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ASPECTS OF THE OPTIMAL MANAGEMENT OF EXCHANGE RATES

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Abstract

This paper analyzes aspects of the economics of the optimal management of exchange rates. It shows that the choice of the optimal exchange rate regime depends on the nature and the origin of the stochastic shocks that affect the economy. Generally, the higher is the variance of real shocks which affect the supply of goods, the larger becomes the desirability of fixity of exchange rates. The rationale for that implication is that the balance of payments serves as a shock absorber which mitigates the effect of real shocks on consumption. The importance of this factor diminishes the larger is the economy's access to world capital markets. On the other hand, the desirability of exchange rate flexibility increases the larger are the variances of the shocks to the demand for money, to the supply of money, to foreign prices and to purchasing power parities. All of these shocks exert a similar effect and their sum is referred to as the "effective monetary shock." It is also shown that the desirability of exchange rate flexibility increases the larger is the propensity to save out of transitory income. When the analysis is extended to an economy which produces traded and non-traded goods it is shown that the desirability of exchange rate flexibility diminishes the higher is the share of non-traded goods relative to traded goods and the lower are the elasticities of demand and supply of the two goods.

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I. Introduction

This paper deals with the problem of the choice of an optimal exchange rate regime for a small open economy. Previous analyses of the choice between fixed and flexible exchange rate systems centered around questions of stabilization policies, the effect of capital mobility on the efficacy of monetary and fiscal policies, the role of speculation in the foreign exchange market, the nature and origin of exogenous disturbances, and the like. Subsequent discussions originating with contributions in the 1960s by Mundell (1961), McKinnon (1963) and Kenen (1969) have shifted the focus of analysis to the choice of the optimal currency area. The shift of emphasis reflected the recognition of the fact that the optimal exchange rate regime need not be the same for all countries. Rather, a country might find it useful to maintain a fixed rate with some currencies while having a flexible exchange rate with some other currencies.

The analysis in this paper recognizes that the spectrum of possibilities open for the various economies is much broader than the one implied by the framework of analysis of the optimal currency area. Rather than dividing the world into currencies among which exchange rates are flexible and those among which exchange rates are fixed, one might consider the optimal degree of fixity of exchange rates between each pair of currencies. In this framework the choice of an exchange rate regime between any pair of currencies need not be a fixed or a flexible rate but rather it might be some optimal mix of the two extremes. The optimal mix is referred to as the optimal managed (or dirty) float and the determinants of the optimal degree of exchange rate management is the subject of this paper.

The analytical framework that is outlined below builds upon, and extends the analysis of recent papers by Fischer (1976) and Gray (1976).

Fischer analyzes the choice between the two extreme exchange rate systems in terms of the source of exogenous disturbances. He demonstrates that when the exogenous shocks are real, the variance of steady-state consumption is lower under a fixed exchange rate system than under a flexible rate system. On the other hand, when the exogenous shocks are monetary, the opposite holds and the flexible rate system is preferred to the fixed rate system. Gray's paper deals with wage indexation in a closed economy and develops the concept of the optimal degree of wage indexation when the system is subject to real and monetary shocks which occur simultaneously. Lack of complete information precludes identifying the effect of each shock separately, and thus results in the optimal degree of wage indexation. In what follows we combine the two approaches of Fischer and Gray into a framework which yields an index measuring the optimal degree of fixity of exchange rates, i.e., the optimal managed float. Section II describes the analytical framework and analyzes the problem for an economy whose production consists only of commodities that are traded internationally. It is shown that the major determinants of the optimal managed float are the variances of and the covariances among the various shocks that affect the economy.[1] In section III we extend the analysis to an economy which produces tradable as well as

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[1]The analytical framework is adapted from Frenkel (1976, 1980). For an early analysis of the optimal exchange rate regime in terms of the structure of the economy see Stein (1963). Modigliani and Askari (1973) have emphasized that the optimal exchange rate regime depends on the nature of the shocks and that the optimum may be an intermediate system between fixed and flexible rates, e.g., sliding parities. A similar emphasis on the origin of shocks is found in Flood (1979), Buiter (1977) and Enders and Lapan (1979) who also emphasize the stochastic nature of the various shocks.

non-tradable goods and examine the dependence of the optimal managed float on the composition of production. Section IV contains some concluding remarks.

II. Optimal Managed Float with only Tradable Goods

In this section we analyze the determinants of the optimal degree of exchange rate management for an economy which produces only tradable goods. We start with a presentation of the analytical framework.

II.1 The Analytical Framework

The key characteristic of the analytical framework is the specification of the stochastic structure of the economy. Consider a small economy that is subject to three types of repetitive and serially uncorrelated shocks. These shocks which are specified below are referred to as real, monetary, and foreign shocks.

Denote the supply of output by Y_t, and assume that

$$(1) \qquad Y_t = ye^{\mu} \; ; \qquad \mu \sim N(-\sigma_\mu^2/2,\ \sigma_\mu^2)$$

where μ is a stochastic disturbance with a constant variance σ_μ^2. The mean of the distribution of μ is chosen to be $-\sigma_\mu^2/2$ so as to assure that the expected value of output $E(Y_t)$ equals y. Thus, y is referred to as permanent income and μ is referred to as the real shock. It can be shown that σ_μ is approximately equal to the standard deviation of current income as a percentage of permanent income.[2]

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[2] $E(Y_t) = y$, $E(Y_t^2) = y^2 e^{\sigma_\mu^2}$ and $\mathrm{var}(Y_t) = y^2(e^{\sigma_\mu^2} - 1)$; thus

$$\sigma_\mu/E(Y) = y(e^{\sigma_\mu^2} - 1)^{1/2}/y = (e^{\sigma_\mu^2} - 1)^{1/2} \simeq \sigma_\mu$$

(footnote continues p. 4)

The second source of disturbances arises from the monetary sector of the economy. Let the demand for nominal balances L_t be

$$(2) \qquad L_t = kP_tY_te^{\varepsilon} \; ; \qquad \varepsilon \sim N(-\sigma_\varepsilon^2/2,\ \sigma_\varepsilon^2)$$

where k is the Cambridge k denoting the desired ratio of money to income, P denotes the domestic price level and ε denotes the stochastic distrubance to the demand for money, where again its time subscript has been omitted. Analogous to the distribution of the real shock, the standard deviation of the monetary shock σ_ε is approximately equal to the standard deviation of the income velocity as a percentage of permanent velocity.

The third source of disturbances stems from the foreign sector. Denote the foreign price level by P_t^* and let it be related to its permanent value p_t^* according to

$$(3) \qquad P_t^* = p^*e^{\chi_1} \; ; \qquad \chi_1 \sim N(-\sigma_{\chi_1}^2/2,\ \sigma_{\chi_1}^2) \; .$$

Thus, χ_1 denotes the shocks due to variability of foreign prices. Again, σ_{χ_1} is approximately equal to the standard deviation of foreign prices as a percentage of their mean.

