixed at $\bar{e}$, the observation of the exchange rate yields no further current information. The fixed exchange rate regime is therefore informationally different from the flexible rate regime, where the current nominal rate aggregates information and expectations over all local markets.[2/] To keep the information structure of both regimes similar, we assume that agents receive a noisy observation of ε_t^M, the unexpected part of the central bank's current intervention on the foreign exchange market.[3/]

$$(14)\quad I_t = \varepsilon_t^M + \xi_t$$

where ξ_t is a normally distributed, serially uncorrelated observation error with zero expectation and variance σ_ξ^2. The latter is assumed to be a policy parameter which can be chosen by the central bank. With $\sigma_\xi^2 = 0$, foreign exchange market activities are completely uncovered to the public, while $\sigma_\xi^2 = \infty$ corresponds to the case where the private sector has no insight at all into these activities. It seems plausible to assume that σ_ξ^2 is finite and strictly positive.

With this specification, we can find the full reduced form solution by elimination of the terms involving expectations in equations (8)-(10). The method of undetermined coefficients is used again to derive the necessary projections. This is shown in detail in the appendix. The full reduced forms are reported in table 2, where

$$E_{t-1}p_{i,t} = E_{t-1}p_t + \lambda_i w_{i,t-1} + \lambda_i(\beta_i - \overline{\beta\lambda}/\lambda)(p^{R*}_{t-1} - p^{*}_{t-1}) - \lambda_i(\beta_i + \psi^{*}_i - (\overline{\beta\lambda} + \overline{\psi^{*}\lambda})/\lambda)\, q_{t-1}$$

These solutions can be used to study the behavior of relative prices in the economy. Equation (11) shows that current, unexpected relative price fluctuations arise only from current relative shocks $\varepsilon^{w}_{i,t}$, as long as the price elasticities of demand and supply are equal across all markets. Aggregate shocks have a direct effect on such fluctuations only if A_{1i} and A_{2i} are nonzero. In this case, the current observation error on the foreign exchange market, ξ_t, enters the relative price together with the foreign shocks ε^{R*}_t, ε^{q}_t, and ε^{P*}_t, due to agents misperceptions of ε^{Q}_t when exchange market interventions are not fully revealed to the public.

Equation (12) gives the full reduced form of the unexpected part of the central bank's interventions. Obviously, ε^{M}_t is affected by the limited information problem, too. With full information about the current price level, the unexpected intervention is

$$(15)\quad \tilde{\varepsilon}^{M}_t = - \overline{\beta\lambda}/\alpha\lambda\ \varepsilon^{R*}_t - \theta_q\ \varepsilon^{Q}_t.$$

Since $(1-\alpha\lambda\theta_q)(1+\tau_2) > 0$, the elasticity of interventions with respect to the external shock ε^{Q}_t is greater under limited information. It follows that the conditional variance of covered interventions is greater than the variance of fully revealed interventions on the foreign exchange market.

III. Determinants of Relative Price Risk

The full reduced forms derived in the previous section can now be used to study how economy wide relative price risk is related to the variances of the aggregate shocks under fixed exchange rates. Economy wide relative price risk is defined as the conditional variance of relative price changes, averaged over all markets.

$$(13') \quad RPR = \Sigma\, u_i E\, (P_{i,t} - P_t - E_{t-1}\, (P_{i,t} - P_t))^2$$

The complete solution of RPR is reported in table 2, equation (13). Using the reduced form (11), (13) is computed as an average from the conditional variance of relative price forecast errors on all markets. Since (13) seems a rather messy expression at a first look, we decompose RPR into several elements and proceed in a stepwise evaluation. This is done by means of table 3.

Relative price risk, in our economy, arises from three sources: The existence of local excess demand shocks $\varepsilon^W_{i,t}$, uncorrelated between markets, the variability of price elasticities across markets, and the limited information problem. Table 3 demonstrates how the effects of these sources are combined and connected. Let us first assume that all price elasticities are constant and agents perfectly observe the current aggregate price level. This reduces RPR to RPR_1, the full information constant elasticities level, which might be considered the nucleus of relative price risk. Table 3 shows that it is proportional to the variance of local excess demand shocks. It increases with this variance and with decreasing price elasticities of demand and supply on all markets (increasing λ).

Consider next the impact of the aggregate-relative confusion problem on relative price risk when price elasticities are equal on all markets. The level of RPR with limited information and constant elasticities is given by RPR_2. In evaluating RPR_2, remember that $\tau_1 < 0$ from the appendix. Thus, we have that $RPR_2 > RPR_1$ unambiguously, with strict inequality whenever the variances σ_ξ^2 and σ_W^2 are strictly positive and, hence, the currently observable signals do not fully reveal the current innovation in the price level, ε_t^Q. This means that the contribution of the information problem to relative price risk is strictly positive. The reason for this is that in the process of signal extraction agents partly misunderstand local excess demand shocks as shifts in the aggregate price level. Since the realizations of local shocks are different across markets, this type of misperception causes different price reactions across markets and, therefore, leads to an increase in relative price dispersion.

