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ABSTRACT

The paper develops a general stochastic macroeconomic model which can be used to study the international transmission of disturbances under alternative exchange-rate systems.

Four types of exchange-rate systems are considered: uniform flexible exchange rates, uniform fixed exchange rates, two-tier exchange rates in which the current-account exchange rate is fixed and the capital-account exchange rate is flexible, and two-tier exchange rates with separate, floating rates for current and capital-account transactions. It is assumed that expectations are rational, so only the unexpected portion of macro policy alters the level of output. In addition, private contracts form the underpinning of the aggregate supply function, and they can be adjusted optimally in response to the country's choice of exchange-rate regime.

It is shown that when the home country takes all prices as exogenous and wages are optimally indexed, the country is fully insulated from foreign disturbances under the two fixed-rate regimes but not under the two flexible-rate regimes. Even so, the fixed-rate regimes are inferior to the flexible-rate regimes in terms of their ability to minimize output variance. When the home country is large in the market for its own produced good, these results must be modified.

The analysis makes two general points. First, one cannot assume stability of structure when assessing the consequences of alternative exchange-rate regimes. For example, the slope of the aggregate supply curve and the rationally-formed expectations in the asset markets can respond dramatically to the government's choice of exchange-rate regime. Second, exchange-rate regimes that provide full insulation from foreign disturbances may nevertheless be inferior to other regimes in terms of their ability to maximize social welfare.

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In a widely cited 1972 paper, Victor Argy and Michael Porter examined the effects of domestic and external disturbances under alternative exchange-rate systems. Our aim is to investigate the same issue in light of recent developments in macroeconomic modeling.[1]

The model used by Argy and Porter, hereafter A-P, was that of a small open economy under perfect capital mobility in which output was demand-determined. The novel feature of the A-P model was the explicit incorporation of the forward exchange market, with the forward rate linked to the spot rate by a simple regressive expectations mechanism.

With their model, A-P examined the transmission of disturbances under three exchange-rate regimes: (1) uniform flexible exchange rates (FLEX), (2) uniform fixed exchange rates (FIX), and (3) two-tier exchange rates (TT) in which the commercial (current-account) exchange rate is fixed and the financial (capital-account) exchange rate is flexible. They found that the introduction of exchange-rate expectations significantly modified the transmission process.

Our model differs from the A-P model in five important respects, all of which have gained professional prominence or institutional relevance since the A-P paper was written.

(1) We employ rational expectations instead of the ad hoc scheme used by A-P.

(2) The aggregate supply function that we use builds into our model the now familiar rational expectations natural rate hypothesis. Only the unexpected portion of macroeconomic policy alters the level of output. Our attention to the economy's supply-side structure contrasts with A-P's focus on demand-determined output.

(3) Private contracts form the underpinning of our aggregate supply

function, and they can be adjusted optimally in response to the country's choice of exchange-rate regime. This feature reflects the increased importance of indexing schemes since the A-P paper was written,[2] as well as the recognition (Lucas, 1973) that some structural characteristics are not invariant to the government's policy choices when expectations are rational.

(4) We assume that residents of the small economy possess sufficient information about the structure of the rest of the world to associate foreign price and interest-rate fluctuations with underlying real and monetary disturbances abroad. This "extended small country framework" is borrowed directly from Flood (1979) whose analysis draws on Fischer (1977a). In contrast, A-P followed the standard practice of assuming that foreign demand shocks are uncorrelated with foreign interest-rate shocks.

(5) In addition to the three exchange systems examined by A-P, we analyze a new exchange rate regime which did not exist in 1972. This regime is a two-tier exchange market with separate, floating rates for current and capital-account transactions (TTF). Several versions of this system have been tried, or are now used, by major countries,[3] and apart from brief treatments in Lanyi (1975) and Marion (1977), we are unaware of any existing analysis of this system.

The A-P model portrayed a country which was small in the sense that it could not affect foreign variables. We retain that notion here, but consider two types of small countries. First, we consider a small country which takes all goods prices as exogenous. Second, we examine a case where the country is not small in all commodity markets. Rather, it faces a less than perfectly elastic demand for its own output. Here, the relative price of domestic output is determined endogenously.

Our examination of the transmission process yields some key results which can be stated at the outset. When the country takes all prices as exogenous and wage indexation is optimal in the sense used by Gray (1976), then the small country is perfectly insulated from foreign disturbances under the FIX and TT exchange-rate regimes. It is not insulated from any foreign disturbance under the FLEX regime, since both real and monetary foreign disturbances penetrate the small country via an interest-rate channel as well as a price channel. We also find that the insulation provided by the TTF regime, which is designed to protect the country from both current-account (price) and capital-account (interest-rate) disturbances, depends on the country's net foreign asset position. Insulation becomes complete in the special case where the country's net foreign asset position approaches zero.

Further, when the country is a price-taker, we are able to rank exchange-rate regimes according to their ability to maximize social welfare, i.e. minimize the loss function of the model. We find that although the FIX and TT regimes yield the same loss and insulate the economy fully from foreign disturbances, they are inferior to the FLEX and TTF regimes.

Our strong results concerning full insulation and regime ranking must be modified when we assume that the country is large in the market for its own produced good. In this altered circumstance we can no longer say that the home country is fully insulated under the FIX and TT regimes, nor can we provide a welfare ranking of the regimes independent of specific parameter values.

The plan of the paper is as follows. In section II we set out a general stochastic macroeconomic model which can be used to study the various exchange-rate systems when the home country is a price taker in all markets. In section III we describe the solution of the model for each exchange-rate system. In section IV the insulation properties of the systems are compared and the systems are ranked in terms of our chosen loss function. Section V examines some implications of assuming the home country is large in the market for its own output. Section VI contains some concluding remarks.

Section II - The Model

In this section we develop a simple open economy model of a small country which faces real and monetary disturbances, both foreign and domestic. There is one traded commodity whose world price is exogenously given to the small country. The financial sector consists of domestic money and an internationally-traded security issued abroad and denominated in foreign currency, with fixed price and variable interest rate. It is assumed that domestic residents hold both domestic money and the international security.