The domestic price level is linked to the foreign price level through the purchasing power parity which is assumed to be satisfied except for random deviations. The stochastic deviations from purchasing power parity

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(footnote 2 continued)

for small σ_μ. It should be clear that the choice of $-\sigma_\mu^2/2$ as the mean of the distribution of μ is made solely for analytical convenience. None of the results are affected by rescaling the distribution so as to move its mean to zero. To simplify notations we have suppressed in equation (1) the subscript t that is attached to the realization of the shock μ. We will follow the same convention in subsequent specifications of shocks.

Thus, the equilibrium exchange rate is

$$(7) \qquad S_t = (\overline{M}_t/kp^*y)e^{-(\mu+\varepsilon+\chi)}$$

and the percentage change thereof is

$$(8) \qquad \log S_t - \log S_{t-1} = \log(\overline{M}_t/kS_{t-1}p^*y) - (\mu+\varepsilon+\chi) \ .$$

For the other extreme regime of the fixed exchange rate system, the exchange rate does not change and therefore

$$(9) \qquad \log S_t - \log S_{t-1} = 0 \ .$$

Using (8) and (9) we may define an index γ such that $0 \leq \gamma \leq 1$:

$$(10) \qquad \gamma \equiv (\log S_t - \log S_{t-1})/[\log(\overline{M}_t/kS_{t-1}p^*y) - (\mu+\varepsilon+\chi)] \ .$$

In equation (10) the parameter γ characterizes the whole spectrum of exchange rate regimes. In the two extreme systems of a fixed and freely flexible exchange rates, the value of the coefficient γ is zero and unity, respectively. Between these two extremes there is the wide range of possible mixtures of the two extremes. The coefficient γ may be viewed as indicating the fraction of money market disequilibrium that is allowed to be eliminated through changes in the exchange rate. In what follows we will refer to γ as the coefficient of managed float. Equation (10) also implies that the current exchange rate is

$$(11) \qquad S_t = S_{t-1}^{1-\gamma} \ (\overline{M}_t/kp^*y)^{\gamma}e^{-\gamma(\mu+\varepsilon+\chi)} \ .$$

II.2 The Objective Function

The optimal managed float strategy is necessary because it is assumed that the government (as well as the private sector) possess information that is incomplete. If information was complete and during each period the various shocks could be observed and identified separately, an optimal policy would be to allow changes in the exchange rates to correct only for the monetary disturbances and not for the real disturbances. This is essentially the main insight from Fischer's paper (1976). In introducing incomplete information it is assumed that during a given period only the joint outcome of the various shocks is known but not their separate values. Because complete information is not available, policymakers face a signal extraction problem and some second-best policy is required.

It is assumed that the objective is to minimize the losses due to imperfect information, and that the policymaker seeks to minimize the quadratic loss function H:

$$\text{(12)} \qquad \text{Minimize } H \equiv E[(c_t - E(Y_t)]^2 = \text{var}(c_t) + [E(Y_t) - E(c_t)]^2 .$$

where c_t denotes the rate of consumption which, from the budget constraint, equals the rate of income minus the real value of additions to cash balances

$$\text{(13)} \qquad c_t = Y_t - \frac{\Delta M_t}{P_t}$$

The previous relationships imply that

$$\text{(14)} \qquad [c_t - E(Y_t)] = y(e^{\mu} - 1) - \alpha ky[e^{\mu+\varepsilon} - (\bar{M}_t/kS_{t-1}p^*y)^{1-\gamma}e^{\gamma(\mu+\varepsilon)+\chi(\gamma-1)}]$$

and using (14) in (12) yields the loss function which is to be minimized with respect to the intervention index γ.[3]

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[3] In a recent analysis of the optimal foreign exchange intervention, Boyer (1978) extends and applies Poole's framework (1970) to the problem at hand. Boyer assumes that real income is fixed and that the objective function is to minimize the variability of prices.

Inspection of (14) suggests that in addition to finding the optimal γ, the policymaker might want to pursue what Fischer terms "active" monetary policy by setting the beginning of period holdings of cash balances $\bar{M}_t$, at some desired level. It is assumed that at the beginning of each period the monetary authority changes the money supply so as to compensate for past disturbances. Thus, the money supply is set at that level for which

$$(15) \qquad \bar{M}_t = kS_{t-1}p^*ye^{\delta} \ ; \qquad \delta \sim N(-\sigma_\delta^2/2,\ \sigma_\delta^2) \ .$$

The stochastic term δ in (15) denotes the stochastic shock to the money supply. It reflects the possibility that in setting the money supply the monetary authorities are unable to avoid stochastic deviations from their target.[4] Recalling that the shock to the demand for money is denoted by ε, the <u>net</u> monetary shock, i.e., the shock to the excess demand for money, is $\varepsilon - \delta$.

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[4]It should be noted that the specification of the "active" monetary policy is somewhat arbitrary since, in principle, other rules are possible. For example, one could specify a rule by which the monetary authority sets $\bar{M}_t$ so as to ensure equality between the values of the mathematical expectations of the streams of consumption and income, i.e., $E(c_t) = E(Y_t)$. Further, equation (14) suggests that the monetary authority possesses two instruments for the attainment of its policy goals: a γ policy--the optimal intervention index and an $\bar{M}_t$ policy--the optimal stock of money at the beginning of each period. The general optimization procedure would then solve simultaneously for the optimal <u>combination</u> of $\bar{M}_t$ and γ so as to minimize the loss function. In the following section we report and analyze the results of computer simulations that are based on determining $\bar{M}_t$ according to Fischer's specification of "active" monetary policy. We have experimented with the other two alternative monetary rules. It turns out that, at least for the range of parameters that have been assumed, the resulting optimal intervention index is almost invariant among the various monetary rules for the choice of $\bar{M}_t$ and thus, for ease of exposition, we report only simulations using Fischer's rule. It is also relevant to note that under rational expectations the precise specification of the $\bar{M}_t$ policy is completely irrelevant for the key results; for an explicit demonstration of this point see Aizenman (1980).

II.3 The Optimal Intervention Index

Having outlined the objective function we now turn to the solution of the optimal intervention index which will be denoted by γ^*. To simplify the computations we approximate the discrepancy between consumption and expected income by the first two terms of a Taylor expansion of equation (14). Thus

$$(14') \qquad [c_t - E(Y_t)] \simeq [\mu - (1 - \gamma)\alpha k\theta]y$$

where the expansion is carried out around a zero value of the shocks.[5] In equation (14′) θ denotes the sum of all shocks, that is,

$$\theta \equiv \mu + \chi + \varepsilon - \delta$$

and, under full flexibility of exchange rates (when $\gamma=1$), money market equilibrium implies that the percentage fall in the exchange rate equals θ.