Furthermore, the partial derivatives of RPR_2 with respect to the variances of the aggregates shocks σ_q^2, σ_*^2 and σ_ξ^2 are strictly positive. An increase in any of these variances causes a rise in agents' uncertainty about the current aggregate external shocks ε_t^q and ε_t^* and aggravates the problem of relative-aggregate confusion. Our results show that this unambiguously leads to an increase in relative price risk. Hence, the information problem creates an excess of relative price risk over its full information level. Since the variance of the expectation error ($\varepsilon_t^Q - E_{i,t}\ \varepsilon_t^Q$) equals the conditional variance of the forecast error with respect to the current price level, the latter is positively associated with relative price risk due to a common source of uncertainty.

In the next step, we revive the assumption of full information to isolate the effect of nonconstant price elasticities across markets. The relevant level of RPR is given by RPR_3. First, with $\sigma_\lambda^2 > 0$, RPR_3 exceeds RPR_1. Secondly, allowing for nonconstant elasticities means that the aggregate shocks from outside are absorbed in different ways on different markets, and, hence, lead to relative price changes. This is expressed by means of the composite parameter variances in RPR_3. Obviously, this part of relative price risk depends positively on the real and nominal foreign shocks and the innovation in the current world market price of imported inputs.

The final step reintroduces the information problem to the case of nonconstant elasticities. This gives rise to the full reduced form expression of RPR from table 2. The solution now combines the elements of RPR_1 to RPR_3 and, in addition, includes a term of interaction between the limited information and the nonconstant elasticity sources of relative price risk. The latter is picked up by the covariance term in RPR_4. While all other components are positive, the net impact of the limited information problem on relative price risk in the case of nonconstant elasticities is ambiguous, because the covariance term cannot be signed a priori. Note, however, that this term vanishes if the variances of β_i and Ψ_i^* tend to zero and differential reactions to perceived relative commodity prices across markets are the main source of parameter variation.

As before, there is a contribution of the limited information problem to relative price risk which arises from agents' partial misperception of local excess demand shocks as aggregate changes in the price level. This contribution is now

$$(16)\ (\Sigma\, u_i\ [\lambda_i - \alpha\lambda\theta_q A_{oi}\,\tau_1]^2 - \lambda^2 - \sigma^2_{A2}\ \tau^2_1)\ \sigma^2_w > 0$$

It remains positive and an increasing function of the aggregate variances σ^2_ξ, σ^2_q, and σ^2_*. The second effect is based on the the complementary partial misperception of the external shock ε^Q_t in the process of signal extraction. With nonconstant elasticities, this misunderstanding affects relative price dispersion, because the forecast error about ε^Q_t induces different price reactions across markets. This term can be simplified to

$$(17)\ (\sigma^2_{A2} + 2\mathrm{cov}(A_{1i},\ A_{2i}))\ \pi$$

where π is the variance of the conditional forecast error about ε^Q_t. Since π is an increasing function in σ^2_q, σ^2_*, and σ^2_ξ, (17) increases numerically as these variances rise. Assuming that the covariance term is non-negative or is dominated by the first term[4/], there is an excess of relative price risk due to limited information problem, again. Relative price risk is augmented by a rise in the variances of the external shocks to the real exchange rate and the foreign price level as well as by an increase in the variance of the observation noise.

Summing up these results, we have shown that the problem of aggregate-relative confusion in an open economy with fixed exchange rates causes a positive deviation of relative price risk from its full information level. While the intervention rule on the foreign exchange market implied by fixed exchange rates eliminates autonomous domestic monetary shocks as a source of relative price risk, innovations in the real exchange rate and the foreign price level distort domestic relative prices unless all central bank activities on the foreign exchange market are completely uncovered to the private sector. If this is not the case, foreign money is non-neutral to the domestic economy to the extent that innovations in the foreign price level can be attributed to foreign monetary policy. Furthermore, our results show that even without any autonomy over domestic money supply, domestic central bank policy can have real effects through its influence on the information structure of the economy.[5/]

IV. A Comparison of Fixed and Flexible Exchange Rates

In a previous paper (Neumann and von Hagen (1987)), we have investigated relative price risk in the open economy with flexible exchange rates. The flexible rate regime differs from the fixed rate regime in two important respects: First, it allows for discretionary domestic monetary policy and in particular for the existence of autonomous, domestic monetary shocks. There is no obligation for the central bank to intervene in the foreign exchange market and, therefore, external shocks are not automatically transmitted into the domestic economy through the money supply as in case of the fixed exchange rate. Secondly, the private sector is provided with a different global signal. Assuming that domestic monetary policy under flexible rates refrains from foreign exchange market interventions, agents are left with the endogenous exchange rate as the source of a global signal. Our previous paper shows that, due to the problem of aggregate relative confusion, domestic relative price risk depends on the variances of aggregate domestic and foreign shocks under flexible exchange rates and that the excess of relative price risk due to the information problem is likely to be positive.