The model can be summarized as follows:

Notation

Note: lower-case letters generally denote logarithms of variables, the levels of which are represented by upper-case letters ;
Greek letters represent parameters;
an asterisk indicates "foreign";
superscripts refer to supplies or demands;
subscripts refer to the time dimension

y	real output
$\tilde{y}$	desired real output
p	the price level
s	commercial exchange rate (home-currency price of foreign exchange)
x	financial exchange rate
m	nominal stock of money balances
k	domestic holdings of foreign securities
i	interest rate (level)
b	price-elasticity of nominal wages
u	white noise supply disturbance
v	white noise monetary disturbance
σ_i^2	variance of i, i = u, v u*, v*

E mathematical expectation operator

${}_{t-1}Ej_t$ expected value of j at time t, conditional on information available at time t-1

The Model

(1) $$y_t = \bar{y} + z(p_t - {}_{t-1}Ep_t) + u_t$$

(1.a) $$z = \tau(1-b)$$

(2) $$m_t^d - p_t = \alpha_o - \alpha_1 h_t + \alpha_2 y_t \quad , \quad (\alpha_1, \alpha_2 > 0)$$

(3) $$h_t = [i_t^* + \gamma_t E(s_{t+1} - x_{t+1})] + {}_tE(x_{t+1} - x_t) \quad , \quad \gamma \geq 0$$

(3a) $$s_t = x_t \quad , \text{ FLEX}$$

(3b) $$s_t = x_t = \bar{s} \quad , \quad \text{FIX}$$

(3c) $$s_t = \bar{\bar{s}} \quad , \quad \text{TT}$$

(4) $$m_t^s = m_t^d$$

(4a) $$m_t^s = m_{t-1} + v_t \quad , \quad \text{FLEX, TTF}$$

(5) $$p_t = p_t^* + s_t$$

(6) $${}_tE\{\eta(m_{t+1} - m_t) + (1-\eta)[(x_{t+1} - x_t) + (k_{t+1} - k_t)]\}$$
$$= \Psi_o + \Psi_1[p_t + y_t - \eta m_t - (1-\eta)(x_t + k_t)]$$

(6a) $$k_t = \bar{k} \quad , \quad \text{TT}, \quad \text{TTF}$$

Rest of the World

(7) $$p_t^* = \pi_{10} + \pi_{11} m_{t-1}^* + \pi_{12} v_t^* + \pi_{13} u_t^*$$

(8) $$i_t^* = \pi_{20} + \pi_{21} m_{t-1}^* + \pi_{22} v_t^* + \pi_{23} u_t^*$$

The social objective is to minimize the loss function:

$$L = E[(y_t - \tilde{y}_t)^2] \tag{9}$$

$$\tilde{y}_t = \bar{y}_t + \rho u_t \quad , \quad 0 < \rho < 1 \tag{9a}$$

Equation (1) is a natural-rate aggregate supply function, based on the work of Friedman (1968) and Phelps (1970). Current output, expressed in terms of its deviation from the normal level, $\bar{y}$, is a function of price prediction errors and u_t, a stochastic disturbance term having zero mean and constant variance. The particular form of (1) that we use requires z, the slope of the supply curve, to depend on b, the degree of indexation, where b is the elasticity of nominal wages with respect to price and b=1 signifies full indexation. The justification for (1) and (1a) is based on Gray (1976) and Fisher (1977b) and is described in detail in the appendix. We follow these authors in assuming that the value of b can be chosen by the private sector to minimize the loss function in (9). For the open economy, this means that the government's choice of exchange-rate regime systematically influences the degree of indexation and consequently the slope of the economy's aggregate supply curve. In turn, the slope of the aggregate supply curve has important implications for how effectively various exchange-rate regimes insulate domestic output from unanticipated disturbances.

Equation (2) states that the demand for real money balances depends on real income and the opportunity cost to domestic residents of holding money instead of foreign securities. This opportunity cost, h_t, is shown in (3) to consist of expected repatriated interest foregone plus expected capital gains on foreign securities due to exchange-rate changes.

In the case of two-tier exchange rates, where the principal on foreign bonds must be acquired and repatriated at the financial exchange rate but interest income (a current-account item) must be repatriated at the commercial rate,[4] we calculate the actual opportunity cost of holding one unit of domestic money as follows: one unit of domestic money will purchase $1/X_t$ units of capital-account foreign exchange, which may be repatriated next period at the rate X_{t+1} for a capital gain of X_{t+1}/X_t. During the period the $1/X_t$ units of foreign exchange earn i^*_t/X_t in interest income which may be repatriated into domestic money in amount $i^*_t S_{t+1}/X_t$. These two elements of actual yield may be combined into an overall yield of $\frac{X_{t+1}}{X_t}(i^*_t \frac{S_{t+1}}{X_{t+1}} + 1)$. We define the actual opportunity cost of holding domestic money to be $(1 + h'_t)$ in (10)

$$(10) \qquad (1 + h'_t) = \frac{X_{t+1}}{X_t}\left(i^*_t \frac{S_{t+1}}{X_{t+1}} + 1\right)$$

A good logarithmic approximation to (10) is given in (10a)[5]

$$(10a) \qquad h'_t = i^*_t + \gamma(s_{t+1} - x_{t+1}) + x_{t+1} - x_t$$

We define h_t, the <u>expected</u> opportunity cost of holding money, to be ${}_tEh'_t$ or

$$(10b) \qquad h_t = i^*_t + \gamma_t E(s_{t+1} - x_{t+1}) + {}_tE(x_{t+1} - x_t)$$

The above expression for h_t, which is a linearization of a similar expression in Marion (1980), gives the expected opportunity cost of holding money for all regimes. The term $\gamma_t E(s_{t+1} - x_{t+1})$ in h_t disappears when the exchange market is unified: for FLEX, $s_{t+1} = x_{t+1}$ so $h_t = i^*_t + {}_tE(s_{t+1} - s_t)$; for FIX, $s_{t+1} = x_{t+1}$ and $x_{t+1} = x_t$ so $h_t = i^*_t$.

Equation (4) represents equilibrium in the money market. Equation (4a) describes a simple money supply rule for the FLEX and TTF regimes, under which money is exogenous. Here, v_t is a domestic white noice disturbance with mean zero and constant variance. Under the FIX regime, the supply of money is entirely endogenous, since residents can always swap domestic money for international securities at any point in time. Under the TT regime, money is determined by a domestic policy component and by reserve changes that accompany current-account imbalances. In the short-run, the policy-determined stock of money must be held by domestic residents since any attempt to exchange money for international securities merely bids up the financial exchange rate. Over time, the money supply is endogenous since current-account imbalances bring about reserve changes that alter the money stock.

Equation (5) is the "law of one price"; in logs, commodity arbitrage equates the domestic currency price of output to the foreign-currency price plus the current-account exchange rate.