Minimization of the loss function requires that the value of γ in (14′) is chosen so as to minimize the squared discrepancy between μ and $(1 - \gamma)\alpha k\theta$. This minimization amounts to computing the ordinary least squares estimate of a regression of μ on $\alpha k\theta$. It follows that the optimal intervention index γ^* is

$$(16) \qquad \gamma^* = 1 - \frac{\mathrm{cov}(\mu,\theta)}{\alpha k\sigma_\theta^2},$$

and when all shocks are independent of each other, the optimal intervention index becomes:

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[5]The expansion is around zero in order to ensure that the approximation would be around the expected value of the function; thus we approximate e^μ by $(1 + \mu)$ and thereby we have that $E(e^\mu) = 1$. Likewise, as was shown in footnote 2, $\sigma^2_{e^\mu} \simeq \sigma^2_{1+\mu}$. It should be noted that in computing the loss function, the second moment of the distributions is much more relevant than the mean and thus the choice of the mean may be made on the basis of convenience.

$$(16') \qquad \gamma^* = 1 - \frac{\sigma_\mu^2}{\alpha k[\sigma_\mu^2 + \sigma_{(\chi+\varepsilon-\delta)}^2]}$$

where σ_θ^2 is expressed as the sum of the variance of the real shock σ_μ^2 and the variance of the effective monetary shock $\sigma_{(\chi+\varepsilon-\delta)}^2$.[6] The intuition underlying equations (16) and (16′) can be provided in terms of the signal extraction problem which is faced by the policymaker given the assumed informational structure. From his knowledge of the intervention rule and from the observed change in the exchange rate, the policymaker can infer the magnitude of the global shock θ. It is assumed that only the value of θ is known but not the individual components of the global shock. The signal extraction problem amounts to an attempt to estimate the unobserved value of the real shock μ from the known value of θ (that is inferred from the change in the exchange rate).

Inspection of (16) and (16′) reveals that when $\sigma_\mu^2 = 0$ so that the disturbances are composed only of effective monetary shocks, $\gamma^* = 1$ and the optimal exchange rate regime is that of complete flexibility. On the other extreme for which $\sigma_{(\chi+\varepsilon-\delta)}^2 = 0$ so that the disturbances are entirely of a real origin, the optimal intervention index is set to equal zero and the optimal exchange rate regime is that of fixed rates.[7] In general, when both

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[6] Since the effective foreign price shock χ (which is composed of the shock to foreign prices, χ_1, and the shock to purchasing power parities, χ_2) exerts similar effects as shocks to the excess demand for money, $\varepsilon - \delta$, their sum $(\chi+\varepsilon-\delta)$ is referred to as the effective monetary shock. Since ε represents a change in taste, we assume that the objective function remains invariant with respect to this shock. If the objective function were to depend on ε, we would have had to assume that there are no shocks to money demand. In that case the effective monetary shock should be read as $\chi-\delta$ instead of $\chi+\varepsilon-\delta$.

[7] From (16) and (16′), when the effective monetary shock is zero, $\gamma^* = 1 - \frac{1}{\alpha k}$ where αk denotes the marginal propensity to save (hoard) out of transitory income. When $\alpha k = 1$, the loss function is minimized when $\gamma^* = 0$. For $\alpha k < 1$, γ^* is set to equal zero since we rule out negative values.

types of shocks are present, the optimal intervention index is within the range (0,1) and the optimal exchange rate system corresponds to neither of the extremes of a completely fixed or of a completely flexible rate regime. In that case the optimal system is an intermediate system, i.e., a system of an optimal managed float.

The magnitude of the optimal intervention index depends on the characteristics of the shocks. As may be inferred from equation (16), as long as the covariance between μ and $(\mu+\chi+\varepsilon-\delta)$ is positive, the optimal intervention index depends negatively on the variance of the real shock. Thus,

$$(17) \qquad \frac{\partial \gamma^*}{\partial \sigma_\mu^2} < 0 \ .$$

High variance of real shocks, ceteris paribus, tends to raise the desirability of greater fixity of exchange rates. Small economies, and in particular developing countries, tend to have concentrated production patterns and thus, are likely to have higher variance of real shocks than more diversified economies. Ceteris paribus, these economies will find it optimal to have greater fixity of exchange rates.

Similarly, equation (16) implies that as long as the covariance between the effective monetary shock $(\chi+\varepsilon-\delta)$ and the global shock $(\mu+\chi+\varepsilon-\delta)$ is positive, the intervention index depends positively on the variance of the effective monetary shock. Thus,

$$(18) \qquad \frac{\partial \gamma^*}{\partial \sigma_{(\chi+\varepsilon-\delta)}^2} > 0 \ .$$

High variance of the effective monetary shock tends to raise the desirability of greater flexibility of exchange rates.

Equation (16) also implies a definite relationship between αk--the propensity to save out of transitory income--and the optimal intervention index. As long as the covariance between μ and $(\mu+\chi+\varepsilon-\delta)$ is positive, a higher value of αk is associated with a higher value of γ^*.

(19) $$\frac{\partial\gamma^*}{\partial\alpha k} > 0 .$$

Thus, high speed of adjustment to asset disequilibrium (high α) and low velocity of circulation (high k) tend to raise the desirability of greater flexibility of exchange rates. This result may be rationalized by noting that the effect of any given value of the real shock on the excess flow demand for money depends positively on αk. Since the desirability of greater flexibility increases with the extent of monetary shocks, and since the monetary disequilibrium which corresponds to a given real shock is larger the higher is the saving propensity, it follows that the effect of αk on γ^* is similar to the effect of a rise in the variance of the effective monetary shock.

From equation (16′) it is clear that the results in (17), (18) and (19) must hold when the various shocks are independent of each other. Further, inspection of equations (16) and (16′) suggests that what is relevant for the optimal intervention index is not the absolute magnitude of the variances of the various shocks but rather their relative magnitude. In general, when the ratio between the variances of the effective monetary shock and the real shock approaches infinity (either because the former approaches infinity or because the latter approaches zero) the optimal exchange rate system is that of freely flexible rates. Likewise, when the same ratio approaches zero (either because the variance of the effective monetary shock approaches zero or because the variance of the real shock approaches infinity) the optimal exchange rate system is that of fixed rates.