From the point of view of relative price risk, therefore, the two exchange rate regimes are not qualitatively different. The question then arises whether it is possible to identify conditions of superiority of one or the other regime. In this section we present a comparison of the two versions of relative price risk for this purpose. The reduced form of relative price risk in the open economy with flexible exchange rates is[6]

$$(18)\quad RPR^{*} = \Sigma\, u_i\, (\lambda_i + \alpha\lambda A_{0i}\, \tau_1^M)^2\, \sigma_w^2 + \sigma_{A1}^2 (\sigma_q^2 + \sigma_*^2)$$

$$+ \sigma_{B\lambda}^2\, \sigma_{R*}^2 + \alpha^2 \lambda^2\, \sigma_{A2}^2\, (\pi^* - (\tau_1^M)^2\, \sigma_w^2)$$

$$+ 2\, \mathrm{cov}(A_1 A_2)\, \alpha\lambda\theta_q\, \pi^*(\sigma_q^2 + \sigma_*^2)$$

where: $\tau_1^M = \alpha\lambda\theta_q^2\, \sigma_m^2\, (\sigma_q^2 + \sigma_*^2)\, \Delta_1^{-1} > 0$

$$\Delta_1 = (\alpha^2 \sigma_M^2 + \sigma_W^2)\, \theta_q^2 (\sigma_q^2 + \sigma_*^2) + \sigma_w^2\, \theta_M^2\, \sigma_M^2$$

$$\theta_M = \alpha(\lambda\theta_q + (1 - \alpha\lambda\theta_q)\, \tau_1^M)$$

$$\pi^* = E(\varepsilon_t^M - E_{i,t}\, \varepsilon_t^M)^2 = \theta_q^2\, \sigma_M^2\, \sigma_w^2\, (\sigma_q^2 + \sigma_*^2)\, \Delta_1^{-1}$$

and σ_M^2 is the variance of the domestic monetary shock, ε_t^M. The coefficient τ_1^M is the regression coefficient of this shock on the local signal.

The dependency of RPR and RPR* on the respective policy determined variances σ_ξ^2 and σ_M^2 obviously requires some assumption relating the two variances in order to make the exchange rate regimes comparable. The natural point to start from is to assume that both are zero, so that the full information levels of relative price risk are realized. This gives

$$(19)\quad RPR = RPR^* = RPR_3.$$

Full information relative price risk is identical under fixed and flexible rates. In other words, with full information flexible and fixed exchange rate regimes are equivalent from the point of view of relative price risk.

To evaluate the aggregate-relative confusion problem, we choose σ_M^2 and σ_ξ^2 such that the conditional variances of the relevant forecast errors, $E(\varepsilon_t^M - E_{i,t}\, \varepsilon_t^M)^2$ and $E(\varepsilon_t^Q - E_{i,t}\, \varepsilon_t^Q)^2$ for flexible and fixed rates are equal.

$$(20)\quad \pi^* = \theta_q^2\, \sigma_M^2\, \sigma_Q^2\, \sigma_W^2\, \Delta_1^{-1} = \theta_X^2\, \sigma_\xi^2\, \sigma_Q^2\, \sigma_w^2\, \Delta^{-1} = \pi$$

This means that agents' uncertainty about current innovations in the price level is equal under both regimes. With this assumption, the condition for superiority of fixed exchange rates is

$$\begin{aligned}(21)\quad RPR^* - RPR = {} & \Sigma_i\, u_i\, [(\lambda_i + \alpha\lambda\tau_1^M A_{0i})^2 - (\lambda_i - \alpha\lambda\theta_q A_{0i}\tau_1)^2]\, \sigma_w^2 \\ & + \sigma_{A2}^2\, [(\pi^{*2} - (\tau_1^M)^2\, \sigma_w^2)\, \alpha^2\lambda^2 - (\pi^2 - \tau_1^2\, \sigma_w^2)] \\ & + 2\, \mathrm{cov}\, (A_1A_2)(\alpha\lambda\theta_q\, \sigma_Q^2 - 1) \\ = {} & C1\, \sigma_w^2 + C2\, \sigma_{A2}^2 + 2\, C3\mathrm{cov}(A_1A_2) > 0\end{aligned}$$