Equation (6) specifies saving behavior. We assume that planned saving (the RHS of (6)) depends positively on real income and negatively on real wealth.[6] Planned saving must be equal to expected asset accumulation (the LHS of (6)). Residents may increase their domestic-currency wealth in several ways. If there is a fixed exchange rate for commercial transactions (FIX, TT), residents can add to their money holdings as the economy acquires reserves through current-account surpluses. If the exchange market is unified (FIX,FLEX), residents can increase their holdings of foreign securities through the capital account: this is not possible under the two-tier regimes since a flexible financial rate prevents net capital flows. Finally, if there is a flexible financial rate (FLEX, TTF), residents may experience capital gains on their foreign bond holdings due to exchange-rate changes. In (6), the coefficient η represents the share of money in the portfolio of domestic residents and $(1-\eta)$ represents the fraction of wealth held in international securities. We treat η as a parameter, an uncomfortable convention which we return to later in Section III.

Equations (7) and (8) are reduced-form equations for the foreign price level and interest rate, derived from a simple macro model of the rest of the world. The rest-of-the-world model and the derivations of (7) and (8) are provided in the appendix. We assume that residents of the small country have complete information about this structure and the processes that generate p_t^* and i_t^*. In particular, they recognize that foreign real and monetary disturbances bring about fluctuations in both foreign prices and the foreign interest rate. Since the home country is small, foreign prices and interest rates are exogenous with respect to domestic variables.

The quadratic loss function in equation (9) indicates that society wants to minimize squared deviations of actual output from desired output. The loss function and definition of desired output are identical to these introduced by Gray (1976).[7] It will be helpful to note that we may use (1) and (9a) to write the loss function (9) in the following form:

$$(11) \qquad L = E[(z(p_t - {}_{t-1}Ep_t) + \beta u_t)^2] \quad , \quad 0 < \beta = 1 - \rho < 1$$

Two final points about the specification of the model need to be made explicit. First, for the operator ${}_{t-i}E$, t-i denotes the t-i information set, which we assume to contain the structure of the model plus all variables, domestic and foreign, dated t-i or earlier. Second, we assume that the four white noise disturbances in the model, v, u, v*, u*, are mutually uncorrelated at any point in time and over time.

Section III

In this section we calculate loss functions for the small economy under four different exchange-rate regimes: FIX, FLEX, TT and TTF. These loss functions will enable us

(1) to determine what degree of wage indexation will minimize the loss function under each exchange regime, and

(2) to compare exchange-rate regimes according to their insulative properties.

In order to derive the various loss functions in the form specified by (11), we must calculate the price-prediction errors ($p_t - {}_{t-1}Ep_t$) that accompany unanticipated disturbances under each exchange regime. This means that we must solve the model for each possible choice of exchange-rate regime, since the log of the domestic price level, p_t, is determined as part of a general equilibrium system. The solution technique we use is the method of undetermined coefficients as used by Lucas (1972). This solution procedure requires the absence of speculative bubbles.[8]

FLEX. To obtain a solution of the model under the FLEX regime, we use equations (1), (2), (3), (3a), (4a) and (5), which describe the output and monetary sectors of the home economy, and equations (7) - (8), which give expressions for the foreign price and interest rate. The model can be solved for p_t and s_t. Note that for the FLEX regime, the model is block recursive, so that the solutions can be obtained independently of the savings equation, (6).

Given that the solution may be obtained as indicated above, we take advantage of the model's linearity in logs in order to write p_t as a linear function of the system's predetermined variables and disturbances. The reduced-form equation for p_t is

(12) $$p_t = \lambda_{10} + \lambda_{11}m_{t-1} + \lambda_{12}v_t + \lambda_{13}u_t + \lambda_{14}m^*_{t-1} + \lambda_{15}v^*_t + \lambda_{16}u^*_t$$

where the λ_{1j} are functions of structural parameters, with

(12a) λ_{10} = constant term

$$\lambda_{11} = 1$$

$$\lambda_{12} = T(1+\alpha_1)$$

$$\lambda_{13} = T(-\alpha_2)$$

$$\lambda_{14} = 0$$

$$\lambda_{15} = T(\pi_{22} - \pi_{11} + \pi_{12})\alpha_1$$

$$\lambda_{16} = T(\pi_{23} + \pi_{13})\alpha_1$$

$$T = (1 + \alpha_1 + \alpha_2 z)^{-1}$$

The unexpected part of p_t, which is

(13) $$p_t - {}_{t-1}Ep_t = \lambda_{12}v_t + \lambda_{13}u_t + \lambda_{15}v_t^* + \lambda_{16}u_t^*$$

can now be substituted into equation (11) to yield the loss function for the FLEX case. This loss function is written in Table I (page 15).

FIX. Obtaining the price solution for the FIX regime is straightforward. We substitute equations (3b) and (7) into (5) to obtain:

(14) $$p_t = \pi_{10} + \pi_{11}m_{t-1}^* + \pi_{12}v_t^* + \pi_{13}u_t^* + \bar{s}$$

The unexpected part of (14) is

(15) $$p_t - {}_{t-1}Ep_t = \pi_{12}v_t^* + \pi_{13}u_t^*$$

which may be substituted into (11) to yield the loss function for the FIX case. This loss function is found in Table I.

TT. Since the standard two-tier exchange-rate regime has a fixed exchange rate for current-account transactions, the price solution is not significantly different from the FIX case. We find the price solution by substituting (3c) and (7) into (5), yielding

$$p_t = \pi_{10} + \pi_{11}m^*_{t-1} + \pi_{12}v^*_t + \pi_{13}u^*_t + \bar{\bar{s}} \tag{16}$$

Since (16) may differ from (4) only in the value of the fixed exchange rate, the unexpected part of p_t for TT regime is given by (15). The loss function for the TT case is identical to the one for the FIX case.

TTF. We will report the price solution for the TTF regime with repatriation of interest income through the current account. The solution for the case where repatriation occurs through the capital account is presented in the Appendix.