Since the optimal intervention index depends negatively on the variance of real shocks and positively on the variance of the effective monetary shock, it is clear that its dependence on the covariance between these two types of shocks is ambiguous since it depends on the relative magnitudes of the two variances. Using equation (16) it can be shown that

$$\text{(20)} \qquad \text{sign}\, \frac{\partial \gamma^*}{\partial \text{cov}(\mu, \chi+\varepsilon-\delta)} = \text{sign}(\sigma^2_{\mu} - \sigma^2_{(\chi+\varepsilon-\delta)}) \quad .$$

Thus, if the variance of the real shock exceeds the variance of the effective monetary shock, a rise in the value of the covariance between these shocks results in a higher value of the optimal intervention index and raises the desirability of greater flexibility of exchange rates. This result may be interpreted by noting that when the covariance between the two types of shocks is zero while the variance of the real shocks is large relative to that of the effective monetary shock, the optimal intervention index is low since the optimal exchange rate regime is close to that of a fixed exchange rate. Under these circumstances, a rise in the covariance between the shocks implies that any given real shock is now being accompanied by a monetary shock. The induced rise in the importance of the monetary shock results in a higher value of the optimal intervention index, and increases the desirability of greater flexibility of exchange rates. A similar result as in (20) also applies to the analysis of the dependence of the optimal intervention index on the correlation between the two types of shocks.

II.4 Illustrative Computations

The analysis of the properties and the determinants of the optimal intervention index was based on a Taylor approximation of the loss function. As is obvious, the accuracy of this approximation depends negatively on the magnitudes of the shocks. While the qualitative conclusions do not depend on the accuracy of the approximation, the quantitative estimates might be somewhat affected. To gain insight into the precise quantitative magnitude of the optimal intervention index we report in Table 1 illustrative computations for the case in which the shocks are independent of each other.[8] These computations are performed for alternative values of the propensity to save out of transitory income as well as for alternative assumptions concerning the magnitudes of the various shocks as measured by the standard deviations σ_{μ} and $\sigma_{(\chi+\varepsilon-\delta)}$. These results illustrate the negative dependence of γ^* on σ_{μ}--the standard error of the real shock as well as the positive dependence of γ^* on $\sigma_{(\chi+\varepsilon-\delta)}$ --the standard error of the effective monetary shock,and on αk--the propensity to save out of transitory income.

In computing the optimal intervention index in Table 1, it was assumed that the covariances among the various shocks were zero. In Table 2 we allow for various covariances among some of the shocks and we report the resulting optimal intervention index. Consider first the comparison between panels A and B of Table 2. In panel A all three shocks are assumed to be of the magnitude of 3 percent while in panel B all three shocks are assumed to be of the magnitude of 9 percent. As is apparent, tripling of the magnitudes of the shocks while maintaing their ratios constant, does not seem to have a significant effect on the optimal intervention index. This illustrates the proposition that the optimal intervention index depends on the ratios of the various shocks rather than on their actual magnitude.

Panels C, D and E of Table 2 illustrate the effects of changing the ratio among the various disturbances. When the magnitudes of the foreign price disturbance or of the domestic monetary disturbance are high relative

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[8] In these computations the optimal intervention index was obtained by using equation (14) in the loss function (12) and minimizing with respect to γ. We are indebted to Michael Bazdarich for helpful assistance in the computations.

TABLE 1

OPTIMAL MANAGED FLOAT FOR ALTERNATIVE VALUES OF REAL AND EFFECTIVE MONETARY DISTURBANCES AND SAVING PROPENSITIES

σ_μ \ $\sigma_{\chi+\varepsilon-\delta}$	αk = .5					αk = 1				
	.01	.03	.05	.07	.09	.01	.03	.05	.07	.09
.01	.0	.80	.92	.96	.98	.50	.90	.96	.98	.99
.03	.0	.47	.69	.80	.87	.10	.50	.74	.85	.90
.05	.0	.0	.0	.33	.53	.04	.27	.50	.67	.77
.07	.0	.0	.0	.0	.25	.02	.16	.34	.50	.63
.09	.0	.0	.0	.0	.0	.01	.10	.24	.38	.51

TABLE 2

OPTIMAL MANAGED FLOAT FOR ALTERNATIVE VALUES OF DISTURBANCES AND THEIR COVARIANCES

cov(χ,ε−δ) → / cov(χ,μ) ↓	A: σ_μ=.03; $\sigma_{\varepsilon-\delta}$=.03; σ_χ=.03; αk=1					B: σ_μ=.09; $\sigma_{\varepsilon-\delta}$=.09; σ_χ=.09; αk=1				
	−.6	−.3	0	.3	.6	−.6	−.3	0	.3	.6
−.6	.33	.66	.78	.83	.87	.35	.67	.78	.84	.87
−.3	.42	.61	.71	.77	.81	.42	.62	.71	.77	.81
0	.44	.58	.67	.72	.76	.45	.59	.67	.73	.76
.3	.46	.57	.64	.69	.73	.46	.57	.64	.69	.73
.6	.47	.56	.62	.67	.70	.47	.56	.62	.67	.71

cov(χ,ε−δ) → / cov(χ,μ) ↓	C: σ_μ=.03; $\sigma_{\varepsilon-\delta}$=.03; σ_χ=.09; αk=1					D: σ_μ=.09; $\sigma_{\varepsilon-\delta}$=.03; σ_χ=.03; αk=1				
	−.6	−.3	0	.3	.6	−.6	−.3	0	.3	.6
−.6	1.0	1.0	1.0	1.0	1.0	.0	.0	.03	.10	.16
−.3	.98	.99	.99	.99	.99	.0	.06	.12	.17	.22
0	.87	.89	.91	.92	.93	.08	.14	.18	.22	.26
.3	.79	.83	.85	.87	.88	.15	.19	.23	.26	.29
.6	.75	.78	.81	.83	.85	.19	.23	.26	.29	.32

cov(χ,ε−δ) → / cov(χ,μ) ↓	E: σ_μ=.03; $\sigma_{\varepsilon-\delta}$=.09; σ_χ=.03; αk=1				
	−.6	−.3	0	.3	.6
−.6	.94	.95	.96	.97	.97
−.3	.90	.92	.93	.94	.95
0	.87	.89	.91	.92	.93
.3	.84	.87	.88	.90	.92
.6	.82	.85	.87	.89	.90

to the other shocks (panels C and E, respectively) the optimal intervention index is close to unity and thus, the optimal regime is closer to that of a freely flexible rate. On the other hand, when the magnitude of the real shock is high relative to the other shocks (panel D), the optimal intervention index is low and the optimal exchange rate regime is closer to that of fixed exchange rates.