With $\tau_1^M = \alpha\pi / \sigma_\omega^2$ and $\tau_1 = -\alpha\pi / \theta_X\, \sigma_w^2$, sufficient conditions for (21) to hold can be stated as follows

$$(22)\ a)\quad \theta_X > \theta_q = 1 + (\overline{\beta\lambda} + \overline{\psi * \lambda}) / \alpha\lambda \qquad => C1 > 0$$

b) $\alpha^2 \pi^2 / \sigma_W^2 (1-\theta_X^{-2}) > (1-\alpha^2 \lambda^2)$ $\quad$ => C2 > 0

c) $\alpha\lambda\theta_M \pi > \theta_q$ $\quad$ => C3 > 0

Recall that $\theta_X = \alpha(\lambda - \tau_1(1 - \alpha\lambda\theta_q))$ which increases with α and decreases in $\overline{\beta\lambda}$, $\overline{\Psi^*\lambda}$, and σ_W^2. Conditions (22) are likely to hold if α, θ_X, and π are large and $\overline{\beta\lambda}$, $\overline{\Psi^*\lambda}$, and σ_W^2 are small. This allows us to identify some situations in which fixed exchange rates will outperform flexible exchange rate under a relative price risk criterion, and vice versa.

For this purpose, we introduce a measure of the degree of openness of an economy. We will call an economy relatively open, if the average responsiveness of commodity prices to current changes in external conditions is high. That is, in the relatively open economy, the price system is strongly exposed to external shocks ε_t^q, ε_t^* and ε_t^{R*} in the real exchange rate, the foreign price level and the price of the imported input. In contrast, this responsiveness is small in a relatively closed economy and most price changes are due to the real balance effect and domestic relative demand and supply shocks. In terms of our model, the relatively open economy is characterized by $\overline{\beta\lambda} + \overline{\Psi^*\lambda}$ approaching unity, while the relatively closed economy has these elasticities approaching zero. Note that the assumption that substitutions effects dominate the real balance effect, $1 - \alpha\lambda - \overline{\beta\lambda} - \overline{\Psi^*\lambda} > 0$, implies that the latter is small in the relatively open economy.

Condition (22a) can be restated as follows

(22a') $\quad \tau_1 / \alpha\tau_2 > (\theta_M \tau_1^M / \alpha\tau_2^M) \; \sigma_\xi^2 / \sigma_Q^2$ => C1 > 0

This version provides us with a comparison of the ratios of the regression coefficients τ_i and τ_i^M, i = 1,2, under the two regimes, corrected for the impact elasticities of ε_t^M and ε_t^Q and the variances of the respective noise in the global signal, σ_Q^2 and σ_ξ^2. These ratios implicitly determine the relative weights of the local price signals in agents' expectations formation process under incomplete information. They can therefore be interpreted as an indicator of the relative informativeness of the local price signals. Hence, if σ_{A2}^2 and $\text{cov}(A_1A_2)$ are zero or small, so that price elasticities are roughly equal across markets, a necessary and sufficient condition for the superiority of one of the exchange rate regimes is that the implied relative informativeness of local prices be higher. Returning to (22a), we can see that this holds for fixed exchange rates, if α is large and $\overline{\beta\lambda} + \overline{\psi^* \lambda}$ small. Fixed exchange rates will thus be preferable for the relatively closed economy. Furthermore, the preferability of this regime increases as the variance of local shocks σ_W^2 becomes smaller. The relatively open economy, on the other hand, will prefer flexible rates, and the more so, the larger is the variance of local disturbances.

If the variance of price elasticities across markets is positive, condition (22b) adds a further element to the comparison of regimes, as now the ratio of the variance of the aggregate price level expectation error, π, and the variance of the local shock becomes relevant. According to this condition, fixed exchange rates outperform flexible rates if the variance of the forecast error about the domestic price level is large relative to the variance of local shocks. Since the former increases in the variances of all aggregate shocks, fixed exchange rates will be preferable if aggregate shocks are the dominant source of uncertainty in the economy.[7/] For given values of all variances, (22b) can be expected to hold if the real balance parameter is large. Hence, again we find that under a relative price risk criterion flexible rates are more appropriate for the relatively open economy, and the more so, the more volatile local supply and demand shifts are. The relatively closed economy with a strong real balance effect has a smaller relative price risk with fixed exchange rates and relatively stable local demand and supply conditions.

The third part of (22) is similar to the previous ones. Again, it will hold if the real balance effect is strong and the variance of price level expectation errors is large. Conversely, it will fail for the relatively open economy and if the variance of local shocks is large. Assuming that the covariance term in (21) is either positive or dominated by the variances, the results of this section can be summarized in the following two propositions:

> For a relatively closed economy with a strong real balance effect, fixed exchange rates are preferable to flexible rates under a relative price risk criterion. The preference for this regime increases as the variance of local relative demand and supply shocks decreases and aggregate shocks become the dominant source of uncertainty in the economy.

> For a relatively open economy, flexible exchange rates are superior to fixed exchange rates under the relative

price risk criterion. The preferability of this regime increases with an increase, both absolutely and relatively to the variances of global shocks, in the variance of domestic local supply and demand shifts.