In the TTF case, the endogenous variables x_t, s_t and p_t are determined jointly by money market equilibrium, the savings relation and the commodity arbitrage condition. In particular, we employ equations (1)-(3), (4), (4a), (5), (6), (6a), (7), and (8).As before, our procedure is to conjecture that the solutions are linear functions of the state variables in the equations just listed. Our solution for p_t is:

$$p_t = \lambda_{20} + \lambda_{21}m_{t-1} + \lambda_{22}v_t + \lambda_{23}u_t + \lambda_{24}m^*_{t-1} + \lambda_{25}v^*_t + \lambda_{26}u^*_t \tag{17}$$

where

(17a) λ_{20} = constant term

$\lambda_{21} = 1$

$\lambda_{22} = \Omega[(\Psi_1-1)(1-\eta)(1+\alpha_1) + \alpha_1(1-\eta) + \alpha_1\Psi_1\eta]$

$$\lambda_{23} = \Omega[-\alpha_2(\Psi_1-1)(1-\eta) - \alpha_1\Psi_1]$$

$$\lambda_{24} = -\pi_{11}\alpha_1\gamma(1-\eta)/(1-\eta + \eta\alpha_1\gamma)$$

$$\lambda_{25} = \Omega(1-\eta)\{(\Psi_1-1)[\alpha_1\pi_{22}+\alpha_1\gamma(\lambda_{24} + \frac{\lambda_{24}}{1-\eta} - \pi_{11}) + \frac{\alpha_1\lambda_{24}}{1-\eta}] + \frac{\alpha_1\lambda_{24}}{1-\eta}\}$$

$$\lambda_{26} = \Omega[\alpha_1(\Psi_1-1)(1-\eta)\pi_{23}]$$

$$\Omega = [(\Psi_1-1)(1-\eta)(1+\alpha_2 z) + \Psi_1\alpha_1(1+z)]^{-1}$$

In addition, we impose the assumption $\lambda_{23}<0$ to ensure that a positive output disturbance will reduce p_t.

In reporting the price solution for the TTF case, we have allowed $k_t=\bar{k}$ to enter the constant term. Such a procedure is legitimate because we have assumed that the internationally-traded security is a fixed-price bond in terms of foreign currency.[9] This point is related to our earlier decision to treat η, the share of money in wealth, as a constant. The only time η enters into the price solutions is in the TTF system, and in this case, $k_t=\bar{k}$ and money at home and abroad follows a random walk. Consequently, the actual share of money in wealth will stay roughly constant and we should feel no less comfortable with treating η as a constant than with any other linear approximation.

Given the solution for p_t in (17), the price prediction error under the TTF regime can be expressed as

$$(18) \qquad p_t - {}_{t-1}Ep_t = \lambda_{22}v_t + \lambda_{23}u_t + \lambda_{25}v_t^* + \lambda_{26}u_t^*$$

Substituting this expression into (11) yields the loss function for the TTF case, which is written in Table I.

We can use the loss functions in Table I to determine the optimal degree of wage indexation (denoted $\hat{b}$) under each exchange-rate regime. Since welfare is maximized when the value of the loss function L is minimized, $\hat{b}$

is obtained from the first-order conditions for a minimum. A useful shortcut is to recognize from equation (1a) that z is a linear function of b, so choosing the optimal value of b is equivalent to choosing the optimal value of z (denoted $\hat{z}$). Thus we calculate the optimal degree of indexation for each exchange-rate regime by differentiating the various loss functions in Table I with respect to z, setting the result equal to zero, and solving for z. The solutions are given in Table II, which shows that full indexation is always optimal for the fixed rate regimes but partial indexation is generally optimal for the flexible rate regimes. Note that the effects of indexing on the real economy depend on the source of price prediction errors. Full indexing prevents the transmission of domestic monetary shocks to the real economy. In the open economy it also insulates the real sector from foreign disturbances. However, when domestic prices depend on the quantity of domestic output, full indexation exacerbates the real effects of domestic output disturbances.

In the FIX and TT regimes the commercial exchange rate is fixed, so fluctuations in the domestic price level occur only as a result of fluctuations in the foreign price level. This means that foreign disturbances are the only source of domestic price prediction errors and it is optimal for the private sector to index fully by setting b=1 and thus z=0.

In the FLEX and TTF regimes, domestic price prediction errors depend not only on unexpected fluctuations in foreign prices but also on unexpected changes in the commercial exchange rate. Since domestic supply shocks form part of the stochastic structure that brings about unanticipated changes in the commercial (uniform) exchange rate, the optimum degree of indexing is generally less than unity in order to moderate the real effects of supply shocks.

TABLE I

$$L_{FLEX} = E\{[z(\lambda_{12}v_t + \lambda_{13}u_t + \lambda_{15}v_t^* + \lambda_{16}u_t^*) + \beta u_t]^2\}$$

$$L_{FIX,TT} = E\{[z(\pi_{12}v_t^* + \pi_{13}u_t^*) + \beta u_t]^2\}$$

$$L_{TTF} = E\{[z(\lambda_{22}v_t + \lambda_{23}u_t + \lambda_{25}v_t^* + \lambda_{26}u_t^*) + \beta u_t]^2\}$$

TABLE II

$$\hat{z}_{FLEX} = \frac{\alpha_2\beta(1+\alpha_1)\sigma_u^2}{(1+\alpha_1)^2\sigma_v^2 + \alpha_2^2(1-\beta)\sigma_u^2 + \alpha_1^2[(\pi_{22} - \pi_{11} + \pi_{12})^2\sigma_{v*}^2 + (\pi_{23} + \pi_{13})^2\sigma_{u*}^2]}$$

$$\hat{z}_{FIX,TT} = 0$$

$$\hat{z}_{TTF} = \frac{\Gamma\{(\Psi_1-1)(1-\eta) + \Psi_1\alpha_1\}}{1 - \Gamma\{(\Psi_1-1)(1-\eta)\alpha_2 + \Psi_1\alpha_1\}}$$

where $$\Gamma = \frac{\beta\{\alpha_1(\Psi_1-1)(1-\eta) + \alpha_1\Psi_1\}\sigma_u^2}{\Omega^{-2}\{\lambda_{22}^2\sigma_v^2 + \lambda_{23}^2\sigma_u^2 + \lambda_{25}^2\sigma_{v*}^2 + \lambda_{26}^2\sigma_{u*}^2\}}$$

From (1a), $z = \tau(1-b)$. Full indexation ($b=1$) implies $z=0$.

Section IV: Comparison of Exchange-Rate Regimes

In this section, we examine two important issues. First, what are the insulative properties of each exchange-rate system when wages are indexed optimally? Second, which exchange-rate regime provides the minimum value of our chosen loss function? This second question is the traditional fixed-versus-flexible exchange-rate question, broadened to take account of some untraditional exchange-rate systems.

The insulative properties of each exchange-rate regime are defined in terms of our loss function. The home country is said to be fully insulated from foreign disturbances when foreign real and monetary variance do not affect the value of the loss function. In Table III we report the values of the loss function under optimal indexation for each exchange-rate regime. The Table shows the FIX and TT regimes provide complete insulation from foreign disturbances, while the TTF regime provides full insulation only when the net foreign asset position is zero, and the FLEX regime never provides full insulation.[10]

The full insulation provided by the FIX and TT regimes is evident from the fact that no foreign variance terms enter $\hat{L}(FIX)$ or $\hat{L}(TT)$. Recall that when the exchange rate for commercial transactions is fixed, domestic price prediction errors arise only when foreign disturbances bring about unanticipated fluctuations in the foreign price level. But, with wages fully indexed under the FIX and TT regimes, wages respond in proportion to the price prediction error. Full indexation implies $\hat{z}=0$, and this removes all foreign influences from the loss function.