The various panels of Table 2 also illustrate the effects of the covariances among foreign and domestic disturbances. Generally speaking, a positive covariance between foreign price shocks and domestic monetary shocks tends to raise the optimal intervention index and thereby lower the desirability of fixed rates. Consistent with the results in equation (19), the effect of a positive covariance between foreign price shocks and domestic real shocks is ambiguous and depends on the sign of the difference between the variance of the real shock and the variance of the effective monetary shock. When this difference is negative, as in panels C and E, a rise in $\mathrm{cov}(\chi,\mu)$ is associated with a decline in γ^*. Likewise, when this difference is positive, as in panel D, a rise in $\mathrm{cov}(\chi,\mu)$ results in a higher value of the optimal intervention index.

II.5 Balance of Payments Variability

The logic underlying the optimal degree of exchange rate management is that the optimal response to monetary shocks differs from the optimal response to a real shock. Monetary shocks are best dealt with through exchange rate changes while real shocks are best dealt with through trade flows. Using the terminology of Mundell (1973) and Laffer (1973), under the fixed exchange rates the current account (which equals the balance of payments in the absence of capital flows) cushions the effects of real shocks. As a result, large variability of real shocks yields large variability of the balance of payments. In what follows we examine the variability of the balance of payments under the optimal degree of managed float.

We first note that the discrepancy between consumption and expected income which is the key element in the objective function (12), can be written as

$$(21) \qquad [c_t - E(Y_t)] = (c_t - Y_t) + (Y_t - E(Y_t))$$

The first term on the right-hand side denotes the deficit in the trade balance (which equals the balance of payments in the absence of capital flows) and the second term denotes transitory income. Minimization of the loss function amounts to choosing the optimal intervention index so as to minimize the average squared deviation of transitory income from the balance of payments deficit. Transitory income is μy and the balance of payments deficit is $(1 - \gamma)\alpha k\theta y$ which measures the fraction of money market disequilibrium that is not allowed to be cleared through exchange rate changes. It follows that the variance of the balance of payments, σ_B^2 can be expressed as the variance of $(1 - \gamma)\alpha k\theta y$. Substituting equation (16′) for the optimal value of γ (under the assumption that the shocks are independent of each other) yields equation (22) as the expression for the variance of the optimal balance of payments σ_{B*}^2:

$$(22) \qquad \sigma_{B*}^2 = \frac{(\sigma_\mu^2)^2}{\sigma_\theta^2} y^2$$

or, expressed in terms of the standard deviation,

$$(22') \qquad \sigma_{B*} = \frac{\sigma_\mu^2}{\sigma_\theta^2} y\sigma_\theta \quad .$$

Thus, given the variability of the global shock θ, a rise in the weight of real variability in total variability increases the variability of the optimal balance of payments. This relationship suggests that, ceteris paribus, countries for which real variability comprises a relatively large share of total variability should hold larger stock of international reserves in order to be able to facilitate the relatively high variance in the optimal balance of payments.

II.6 The Capital Account

An important limitation of the analysis in the previous sections has been the assumed absence of an integrated world capital market which reflects itself in the capital account of the balance of payments. As a result, the previous analysis identified the trade balance with the balance of payments. While such a simplification might be appropriate for economies with severe limitations on access to world capital markets, it may not represent the conditions faced by developed countries. In what follows we introduce some elements of the capital account.

It is assumed that the economy faces a perfect world capital market in which it can borrow and lend at a fixed rate of interest. Suppose that the desired ratio of money to securities depends on the rate of interest and, due to the assumed fixity of the world rate of interest this ratio is also fixed. Since the economy may be a net debtor or a net creditor in the world capital market, the value of its permanent output need not equal the value of its permanent income. The analysis simplifies considerably by assuming that the world rate of interest is deterministic since in that case the stochastic characteristics of output are similar to those of income.[9]

[9] Flood (1979) analyzes the implications of stochastic interest rates on the choice of the exchange rate system.

As a result, the previous analysis which minimized the squared deviation of consumption from permanent output remains relevant even though the concepts of income and output need not coincide. The only difference that has to be kept in mind is that when the economy has an access to world capital markets the previous analysis applies to the current account rather than to the overall balance of payments.

The signal extraction problem is similar to that in section II.3. Individuals are assumed to observe the global shock $\theta \equiv \mu+\chi+\varepsilon-\delta$, from which they attempt to estimate the real shock component μ and, thereby, the value of transitory income $\hat{\mu}y$ (where $\hat{\mu}$ denotes the estimated real shock given the realization of θ). The least squares estimate of the real shock is:

$$(23) \qquad E(\mu|\theta) = \frac{\text{cov}(\mu,\theta)}{\sigma_\theta^2}\,\theta$$

which, when multiplied by y, provides the estimated value of transitory income. In the previous analysis we argued that the optimal policy should aim at minimizing the squared discrepancy between transitory income and the current account (which was equal to the balance of payments). Suppose now that, given the rate of interest, portfolio holders wish to add to their holdings of securities a fraction β of their estimated transitory income. Under these circumstances, only a fraction $(1 - \beta)$ of the current account should be offset by monetary flows, and the analogous equation to (14′) becomes

$$(24) \qquad [c_t - E(Y_t)] \simeq [\mu - (1 - \gamma)\alpha k\theta - \beta\,\frac{\text{cov}(\mu,\theta)}{\sigma_\theta^2}\,\theta]y + \text{constant}$$

where the constant in (24) is independent of the current values of the shocks and of γ, and where the term $[\beta\ \text{cov}(\mu,\theta)/\sigma_\theta^2]y\theta$ represents the desired change in security holdings given the (conditional) estimate of transitory income. Minimizing the squared value of (24) with respect to γ yields the optimal intervention index:

$$(25) \qquad \gamma^* = 1 - (1 - \beta) \frac{\text{cov}(\mu,\theta)}{\alpha k \sigma_\theta^2} \quad .$$

As is evident, when $\beta = 0$, the optimal intervention index in equation (25) is identical to that in equation (16). Further, as long as the covariance between μ and $(\mu+\chi+\varepsilon-\delta)$ is positive, a rise in the fraction β raises the optimal intervention index. Thus

$$(26) \qquad \frac{\partial \gamma^*}{\partial \beta} > 0 \quad .$$

The higher is the share of transitory income that is absorbed by changes in the holdings of securities, the larger becomes the desirability of greater flexibility of exchange rates. The rationale for that result is quite clear since a high value of β (which may be viewed as reflecting a high degree of capital mobility) implies that a larger fraction of the real shocks can be cushioned through the international capital market and, thereby, reducing the need for international reserves flows.

Finally, when some of the cushioning is provided by the capital account, the standard deviation of the optimal balance of payments becomes

$$(27) \qquad \sigma_{B*} = (1 - \beta) \frac{\sigma_\mu^2}{\sigma_\theta^2} y \sigma_\theta$$

which is smaller than the magnitude corresponding to the case of no capital mobility. Again, in the special case for which $\beta = 0$, equation (27) becomes identical to equation (22′).