V. Summary and Conclusions

In this paper, we have analyzed the determinants of relative price risk in an open economy with fixed exchange rates, where private agents suffer from aggregate-relative confusion. The model we have used is richer in its information structure, in comparison to previous studies, in that agents not only observe their local commodity prices but, in addition, a jammed signal of central bank interventions on the foreign exchange market. It has been shown that relative price risk under fixed exchange rates depends crucially on the extent to which agents have insight into the current exchange market activities of the central bank. Without perfect observability of these activities, the limited information problem causes an excess of relative price risk over its full information level. Nominal and real shocks from outside then become a major source of domestic relative price risk. The deviation of relative price risk from its full information level depends positively on the variance of these shocks.

From a monetary policy point of view, an important property of the fixed exchange rate regime is that is leaves no room for autonomous domestic monetary shocks, produced by discretionary central bank action. The fixed exchange rate regime therefore eliminates the source of relative price risk that previous studies in this field have concentrated on. Our results demonstrate that this alone does not in general lead to a reduction of excess relative price risk, unless the central bank is obliged to uncover her foreign exchange market activities. The fixed rate model yields an explicit analytical separation of monetary action and monetary information. As a general result, it shows that the latter matters much, while the former does not.

A further question addressed in this paper is whether relative price risk will be lower under fixed than under flexible rates. The case of flexible rates has been studied in detail in Neumann and von Hagen (1987). While it turns out that the two regimes are equivalent from the point of view of relative price risk if full information is available to private agents, we have identified some conditions for the superiority of flexible rates when aggregate-relative confusion prevails. Flexible rates are most likely to be preferable for a relatively open economy. Relative price risk in the relatively closed economy will be smaller under fixed rates, if the real balance effect is strong. Furthermore, increasing stability of local demand and supply shifts in comparison to aggregate sources of uncertainty tends to enhance the superiority of fixed exchange rates. Monetary policy may therefore face a trade-off between the level of relative price risk and autonomy in the determination of the domestic rate of inflation.

FOOTNOTES

1/ A first review of the literature is provided in Cukierman (1983).

2/ Neumann and von Hagen (1987).

3/ Similar specifications are introduced in King (1981) and Kimbrough (1983).

4/ A sufficient condition for this is that the variance of $\lambda_i(\beta_i + \Psi_i^*)$ is small relative to σ_{A2}^2.

5/ This result is similar in spirit to the effect of an observation error on real output in King (1981) and Kimbrough (1983).

6/ For details, see Neumann and von Hagen (1987).

REFERENCES

Cukierman, A. (1983), Relative Price Variability and Inflation: A Survey and Further Results, in: K. Brunner and A.H. Meltzer (eds.): Variability in Employment, Prices, and Money, Carnegie Rochester Conference Series 19, Amsterdam, 103-158.

Friedman, M. (1977), Nobel Lecture: Inflation and Unemployment, Journal of Political Economy 85, 451-572.

Kimbrough, K.P. (1983), Exchange Rate Policy and Monetary Information, Journal of International Money and Finance 2, 333-346.

King, R.G. (1981), Monetary Information and Monetary Neutrality, Journal of Monetary Economics 7, 195-206.

Neumann, M.J.M. and J. von Hagen (1987), Relative Price Risk in an Open Economy with Flexible Exchange Rates, Working Paper A-97, SFB-303, University of Bonn.

Table 1: The Model

Demand on market i:

$$(1)\quad y^d_{i,t} = y^h_{i,t} + y^f_{i,t}$$

$$y^h_{i,t} = \alpha(M_t - E_{i,t}p_t) - \Psi_i(p_{i,t} - E_{i,t}p_t) + w^d_{i,t}$$

$$y^f_{i,t} = -\Psi^*_i(p_{i,t} - e_t - E_{t-1}p^*_t)$$

Supply on market i:

$$(2)\quad y^s_{i,t} = \bar{y}_{i,t} + y^{Ts}_{i,t}$$

$$\bar{y}_{i,t} = c_i - \beta_i(E_{t-1}p^R_t - E_{t-1}p_{i,t}) + \gamma_i(E_{t-1}p_{i,t} - E_{t-1}p_t)$$

$$y^{Ts}_{i,t} = -\beta_i(p^R_t - E_{t-1}p^R_t - p_{i,t} + E_{t-1}p_{i,t})$$

$$+\gamma_i(p_{i,t} - E_{t-1}p_{i,t} - E_{i,t}p_t + E_{t-1}p_t) + w^s_{i,t}$$

Local equilibrium

$$(3)\quad y^s_{i,t} = y^d_{i,t}$$

Equilibrium exchange rate

$$(4)\quad e_t = p_t - p^*_t + q_t$$

Exchange rate target

$$(5)\quad e_t = \bar{e}$$

Price of imported input

$$(6)\quad p^R_t = p^{R*}_t + e_t$$

General price level

(7) $p_t = \Sigma_i u_i p_{it}$

Stochastic specification

$$\Delta x_t = \varepsilon_t^x ; \quad \varepsilon_t^x \sim N(0, \sigma_x^2), \quad E(\varepsilon_\tau^x, \varepsilon_\tau^x) = 0, \; t \neq \tau$$