When the economy operates a TTF regime, insulation is incomplete unless the domestic net foreign asset position is zero. The coefficients attached to foreign monetary and real variance are $(\hat{z}(TTF)\lambda_{25})^2$ and $(\hat{z}(TTF)\lambda_{26})^2$ respectively, where λ_{25} and λ_{26} are the coefficients attached respectively

Table III

$$\hat{L}(FLEX) = (\hat{z}(FLEX)\lambda_{15})^2\sigma^2_{v*} + (\hat{z}(FLEX)\lambda_{16})^2\sigma^2_{u*} + (\hat{z}(FLEX)\lambda_{12})^2\sigma^2_{v} + (\hat{z}(FLEX)\lambda_{13}+\beta)^2\sigma^2_{u}$$

$$\hat{L}(TT) = \hat{L}(FIX) = \beta^2\sigma^2_u$$

$$\hat{L}(TTF) = (\hat{z}(TTF)\lambda_{25})^2\sigma^2_{v*} + (\hat{z}(TTF)\lambda_{26})^2\sigma^2_{u*} + (\hat{z}(TTF)\lambda_{22})^2\sigma^2_{v} + (\hat{z}(TTF)\lambda_{23}+\beta)^2\sigma^2_{u}$$

Notes: $\hat{L}$ is the optimal value of L. In this table the values of λ_{ij} are calculated using the relevant optimal values of z from Table II.

to v_t^* and u_t^* in the TTF price solution. Note that λ_{25} is a linear function of both π_{22} and π_{11}. The presence of π_{22} in λ_{25} indicates that foreign monetary disturbances are transmitted to the small economy by an interest rate channel; the presence of π_{11} in λ_{25} indicates that the price channel also transmits foreign monetary disturbances. Our previous results further show that λ_{26} is proportional to π_{23}; indicating that foreign real disturbances are transmitted through the interest rate. Since none of the $\pi_{1i}(i=0,1,2,3)$ enters λ_{26}, the TTF regime insulates the economy from real disturbances which are carried by the price channel.

An interesting feature of the TTF regime is that insulation becomes complete as the home country's net foreign asset position , $1-\eta$, goes to zero. Formally, $\lambda_{25}=\lambda_{26}=0$ when $1-\eta=0$. This result should not be surprising. Having a balanced net foreign asset position under the TTF regime is equivalent to operating a FLEX regime when there is no financial integration. Under such circumstances, only the price channel transmits foreign real and monetary shocks and the commercial exchange rate can fully offset such disturbances.

When the economy operates a FLEX regime, insulation is incomplete since foreign disturbances enter through both price and interest-rate channels. The coefficients attached to foreign monetary and real variance in $\hat{L}$(FLEX) are $(\hat{z}(\text{FLEX})\lambda_{15})^2$ and $(\hat{z}(\text{FLEX})\lambda_{16})^2$. Both λ_{15} and λ_{16} go to zero as α_1 goes to zero, indicating that foreign disturbances enter the domestic economy through their influence on domestic interest rates. We should note that λ_{15} is a linear function of π_{22}, π_{11} and π_{12} and λ_{16} is a linear function of π_{23} and π_{13}; the presence of π_{11}, π_{12} and π_{13} in these expressions indicates that the price channel is transmitting both real and monetary disturbances. Further, the presence of π_{22} and π_{23} in λ_{15} and λ_{16} indicates transmission of monetary and real disturbances via the interest rate channel.

Foreign disturbances under FLEX influence the domestic economy through domestic interest rates, and both foreign interest rates and foreign prices transmit disturbances to domestic interest rates. The interest rate channel's influence is direct; the domestic error in predicting foreign interest rates, $i_t^* - {}_{t-1}Ei_t^* = \pi_{22}v_t^* + \pi_{23}u_t^*$, results in an equal domestic error in predicting domestic interest rates. The influence of the price channel is more indirect. An unexpected change in foreign prices leads to an unexpected revision in the expected rate of depreciation of s_t. This revision, ${}_tE(s_{t+1} - s_t) - {}_{t-1}E(s_{t+1} - s_t)$, causes an unexpected change in h_t.

Our striking results--that fixed exchange-rate regimes fully insulate while flexible exchange-rate regimes do not--are quite different from those obtained by A-P and others. The difference can be explained by our use of the extended small-country framework and by our incorporation of Lucas' point (1973) that agents' behavior may respond to the government's policy choices. In the open-economy context, this means that structural characteristics may in fact be a function of the choice of exchange-rate regime and should be treated as variables rather than parameters in questions involving the choice of regime. In our model, both expectations and the slope coefficient of the aggregate supply curve respond to the government's choice of exchange regime. This dramatically influences the insulative properties of various regimes.

An examination of the loss functions in Table III also reveals some interesting welfare properties. We find that even though the FIX and TT regimes fully insulate the home economy when indexation is optimal, the loss is greater under these two regimes than under either uniform floating rates or the two-tier float.

The proof of this result is simple. From Table I it can be seen that full indexation (z=0) makes the loss function for each of the four exchange-rate regimes equal to $\beta^2\sigma_u^2$. For the FIX and TT regimes, this is the best the private sector can do, since the loss function is minimized when

$\hat{z}(FIX) = \hat{z}(TT) = 0$. For the FLEX and TTF regimes, $\beta^2\sigma_u^2$ is a feasible value for the loss function, but it is not generally the chosen (minimum) value of the loss function since $\hat{z}(FLEX)$, $\hat{z}(TTF) \neq 0$. Consequently, it must be the case that

$$(19) \qquad \hat{L}(FIX) = \hat{L}(TT) > \begin{cases} \hat{L}(FLEX) \\ \hat{L}(TTF), \end{cases}$$

Comparing the loss functions of the FLEX and TTF regimes is more difficult as savings parameters occur in $\hat{L}(TTF)$ which do not occur in $\hat{L}(FLEX)$.

We view our results on insulation and welfare as interesting and important, but recognize that they are applicable only to the special case in which the home country is small in all markets and the covariance of the domestic supply disturbance with foreign price is zero. Our next task is to see how the results are modified when the analysis is extended to a home country with some market power.

Section V: The Case of Market Power

In this section, we extend the model in order to consider the case where the home country is large in the market for the commodity produced at home but remains small in other goods markets and in the world bond market. Such an extension not only draws our model closer to the case considered by A-P, but serves to illustrate that the strong conclusions of the previous section hold only for the special small-country case considered.