II.7 The Supply of Output

Up to this point we have assumed that variations in the supply of output are determined exclusively by the characteristics of the stochastic shock μ. In what follows we modify the specification of equation (1) and we assume a supply function of the Lucas and Rapping (1969) variety. Accordingly, output is assumed to depend on the ratio of realized to expected prices. Thus,

$$(28) \qquad Y_t = y\left(\frac{P_t}{E_{t-1}P_t}\right)^h e^{\mu}$$

where $E_{t-1}P_t$ denotes the expected price level for period t based on the information available at period t-1, h denotes the elasticity of the supply of output with respect to the ratio of realized to expected prices and, as before, μ denotes a stochastic disturbance. The specification in equation (28) may be rationalized in terms of models which allow for a confusion between relative and absolute price changes like in Lucas (1973) as well as in terms of models which postulate short-term fixity of nominal wages, e.g., Fischer (1977). Using the first two terms of a Taylor expansion, the supply of output in equation (28) can be approximated as

$$(29) \qquad Y_t \simeq y[1 + \mu + h(\chi + \hat{S}_t)]$$

where $\hat{S}_t$ denotes the percentage change in the exchange rate, i.e., $\hat{S}_t \equiv \ell nS_t - \ell nS_{t-1}$.

Under full flexibility of exchange rates, changes in the rate ensure that the money market clears. Thus, analogously to equation (6),

$$(30) \qquad kY_t e^{\varepsilon} = \frac{\bar{M}_t}{S_t p^* e^{\chi}}$$

where, from equation (4′), $S_t p^* e^{\chi}$ designates the price level. Differentiating equation (30) logarithmically and using equations (15) and (29) for $\bar{M}_t$ and Y_t, the change in the exchange rate may be expressed as

$$(31) \qquad \theta \equiv \frac{\mu + h\chi + \chi + \varepsilon - \delta}{1 + h} = -\hat{S}_t \quad .$$

The equality in equation (31) between the change in the exchange rate and the sum of the shocks θ, is confined to the case in which the exchange rate is fully flexible. Under managed float $-\hat{S}_t = \gamma\theta$, and the supply of output becomes

$$(29') \qquad Y_t \simeq y[1 + \mu + h(\chi - \gamma\theta)] \quad .$$

Using the previous expressions for the values of consumption and output, the discrepancy between consumption and expected income may be approximated by

$$(32) \qquad [c_t - E(Y_t)] \simeq [\mu + h\chi - \{(1 - \gamma)\alpha k + \gamma h\}\theta]y \quad .$$

In this formulation, $\mu + h\chi$ may be referred to as a real shock. It is composed of two terms: the first is the genuine output supply shock μ, while the second is induced by the effective foreign price shock χ that is translated into changes in output through the supply elasticity h. Thus, in addition to its direct monetary effect on the price level, χ contributes to output variations. It is noteworthy that in the special case for which h=0, the value of θ reduces to the one obtained in the previous analysis, and the real shock reduces to μ.

The optimal intervention index, γ^*, is computed so as to minimize the discrepancy between $\mu + h\chi$ and $[(1 - \gamma)\alpha k + \gamma h]\theta$. It follows that

$$(33) \qquad \gamma^* = 1 - \frac{b - h}{\alpha k - h}$$

where b denotes the regression coefficient of the real shock $\mu + h\chi$ on θ, i.e.,

$$b = \frac{\text{cov}(\mu + h\chi, \theta)}{\sigma_\theta^2} \quad .$$

As is evident, in the special case for which the value of the output elasticity h is zero, equation (33) coincides with (16).

As is revealed by equation (33), the magnitude of γ^* depends on the stochastic structure of the economy and on whether αk--the propensity to save out of transitory income, exceeds or falls short of h--the elasticity of output with respect to the ratio of realized to expected prices. As long as $\alpha k > h$, the relation between γ^* and the variances of μ and $(\varepsilon-\delta)$ is similar to the one analyzed before: a rise in σ_μ^2 lowers γ^* while a rise in $\sigma_{(\varepsilon-\delta)}^2$ raises it. On the other hand, when $\alpha k < h$, these relations are reversed and a rise in the variance of $(\varepsilon-\delta)$ lowers it. The rationale for this reversal is that when the value of h is high (relative to αk), changes in the price level which result from monetary shocks induce relatively large changes in output. Thus, when $\alpha k < h$, monetary shocks act more like real shocks. Finally, since the foreign price shock exerts both real and monetary effects, the dependence of γ^* on σ_χ^2 depends on the variances of the real and the monetary shocks as well as on the sign of $\alpha k - h$:

$$\text{(34)} \qquad \frac{\partial \gamma^*}{\partial \sigma_\chi^2} = (\alpha k - h)[(1 + h)\sigma_\mu^2 - h(1 + h)\sigma_{\varepsilon-\delta}^2] \quad .$$

III. Optimal Managed Float with Tradable and Non-Tradable Goods

The preceding analysis was confined to an economy whose production consists only of commodities that are traded internationally. This assumption implied that, except to random deviations from purchasing power parities, the domestic price level was tied to the foreign price. In this section we extend the analysis to an economy which produces both traded and non-traded goods. This production structure relaxes the constraint that was imposed by the small country assumption. Due to its relative size the economy is a price taker in the world traded goods market but it is obviously large in the market for its own non-traded goods. Thus, the relative price of non-traded goods may not be viewed as given to the small economy but rather it is determined endogenously by the market-clearing conditions. In extending the analysis we first specify the stochastic characteristics of the production structure and then proceed to determine the optimal intervention index.

III.1 Equilibrium in the Market for Non-Traded Goods

Production of traded and non-traded goods is assumed to be carried along a production possibility frontier which is assumed to be concave to the origin. Denoting the nominal prices of traded and non-traded goods by P^T and P^N, respectively, we define the relative price of non-traded goods by $q \equiv P^N/P^T$. Production of traded goods X^T is assumed to depend negatively on the relative price according to

$$(35) \qquad X^T = X^T(q)e^{\mu}$$

where μ, which denotes the real shock, is defined in equation (1). Production of non-traded goods X^N is assumed to depend positively on the relative price according to

$$(36) \qquad X^N = X^N(q)e^{\omega+\mu} \; ; \qquad \omega \sim N(-\sigma_{\omega}^2/2,\ \sigma_{\omega}^2)$$

where ω denotes a stochastic shock that is specific to the production of non-traded goods. Thus, μ may be viewed as an aggregative real shock which moves the transformation schedule in a uniform way while ω may be viewed as a sector specific real shock.