for $x = *, q, p^{R*}$ and $\Delta p_t^* = \varepsilon_t^*$

$$E(\varepsilon_t^{p*} \varepsilon_t^q) = E(\varepsilon_t^{p*} \varepsilon_t^{R*}) = E(\varepsilon_t^q \varepsilon_t^{R*}) = 0 \text{ for all } t$$

$$w_{i,t} = w_{i,t}^d - w_{i,t}^s = w_{i,t-1} + \varepsilon_{i,t}^w$$

$$\varepsilon_{i,t}^w \sim N(0, \sigma_w^2), \quad E(\varepsilon_{i,t}^w \varepsilon_{i,\tau}^w) = 0, \; t \neq \tau$$

$$\Sigma_i u_i \varepsilon_{i,t}^w = 0$$

Elasticities

$$\alpha, \beta_i, \gamma_i, \psi_i, \psi_i^* \geq 0$$

$$\lambda_i = (\gamma_i + \beta_i + \psi_i + \psi_i^*)^{-1}$$

$$\lambda = \Sigma_i u_i \lambda_i, \quad \overline{\lambda\beta} = \Sigma_i u_i \lambda_i \beta_i, \quad \overline{\lambda\psi^*} = \Sigma_i u_i \lambda_i \psi_i^*$$

Table 2: Reduced Form Solutions

A) Semi-reduced form

Local commodity price

$$(8)\quad p_{i,t} = \bar{e} + \lambda_i(w_{i,t-1} + \varepsilon^{w}_{i,t}) + p^{*}_{t-1} + \lambda_i(\beta_i - \overline{\beta\lambda}/\lambda)(p^{R*}_{t} - p^{*}_{t-1})$$

$$-(1 - \lambda_i(\alpha + \beta_i + \Psi^{*}_{i}) + \alpha\lambda_i\theta_q)q_{t-1} + (\lambda_i/\lambda - \alpha\lambda_i\theta_q)\overline{E\varepsilon^{Q}_{t}}$$

$$- \alpha\lambda\theta_q A_{oi} E_{i,t}\varepsilon^{Q}_{t} - \lambda_i/\lambda\varepsilon^{Q}_{t}$$

Domestic money supply

$$(9)\quad E_{t-1}M_t = \bar{e} + (1 + \overline{\beta\lambda}/\alpha\lambda)p^{*}_{t-1} - \overline{\beta\lambda}/\alpha\lambda p^{R*}_{t-1} - \theta_q q_{t-1}$$

$$(10)\quad \varepsilon^{M}_{t} = -[\overline{\beta\lambda}/\alpha\lambda\varepsilon^{R*}_{t} + \alpha/\alpha\lambda(\varepsilon^{Q}_{t} - \overline{E\varepsilon^{Q}_{t}}) + \theta_q\overline{E\varepsilon^{Q}_{t}}]$$

where: $\theta_q = (\alpha\lambda + \overline{\beta\lambda} + \overline{\Psi^{*}\lambda})/\alpha\lambda$

$$A_{oi} = (1 - \lambda_i(\beta_i + \Psi^{*}_{i} + \alpha))/\alpha\lambda\theta_q > 0$$

$$\varepsilon^{Q}_{t} = \varepsilon^{q}_{t} - \varepsilon^{*}_{t}$$

$$\overline{E\varepsilon^{Q}_{t}} = \Sigma_i u_i\ E_{i,t}\varepsilon^{Q}_{t}$$

B) Full reduced forms

$$(11)\quad p_{i,t} = E_{t-1}(p_{i,t} - p_t) + (\lambda_i - \alpha\lambda\theta_q A_{oi}/\tau_1)\varepsilon^{w}_{i,t}$$

$$+ \lambda_i(\beta_i - \overline{\beta\lambda}/\lambda)\varepsilon^{R*}_{t} + A_{1i}\varepsilon^{Q}_{t}$$

$$+ A_{2i}((1+\tau_2)\varepsilon^{Q}_{t} + (\tau_1\alpha - \tau_2\theta_X)\ \xi_t)$$

$$(12)\quad \varepsilon_t^M = -\left(\frac{\beta\lambda}{\alpha\lambda}\right)\ \varepsilon_t^{R*} - [\alpha\lambda\theta_q + (1-\alpha\lambda\theta_q)(1+\tau_2)](\alpha\lambda)^{-1}\varepsilon_t^Q + (1-\alpha\lambda\theta_q)(\alpha\lambda)^{-1}(\tau_2\theta_X - \alpha\tau_1)\xi_t$$

where: $A_{1i} = \lambda_i(\beta_i + \psi_i^* - (\overline{\beta\lambda} + \overline{\psi^*\lambda})/\lambda)$

$$A_{2i} = 1 - \lambda_i/\lambda - \lambda_i(\beta_i + \psi_i^* - (\overline{\beta\lambda} + \overline{\psi^*\lambda})/\lambda)$$