Since our strongest insulation result was that fixed-rate regimes provide full insulation from foreign disturbances under optimal indexation, we shall consider only the case of uniform fixed rates in this section.

In a two-good world, equation (1) from Section II must be replaced by

$$(20) \qquad y_t = \bar{y} - \frac{(1-\theta)}{\theta} \left\{ \frac{{}_{t-1}E(p_t-q_t)}{1+\theta\delta} - (p_t-q_t) - (1-b)(q_t-{}_{t-1}Eq_t)\right\} + u_t$$

where p_t is the log of domestic price of the good produced at home and q_t is the domestic consumer price index, with

$$q_t = \omega p_t + (1-\omega)(p_t^*+\bar{s}) \quad , \quad 0 < \omega < 1,$$

and $p_t^* + \bar{s}$ being the domestic price of the imported good.

Equation (20), which is derived in the appendix, is based on the assumptions that: (1) only one good is produced at home, (2) two goods are consumed at home, and (3) wages are indexed to the consumer price index.

We assume that domestic and foreign demand for the home good is given by

$$(21) \qquad y_t^d = \Delta_o - \Delta_1(p_t-p_t^*-\bar{s}) + \Delta_2 y_t + \Delta_3 y_t^* \qquad \Delta_1,\ \Delta_3>0,\ 0<\Delta_2<1$$

where we have grouped together all relative price terms and have assumed the Marshall-Lerner condition to hold. For the FIX regime, p_t is determined by equating aggregate supply (20) to aggregate demand (21). The value of p_t that clears the domestic output market may be expressed as

(22) $$p_t = \lambda_{30} + \lambda_{31}m_{t-1} + \lambda_{32}v_t + \lambda_{33}u_t + \lambda_{34}m^*_{t-1} + \lambda_{35}v^*_t + \lambda_{36}u^*_t$$

where

λ_{30} = constant term

$\lambda_{31} = 0$

$\lambda_{32} = 0$

$\lambda_{33} = \mu[\Delta_2 - 1]$

$\lambda_{34} = 1$

$\lambda_{35} = \mu[\theta\Delta_1\pi_{12} + \theta\Delta_3\pi_{32} + (1-\Delta_2)(1-\theta)b(1-\omega)\pi_{12}]$

$\lambda_{36} = \mu[\theta\Delta_1\pi_{13} + \theta\Delta_3\pi_{33} + (1-\Delta_2)(1-\theta)b(1-\omega)\pi_{13}]$

$\mu = [(1-\Delta_2)(1-\theta)(1-b\omega) + \theta\Delta_1]^{-1}$.

In the appendix we derive the function $y^*_t = \pi_{30} + \pi_{31}m^*_{t-1} + \pi_{32}v^*_t + \pi_{33}u^*_t$, which has been used in obtaining (22).

We retain the loss function proposed in Section II,[11] and find that when the country is large in the market for its own output, the loss function may be written as

(23) $$L = E\{(\frac{(1-\theta)}{\theta}[\frac{(p_t-q_t) - {}_{t-1}E(p_t-q_t)}{1+\theta\delta} + (1-b)(q_t - {}_{t-1}Eq_t)] + \frac{(1-\theta)}{1+\theta\delta}u_t)^2\}$$

which shows that both unexpected movements of the CPI, $(q_t - {}_{t-1}Eq_t)$, and unexpected movements in relative prices, $(p_t-q_t) - {}_{t-1}E(p_t-q_t)$, will cause deviations of actual output from desired output.

The degree of indexation which minimizes the loss function in (23) is generally less than one. This may be seen from equation (22), where we observe that domestic supply disturbances can alter the price of domestic output when the country is large in this market. Consequently, domestic supply disturbances are a cause of price prediction errors and to fully index under these conditions would only exacerbate the real effects of supply-side shocks.

Moreover, equation (23) shows that even if there were full indexation, the economy is not completely insulated since foreign disturbances also cause unexpected changes in relative prices, and no amount of indexation can prevent these unexpected changes in relative prices from entering the loss function. In conclusion, fixed exchange-rate regimes do <u>not</u> provide full insulation from foreign disturbances unless the home country is small in all markets.

VI Concluding Remarks

Two general points are worth reemphasizing and should prove robust to alternative model specifications. First, the policy-maker cannot assume stability of structure when assessing the consequences of alternative exchange-rate regimes. Certain aspects of private behavior that might be parametric under one regime may adjust fundamentally to an alteration in regimes. In our model, for example, the slope of the aggregate supply curve and the rationally-formed expectations in the asset markets responded dramatically to the government's choice of exchange-rate regime. Second, the analysis powerfully demonstrates the notion that insulation from foreign disturbances is not necessarily a desirable policy goal. For the small open economy in Section IV, fixed-rate regimes provide full insulation but are unambiguously inferior to flexible-rate regimes.

Appendix

1 - Derivation of Equations (1) and (1a)

Equation (1) in the text is derived from a model which specifies the behavior of firms, labor, and contract-setting. The model originates with Gray (1976) and Fischer (1977b).

Let production be a function of labor inputs and a productivity factor:

(A1) $$Y_t = \exp(\varepsilon_t) L_t^{(1-\theta)}, \quad 0 < (1-\theta) < 1$$

Converting to logs, we have

(A 1a) $$y_t = (1-\theta)\ell_t + \varepsilon_t$$

Labor demand is derived by differentiating (A1) with respect to labor, equating the resulting marginal product of labor expression to the real wage, and converting to logs:

(A2) $$\ell_t^d = \frac{-1}{\theta}(w_t - p_t) + \frac{1}{\theta}\ln(1-\theta) + \frac{1}{\theta}\varepsilon_t .$$

Labor supply is assumed to be an increasing function of the real wage

(A3) $$\ell_t^s = \delta(w_t - p_t) \quad , \quad \delta > 0.$$

The wage-contracting scheme can be written as

(A4) $$w_t = w_t' + b(p_t - {}_{t-1}Ep_t)$$

where w_t' is the nominal wage that clears the labor market in the absence of uncertainty and b is the indexing parameter.