On the demand side it is assumed that the demand for the two goods is homothetic and that the share of spending on non-traded goods depends negatively on the relative price. Measuring income as the value of production in terms of traded goods and denoting the share of spending on non-traded goods by ψ, we can describe the equilibrium in that market (when income equals spending as under flexible exchange rates) by equation (37):

$$(37) \qquad \psi(q)[qX^N(q)e^{\omega} + X^T(q)]e^{\mu} = qX^N(q)e^{\omega+\mu}$$

In equation (37), the left-hand side denotes the demand for non-traded goods while the right-hand side describes the supply. Equation (37) implies that the equilibrium relationship between the relative price and the specific real shock may be expressed as

$$(38) \qquad q = q_o e^{-m\omega}$$

where q_o denotes the equilibrium relative price in the absence of shocks and where m denotes the elasticity of the relative price with respect to the relative price shock, i.e.,

$$m = \frac{1}{\eta/(1-\psi) + 1 + \xi^N + \xi^T}$$

where η denotes the elasticity of the share of spending on non-traded goods (defined to be positive) and where ξ^N and ξ^T denote, respectively, the elasticities of supply of non-traded and traded goods with respect to their relative price.

III.2 The Optimal Intervention Index

When the exchange rate is freely flexible, the demand for real balances equals the supply at each moment of time. Assuming, as before, that the demand is proportional to income and is subject to a stochastic shock ε, money market equilibrium obtains when

$$(39) \qquad k[qX^N(q)e^{\omega} + X^T(q)]e^{\mu+\varepsilon} = \frac{\overline{M}_t}{S_{t-1}p^*e^{\chi}e^{-\theta}}$$

where $\overline{M}_t$ is defined in equation (15)[10] and where the denominator on the right-hand side denotes the price level P_t^T. The parameter θ denotes the percentage change in the exchange rate that is necessary to ensure stock equilibrium in the money market. By differentiating equation (39) and using (38) for the equilibrium relative price we note that θ, the percentage change in the exchange rate that is required to clear the money market under a freely flexible exchange rate regime is[11]

$$(40) \qquad \theta = \mu + \chi + \varepsilon - \delta + \omega\psi(1 - m) .$$

As before, θ denotes the global shock. In this case, however, it also contains terms that reflect the effects of changes in the relative price which result from the various shocks. It is relevant to note that when the specific real shock (ω) is zero, the required change in the exchange rate is, as before, $\mu+\chi+\varepsilon-\delta$.

The above analysis characterized the equilibrium under a freely flexible exchange rate regime. When the exchange rate is managed, only a fraction γ of the stock disequilibrium in the money market is allowed to be eliminated through changes in the exchange rate. In terms of equation (39), when the

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[10]Since the economy produces both goods, permanent income in this case is defined as the value of production in terms of traded goods when the relative price is q_o.

[11]In deriving equation (40) we have used the envelope theorem for movements along the transformation curve according to which $\psi\xi_N - (1 - \psi)\xi_T = 0$.

exchange rate is managed the domestic currency price of traded goods becomes $P_t^T = S_{t-1}p^*e^{\chi}e^{-\gamma\theta}$, and the money market remains in stock disequilibrium. Under such circumstances, the value of income diverges from the value of spending by the resultant flow demand for real balances (as indicated by equation (13)). Consequently, the demand for non-traded goods is not described any more by the left-hand side of equation (37)--which was only appropriate for a freely flexible exchange rate regime. Rather, the demand for non-traded goods is equal to

$$\psi(q)\,[\overline{Y}_t - \frac{\alpha(L_t - \overline{M}_t)}{P_t^T}]$$

where $\overline{Y}_t$ denotes the value of output in terms of traded goods. By substituting the previous expressions for $\overline{Y}_t$, L_t, $\overline{M}_t$ and P_t^T and equating the demand for non-traded goods to the supply, we obtain the equilibrium relative price of non-traded goods:

$$(41) \qquad q = q_o e^{-m\omega} - (1 - \gamma)\theta z$$

where

$$z = \frac{m\alpha k}{\psi m\alpha k + (1 - \psi)} < 1$$

Equation (41) reveals that the equilibrium relative price is influenced by both the specific shock ω and the global shock θ. The sensitivity of the equilibrium price to the specific shock depends on the elasticities of demand and supply which determine the value of the parameter m. This sensitivity is independent of the exchange rate regime. On the other hand, the dependence of the equilibrium price on the global shock depends on the intervention index γ. The higher the value of γ the smaller is the effect of the global shock. In the extreme case for which $\gamma = 1$, the exchange rate is freely flexible and the equilibrium relative price depends only on the specific real shock ω. In that case equation (41) coincides with (38).

In order to find the optimal intervention index we turn to the specification of the objective function. We first note that the objective function (12) needs to be specified in greater care once there are traded and non-traded goods. In order to avoid an index number problem we express the value of consumption and production in terms of the general price index which is assumed to be a Cobb-Douglas function of the prices of the two goods. Thus, if we denote the values of spending and income (measured in terms of traded goods) by $\bar{c}_t$ and $\bar{Y}_t$, respectively, their corresponding values in terms of the general price index are $\bar{c}_t/q^{\psi}$ and $\bar{Y}_t/q^{\psi}$, and the loss function becomes

$$E[\frac{\bar{c}_t}{q^{\psi}} - E(\frac{\bar{Y}_t}{q^{\psi}})]^2 \quad .$$

Substituting the previous expressions for the real values of consumption and income and expending in Taylor series we approximate the discrepancy between real consumption and expected real income by

$$(42) \qquad [\frac{\bar{c}_t}{q^{\psi}} - E(\frac{\bar{Y}_t}{q^{\psi}})] \simeq [(\mu + \omega\psi) - \alpha k\{(\mu + \omega\psi) + (\chi + \varepsilon - \delta - \theta\gamma + \hat{q}\psi)\}]\frac{\bar{Y}}{q_o^{\psi}}$$

where $\bar{y}$ denotes the permanent value of income in terms of traded goods and where $\hat{q}$ denotes the percentage change in the equilibrium relative price of non-traded goods. In equation (42), $\mu+\omega\psi$ and $(\chi+\varepsilon-\delta-\theta\gamma+\hat{q}\psi)$ may be referred to, respectively, as the real shock and the monetary shock.[12] Using equation (40)

[12] As may be seen, the real shock does not include the effect of the relative price change, $\hat{q}$, since, due to the envelope theorem, the change in price does not affect the value of production. The effect of $\hat{q}$ is classified as a monetary shock since it induces a change in the price level (equal to $\hat{q}\psi$).