C) Relative price risk

$$(13)\quad RPR = \Sigma_i u_i E_{t-1}[p_{i,t} - p_t - E_{t-1}(p_{i,t} - p_t)]^2$$

$$= \Sigma u_i[\lambda_i - \alpha\lambda^2\theta_q A_{oi}\tau_1]^2\sigma_w^2 + \sigma_{\beta\lambda}^2\sigma_{R*}^2 + \sigma_{A1}^2(\sigma_q^2 + \sigma_*^2)$$

$$+ \sigma_{A2}^2[(1+\tau_2)(\sigma_q^2+\sigma_*^2) - \tau_1^2\sigma_w^2] + 2\,\mathrm{cov}(A_1A_2)(1+\tau_2)(\sigma_q^2+\sigma_*^2)$$

where: $\sigma_{\beta\lambda}^2 = \Sigma u_i(\lambda_i\beta_i - \lambda_i\overline{\beta\lambda}/\lambda)^2$

$$\sigma_{A1}^2 = \Sigma u_i A_{1i}^2$$

$$\sigma_{A2}^2 = \Sigma u_i A_{2i}^2$$

Table 3: Components of Relative Price Risk

1. Full Information, constant elasticities

$$RPR_1 = \lambda^2 \sigma_w^2$$

2. Limited information, constant elasticities

$$RPR_2 = \lambda^2 \sigma_w^2 - 2\lambda(1 - \alpha\lambda\theta_q)\tau_1 \sigma_w^2 + (\alpha - \alpha\lambda\theta_q)^2 \tau_1^2 \sigma_w^2$$

$$\frac{dRPR_2}{d\sigma_q^2} = \frac{dRPR_2}{d\sigma_*^2} = 2(1 - \lambda\alpha\theta_q)\sigma_w^2((1 - \alpha\lambda\theta_q)\tau_1 - \lambda) \frac{d\tau_1}{d\sigma_q^2} > 0$$

$$\frac{dRPR_2}{d\sigma_\xi^2} = 2(1 - \alpha\lambda\theta_q)\sigma_w^2(1 - \alpha\lambda\theta_q)\tau_1 - \lambda) \frac{d\tau_1}{d\sigma_\xi^2} > 0$$

3. Full information, variable elasticities

$$RPR_3 = (\sigma_\lambda^2 + \lambda^2)\sigma_w^2 + \sigma_{\beta\lambda}^2 \sigma_{R*}^2 + \sigma_{A1}^2(\sigma_q^2 + \sigma_*^2)$$

4. Limited information, variable elasticities

RPR_4 = RPR (from Table 2)

$$\frac{dRPR_4}{d\sigma_q^2} = [-2(A_3 - A_4 \tau_1)]\sigma_w^2 \frac{d\tau_1}{d\sigma_q^2}$$

$$+ (\sigma_{A2}^2 + 2\text{cov}(A_{1i}, A_{2i})) \frac{d\pi}{d\sigma_q^2} + \sigma_{A1}^2$$

$$\frac{dRPR_4}{d\sigma_*^2} = \frac{dRPR_4}{d\sigma_q^2}$$

$$\frac{dRPR_4}{d\sigma_\xi^2} = -2(A_3 - A_4 \tau_1)]\sigma_w^2 \frac{d\tau_1}{d\sigma_\xi^2}$$

$$+ (\sigma_{A2}^2 + 2\text{cov}(A_{1i}\ A_{2i})) \frac{d\pi}{d\sigma_\xi^2}$$

where: $$\frac{d\,\tau_1}{d\,\sigma_q^2} = \frac{d\,\tau_1}{d\,\sigma_*^2} < 0$$

$$\frac{d\,\tau_1}{d\,\sigma_\xi^2} < 0$$

$$\pi = E\,(\varepsilon_t^Q - E_{i,t}\,\varepsilon_t^Q)^2 = (1 + \tau_2)(\sigma_q^2 + \sigma_*^2)$$

$$\frac{d\,\pi}{d\,\sigma_q^2} = \frac{d\,\pi}{d\,\sigma_*^2} > 0$$

$$\frac{d\,\pi}{d\,\sigma_\xi^2} > 0$$

$$A_3 = \Sigma_i u_i \lambda_i \alpha\lambda\theta_q A_{oi} > 0$$

$$A_4 = (1-\alpha\lambda\theta_q)[(1-\alpha\lambda\theta_q)(1+\sigma_\lambda^2/\lambda^2) + 2(\sigma_\lambda^2+\lambda^2+\lambda^4 \mathrm{var}(\beta+\Psi^*))] > 0$$