Setting (A2) equal to (A3) and $\varepsilon_t=0$, we get

(A5) $$w_t' = {}_{t-1}Ep_t + \frac{\ln(1-\theta)}{\theta(\delta + \frac{1}{\theta})}$$

Next we substitute (A5) into (A4) to get w_t, substitute w_t into (A2) to get ℓ_t (since labor inputs are demand-determined), and substitute ℓ_t into (A 1a) to get our expression for y_t:

(A6) $$y_t = \bar{y} + z(p_t - {}_{t-1}Ep_t) + u_t$$

where $\bar{y} = (1-\theta)\ \bar{\ell}$

$$\bar{\ell} = (\frac{\delta}{\theta\delta+1})\ \ell n(1-\theta)$$

$$z = \tau(1-b)$$

$$\tau = \frac{(1-\theta)}{\theta}$$

$$u_t = \frac{\varepsilon_t}{\theta}$$

2 - <u>Derivation of $\tilde{y}_t$</u>

The log of desired output, $\tilde{y}_t$, is the amount of output that would obtain in a frictionless world. In order to calculate $\tilde{y}_t$, equate labor demand (A2) to labor supply (A3) under the assumption that there are no binding contracts and solve for equilibrium employment, ℓ_t. Substituting ℓ_t into (A 1a) yields

(A7) $$\tilde{y}_t = \bar{y}_t + \rho u_t$$

where

$$\bar{y}_t = (1-\theta)\bar{\ell}$$

$$\rho = \frac{\delta\theta+\theta}{\delta\theta+1} < 1$$

3 - <u>Rest-of-the-World Model</u>

The model for the rest of the world consists of a goods market and a money market. The equations governing behavior in the rest of the world are:

(A8) $y^*_t = z^*(p^*_t - {}_{t-1}Ep^*_t) + u_t$

(A9) $y^*_t = \delta^*_o + \delta^*_1 y^*_t + \delta^*_2(m^*_t - p^*_t)$, $0 < \delta^*_1 < 1,\ \delta^*_2 > 0$

(A 10) $m^{d*}_t - p^*_t = \alpha^*_o - \alpha^*_1 i^*_t + \alpha^*_2 y^*_t$, $\alpha^*_1,\ \alpha^*_2 > 0$

(A 11) $m^*_t = m^*_{t-1} + v^*_t$

Equation (A8) is the aggregate supply function. Equation (A9) is aggregate demand, which depends positively on real income and real money balances. Aggregate demand is not dependent on the stock of international securities, since foreign residents do not consider these securities as part of their wealth. Equation (A 10) states that the demand for real money balances depends on real income and the opportunity cost of holding money. Equation (A 11) specifies the money supply process.

We assume market-clearing behavior and solve the model for p^*_t and i^*_t by the method of undetermined coefficients. The solution for y^*_t can be obtained by substituting the equilibrium value of p^*_t into (A8). The solutions are as follows:

$$p^*_t = \pi_{10} + \pi_{11}m^*_{t-1} + \pi_{12}v^*_t + \pi_{13}u^*_t$$

$$i^*_t = \pi_{20} + \pi_{21}m^*_{t-1} + \pi_{22}v^*_t + \pi_{23}u^*_t$$

$$y^*_t = \pi_{30} + \pi_{31}m^*_{t-1} + \pi_{32}v^*_t + \pi_{33}u^*_t$$

where π_{10} = constant term

$\pi_{11} = 1$

$\pi_{12} = \dfrac{\delta^*_2}{(1-\delta^*_1)z^* + \delta^*_2}$, $0 < \pi_{12} < 1$

$\pi_{13} = \dfrac{-(1-\delta^*_1)}{(1-\delta^*_1)z^* + \delta^*_2} < 0$

π_{20} = constant term

$$\pi_{21} = 0$$

$$\pi_{22} = [\frac{\alpha_2^*}{\alpha_1^*} - \frac{(1-\delta_1^*)}{\delta_2^*\alpha_1^*}] \; \pi_{12} \gtrless 0$$

$$\pi_{23} = \frac{\pi_{22}}{z^*} \gtrless 0$$

$$\pi_{30} = 0$$

$$\pi_{31} = 0$$

$$\pi_{32} = z^*\pi_{12} > 0$$

$$\pi_{33} = z^*\pi_{13} + 1 > 0$$

4 - Real Rate of Return on Savings

When savings depends on the real rate of interest as well as on real income and real wealth, equation (6) of the model must be modified to:

(A 12) $${}_tE\{\eta(m_{t+1}-m_t) + (1-\eta)[(x_{t+1}-x_t)+(k_{t+1}-k_t)]\} =$$

$$\Psi_o + \Psi_1[p_t + y_t - \eta m_t - (1-\eta)(x_t + k_t)]$$

$$+\Psi_2[h_t - {}_tE(p_{t+1} - p_t)] \quad , \Psi_2 > 0$$

As shown in Section II of the text, the price of domestic output can be solved for independently of the savings function under a FIX, FLEX and TT regime. Hence the inclusion of the real rate of return in (A 12) has no bearing on our insulation results for these three regimes. The inclusion of the real rate of interest in the savings function does matter for the TTF regime, however, since the solution for p_t depends, in part, on (A 12). Now TTF no longer provides complete insulation of the home economy as $(1-\eta)\to 0$. A balanced net foreign asset position will prevent changes in the financial rate from penetrating the small economy via a wealth channel, but will not prevent financial exchange-rate fluctuations from altering aggregate demand via an interest-rate channel. This interest-rate effect prevents the commercial exchange rate from fully offsetting foreign price disturbances.

5 - Derivation of Equation (20)

Equation (20) in the text is derived from a model which specifies the behavior of firms, labor, and contract-setting. The derivation is like that of equation (1), only extended to the two-good case.

Production is a function of labor inputs and a productivity factor:

$$\text{(A 14)} \qquad Y_t = \exp(\varepsilon_t)L_t^{(1-\theta)}, \qquad 0 < (1-\theta) < 1$$

converting (A 14) to logs:

(A 14a) $y_t = (1-\theta)\ell_t + \varepsilon_t$

Labor demand is derived by differentiating (A 14) with respect to labor, equating the resulting marginal product of labor to the real wage in terms of the domestic good, and converting to logs:

(A 15) $\ell_t^d = \frac{-1}{\theta}(w_t - p_t) + \frac{1}{\theta}\ell n(1-\theta) + \frac{1}{\theta}\varepsilon_t$

Labor supply is assumed to be a positive function of the real purchasing power of wages:

(A 16) $\ell_t^s = \delta(w_t - q_t)$

where

(A 16a) $q_t = \omega p_t + (1-\omega)(p_t^* + s), \quad 0 < \omega < 1$

Nominal wages are indexed to the CPI in the following manner:

(A 17) $w_t = w_t' + b(q_t - {}_{t-1}Eq_t)$

where w_t' is the nominal wage that clears the labor market in the absence of uncertainty and b is the indexing parameter.