Appendix: Expectational Solution

On each market i, agents observe an unanticipated local price $p_{i,t}$ movement

$$\text{(A1)} \qquad l_{i,t} = \alpha\lambda(\varepsilon_t^M + \overline{\beta\lambda}/\alpha\lambda\varepsilon_t^{R*}) + \lambda\varepsilon_{i,t}^w$$

Furthermore, agents observe a noisy signal about the unexpected part of the current central bank intervention on the foreign exchange market

$$\text{(A2)} \qquad I_t = \varepsilon_t^M + \xi_t = -\frac{1}{\alpha\lambda}(\overline{\beta\lambda}\,\varepsilon_t^{R*} + \varepsilon_t^Q - (1-\alpha\lambda\theta_q)\overline{E\varepsilon_t^Q}) + \xi_t$$

$$\xi_t \sim N(0,\sigma_\xi^2), \quad E(\xi_t\,\xi_\tau) = 0,\ t \neq \tau$$

From the semi-reduced form of ε_t^M, we know that ε_t^M contains both the realized and the perceived foreign shocks $\varepsilon_t^Q = \varepsilon_t^q$ and ε_t^{R*}. We now derive a reduced form for I_t by means of the method of undetermined coefficients. Let

$$\text{(A3)} \qquad \alpha\lambda I_t + \overline{\beta\lambda}\varepsilon_t^{R*} = H_Q\,\varepsilon_t^Q + H_x\,\xi_t.$$

The global signal agents use in forming expectations about ε_t^Q must be proportional to (A3) - remember that ε_t^{R*} is observable.

$$\text{(A4)} \qquad g_t = \eta(H_Q\,\varepsilon_t^Q + H_x\,\xi_t)$$

The local signal is derived from (A1) and (A2) as follows

$$\text{(A5)} \qquad Z_{i,t} = (l_{i,t} - \alpha\lambda I_t - \overline{\beta\lambda}\varepsilon_t^{R*})/\lambda = \varepsilon_{i,t}^w - \alpha\,\xi_t$$

Local perceptions of ε_t^Q consist of a regression of ε_t^Q on $Z_{i,t}$ and g_t

$$\text{(A6)} \qquad E_{i,t}\,\varepsilon_t^Q = \tau_1 Z_{i,t} + \tau_2 g_t$$

where τ_1 and τ_2 are regression coefficients. Thus, average perceptions are

(A7) $\quad \overline{E\varepsilon_t^Q} = \Sigma u_i E_{i,t} \varepsilon_t^Q = \eta \tau_2 H_Q \varepsilon_t^Q + (\eta H_x \tau_2 - \alpha\tau_1) \xi_t$

Insert (27) into (A2) to find

(A8) $\quad H_Q = -(1 - (1-\alpha\lambda\theta_q) \eta\tau_2)^{-1}$

$\quad H_X = -(\alpha\lambda - \alpha\tau_1(1-\alpha\lambda\theta_q)) H_Q$

Hence, the global signal is

(A9) $\quad g_t = -\eta [\varepsilon_t^Q - (\alpha\lambda - \alpha\tau_1(1-\alpha\lambda\theta_q))]/(1-(1-\alpha\lambda\theta_q) \eta\tau_2)$

η is now still a free parameter which can be chosen for analytical convenience (note that this involves the choice of a particular set of regression coefficients). Choosing $\eta = -H_Q^{-1}$, we have

(A10) $\quad g_t = -\varepsilon_t^Q + \alpha(\lambda - \tau_1(1-\alpha\lambda\theta_q)) \xi_t = -\varepsilon_t^Q + \theta_X \xi_t$

The regression coefficients τ_1 and τ_2 can now be derived from the covariance matrix of the stochastic vector $(\varepsilon_t^Q, Z_{i,t}, g_t)$.

This yields

(A11) $\quad \tau_1 = -\alpha\theta_X \sigma_\xi^2 \sigma_Q^2 / \Delta$

$\quad \tau_2 = -\sigma_Q^2(\sigma_W^2 + \alpha^2 \sigma_\xi^2)/\Delta$

$\quad \Delta = \sigma_Q^2(\sigma_W^2 + \alpha^2\sigma_\xi^2) + \theta_X^2 \sigma_W^2 \sigma_\xi^2$

The discussion within text makes use of the property

(A12) $\quad -\dfrac{d\tau_1}{d\sigma_Q^2} > 0$

$\quad -\dfrac{d\tau_1}{d\sigma_\xi^2} > 0$