Setting (A 15) equal to (A 16) and $\varepsilon_t = 0$, we get

(A 18) $w_t' = (\frac{1}{\theta\delta+1})\{{}_{t-1}Ep_t + \theta\delta\,{}_{t-1}Eq_t + \ell n(1-\theta)\}$

We then substitute (A 18) into (A 17) to get w_t, substitute w_t into (A 15) to get ℓ_t and substitute ℓ_t into (A 14a) to get the expression for y_t when the country is large in the market for its own produced good:

(A 19) $y_t = \bar{y} - \frac{(1-\theta)}{\theta}\{\frac{{}_{t-1}E(p_t - q_t)}{1+\theta\delta} - (p_t - q_t) - (1-b)(q_t - {}_{t-1}Eq_t)\} + u_t$

where

$$\bar{y} = \frac{(1-\theta)}{\theta}\{(\frac{\delta}{1+\theta\delta})\ell n(1-\theta)\}$$

$$u_t = \frac{1}{\theta}\varepsilon_t$$

6 - Capital Account Repatriation of Interest Income Under TTF

In the text we assumed that all interest income is repatriated through the current account under TT and TTF. If interest income goes through the capital account instead we must replace (6a) with

(A20) $$i_t^* = k_{t+1} - k_t$$

which is a logrithmic approximation to the condition that the capital account be in balance. In addition to (A20) we also set $\gamma=0$ in h_t.

The model's solution under this regime is

(A21) $$p_t = \lambda_{40} + \lambda_{41}m_{t-1} + \lambda_{42}v_t + \lambda_{43}u_t$$

with

λ_{40} = constant term

$\lambda_{41} = 1$

$\lambda_{42} = 1/(1+\alpha_2 z)$

$\lambda_{43} = -\alpha_2/(1+\alpha_2 z)$.

It is evident that the economy would be fully insulated under this regime. However, we feel that this regime is not really a viable long term alternative to the regimes studied in the text. The problem with the regime is that the only rational solution to the model yields

(A22) $i_t^* = -{}_tE(x_{t+1} - x_t)$

implying

(A23) $h_t = 0.$

Equation (A23) states that the opportunity cost of holding money is zero. In such a world we do not see any reason for foreign securities to be held by domestic residents. A second problem is that the gap between x_t and s_t is expected to widen indefinitely with this system. Such an expectation can only be consistent with the expectation of the eventual demise of the regime. However, if agents view this regime as temporary then it would be a viable system.[12]

Footnotes

[1]Since 1972, much attention has been devoted to stock-flow distinctions, the role of asset markets in exchange-rate determination, supply-side behavior and the formulation of expectations, to cite just a few examples.

[2]For a survey of indexing schemes in industrial countries, see the references in Sachs (1979) who along with Rehm (1979) examines indexing in open economies.

[3]Italy and France experimented briefly with a TTF regime during the 1973-74 period. The BLEU has operated such a system since 1973, although it maintains margins for its commercial exchange rate against certain European currencies. The U.K. and the Netherlands have had a more limited version of this system, with a flexible rate for most transactions and a separate floating exchange rate for certain types of capital transactions.

[4]In the Appendix we discuss the case where interest income is repatriated through the capital account.

[5]We use two approximations in obtaining (10a). First, for small h'_t, $\ln(1+h'_t) \approx h'_t$. Second, $i^*_t \frac{S_{t+1}}{X_{t+1}} \approx i^*_t + i^*_t(s_{t+1} - x_{t+1})$. We have used $i^*_t(s_{t+1} - x_{t+1}) \approx \gamma(s_{t+1} - x_{t+1}) + \chi i^*_t + \gamma\chi$, where γ is the mean value of i^*_t and χ is the mean value of $(s_{t+1} - x_{t+1})$. For simplicity, we have chosen the normalization $\chi = 0$.

[6]The implications of a savings function which depends on the real rate of return as well as on income and wealth are explored in the appendix. The RHS of (6) is a special functional form (log linear) of private savings behavior, where saving is homogeneous of degree 1 in income and wealth and thus is homogenous of degree zero in those arguments when we examine saving per unit of wealth.

[7]For the derivation of $\tilde{y}_t$, in (9a), see the appendix.

[8]The assumption of absence of speculative bubbles is an issue which has been explored theoretically by Brock (1974), and was tested by Flood and Garber (1980).

[9]It would be only slightly more difficult to handle a foreign security whose price in logs varies inversely (but linearly) with the foreign rate of interest and directly with expected future output abroad. If we allow such securities, we introduce another channel for foreign disturbances to enter the small country.

[10] Our main results are robust to some generalizations of our loss function. In particular our insulation results would be duplicated for b set to minimize output variance, $E[(y_t - \bar{y})^2]$, or to minimize some functions future deviations of output from $\tilde{y}$ or $\bar{y}$. For instance if we minimize $E[(\sum_{i=0}^{\infty} (y_{t+i} - \tilde{y}_{t+i})\phi^{-i})^2]$, where $\phi > 1$ is the social discount rate, our results follow exactly.

[11] In the two-good case, real income is not equivalent to real output. It is more appropriate to assume that society wishes to minimize real income variance rather than real output variance. Thus the loss function might be specified as

$$L = E\{(y_t - \tilde{y}_t)^2 + ([p_t - p_t^* - \bar{s}] - [\tilde{p}_t - p_t^* - \bar{s}])^2\}$$

which simplifies to

$$L = E\{(y_t - \tilde{y}_t)^2 + (p_t - \tilde{p}_t)^2\}$$

where $\tilde{y}_t$ is derived in a similar fashion to the small country case, and $\tilde{p}_t$ is the level of p_t which would prevail in an equilibrium with $y_t = \tilde{y}_t$.

For our purpose this loss function is really no different from the loss function in Section II. The proof is as follows. Using equation (21), we can write equilibrium output and desired output as

$$y_t = \Delta_0 - \Delta_1(p_t - p_t^* - \bar{s}) + \Delta_2 y_t + \Delta_3 y_t^*$$

$$\tilde{y}_t = \Delta_0 - \Delta_1(\tilde{p}_t - p_t^* - \bar{s}) + \Delta_2 \tilde{y}_t + \Delta_3 y_t^*$$

Subtracting y_t from y_t gives

$$(y_t - \tilde{y}_t)(1 - \Delta_2) = -\Delta_1(p_t - \tilde{p}_t)$$

so

$$(p_t - \tilde{p}_t) = \frac{-(1 - \Delta_2)}{\Delta_1}(y_t - \tilde{y}_t)$$

Substituting this expression into the loss function written above gives

$$L = (1 + \frac{(1 - \Delta_2)^2}{\Delta_1^2}) E\{(y_t - \tilde{y}_t)^2\}.$$

[12]We study agents' expectations in temporary TTF regimes in Flood and Marion (1980).

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