as the definition of the global shock θ and substituting from equation (41) for the relative price change, the discrepancy between consumption and permanent income can be expressed as

$$(42') \qquad [\frac{\overline{C}_t}{q^{\psi}} - E(\frac{\overline{Y}_t}{q^{\psi}})] \simeq [\mu + \omega\psi - (1-\gamma)(1-\psi z)\alpha k\theta]\frac{\overline{Y}}{q_o^{\psi}} \quad .$$

Minimizing the loss function amounts to choosing γ so as to minimize the squared discrepancy between $\mu+\omega\psi$ and $(1-\gamma)(1-\psi z)\alpha k\theta$. Following the same logic of the signal extraction problem of the previous analysis, individuals who observe the global shock θ (through its effect on the exchange rate) attempt to estimate the real shock component which in this case is composed of the ordinary real shock μ plus $\omega\psi$ which represents the effect of the specific real shock on the real value of aggregate output in terms of the general price level. Computing the least squares estimate of relevant regression coefficient yields the optimal intervention index:

$$(43) \qquad \gamma^* = 1 - (1 + \frac{\psi}{1-\psi}\alpha km)\frac{\operatorname{cov}(\mu+\omega\psi,\theta)}{\alpha k\sigma_\theta^2} \quad .$$

As in the earlier sections, the magnitude of the optimal intervention index depends on the structure of the economy. In general, the optimal value of γ^* declines when the variance of the real shock rises. In this context both σ_μ^2 and σ_ω^2 are viewed as real shocks. Also, consistent with the previous results a higher value of αk is associated with a higher value of γ^*.

The new results of this section concern the relation between the optimal intervention index and the share of the non-traded goods sector (which may characterize the degree to which the economy is open), as well as between the optimal intervention index and the elasticities of demand and supplies of traded and non-traded goods. It can be shown that as long as the covariance between the real shock and the global shock is positive, a higher value of ψ is associated with a lower value of γ^*:

$$(44) \qquad \frac{\partial \gamma^*}{\partial \psi} < 0 \quad .$$

Thus, a high share of spending on (and production of) non-traded goods, tends to reduce the desirability of greater flexibility exchange rates. This result seems to conflict with some of the well-known arguments on the relationship between the openness of the economy and the optimal exchange rate regime [e.g., McKinnon (1963)]. Likewise, by noting that m--the elasticity of the relative price of non-traded goods--depends negatively on η, ξ^N and ξ^T, it follows that

$$(45) \qquad \frac{\partial \gamma^*}{\partial \eta} > 0, \qquad \frac{\partial \gamma^*}{\partial \xi^N} > 0, \qquad \frac{\partial \gamma^*}{\partial \xi^T} > 0 \quad .$$

Thus, the higher is the degree of flexibility in the structure of an economy the larger becomes the need for increased flexibility of exchange rates.

These results can be rationalized by noting from equation (41) that, ceteris paribus, a given monetary shock induces a larger change in the relative price of non-traded goods the higher is the relative share of that sector and the lower are the elasticities of demand and supply. For a given exchange rate the change in the relative price is reflected in a change in the nominal price of non-traded goods which in turn affects the aggregate price level in proportion to the relative share ψ. The induced change in the price level mitigates the initial disequilibrium and thereby reduces the need for exchange rate flexibility. When all goods are internationally traded so that the internal relative price structure cannot be adjusted, the necessary changes in the price level can only be obtained through changes in the exchange rate. In contrast, the presence of non-traded goods provides for a flexible internal price structure which is capable of inducing some of the necessary adjustments in the price level. It follows that the need for exchange rate flexibility is reduced the higher is the degree of price level flexibility which, in turn, depends negatively on the elasticities of demand and supply, and positively on the relative share of non-traded goods.[13]

This discussion of the relationship between internal price flexibility and the optimal exchange rate regime has implications for the choice between tariffs and quotas as alternative forms of commercial policy. In some respects the imposition of an import quota (in contrast with the imposition of an import tariff) may be viewed as transforming a traded commodity whose relative price is determined in world markets into a non-traded commodity whose price is determined in the domestic market. It follows that the desirability of exchange rate flexibility is lower for economies with import quotas than for economies with equivalent import tariffs since the former enjoy a greater degree of internal price flexibility than the latter. Put differently, ceteris paribus, a rise in the degree of exchange rate flexibility provides an incentive to convert quota protection into tariff protection.

Inspection of equation (43) and its comparison with equation (16) reveals that even when the specific shocks are zero, the optimal intervention index for an economy with non-traded goods is smaller than the corresponding coefficient for an economy that produces only traded goods. Therefore, the mere existence of non-traded goods raises the desirability of greater fixity of exchange rates. The explanation is that even in the absence of specific

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[13]The conventional result that γ^* depends positively on γ reflects the assumption that both the foreign currency price of traded goods <u>and</u> the domestic currency price of non-traded goods are given. In that case changes in the exchange rate are the only source for changes in the price level and, as a result, the required change in the exchange rate is larger the smaller is the share of traded goods (i.e., the higher is γ). Our analysis shows that this dependence is reversed when the price of non-traded goods is flexible.

supply shocks changes in demand will be absorbed in part by changes in the price of non-traded goods. The induced change in the price level will mitigate the initial disequilibrium and thereby reduce the need for exchange rate flexibility. Finally, it can be seen that in the special case for which $\psi = 0$, equation (43) coincides with (16).

IV. Concluding Remarks

In this paper we have analyzed aspects of the economics of managed float. We have shown that the choice of the optimal exchange rate regime depends on the nature and the origin of the stochastic shocks that affect the economy. Generally, the higher is the variance of real shocks which affect the supply of goods, the larger becomes the desirability of fixity of exchange rates. The rationale for that implication is that the balance of payments serves as a shock absorber which mitigates the effect of real shocks on consumption. The importance of this factor diminishes the larger is the economy's access to world capital markets. On the other hand, the desirability of exchange rate flexibility increases the larger are the variancaes of the shocks to the demand for money, to the supply of money, to foreign prices and to purchasing power parities. All of these shocks exert a similar effect and their sum was referred to as the effective monetary shock. We have also shown that the desirability of exchange rate flexibility increases the larger is the propensity to save out of transitory income. When we extended the analysis to an economy which produces traded and non-traded goods it was shown that the desirability of exchange rate flexibility diminishes the higher is the share of non-traded goods relative to traded goods and the lower are the elasticities of demand and supply of the two goods.

As a general comment it should be noted that in this paper monetary policy and foreign exchange intervention were treated as being close substitutes. In fact, as a first approximation, in our framework, these two policies are non-distinguishable. It is believed that this feature of the model is much closer to reality than would be the other extreme in which monetary policy and foreign exchange policies are viewed as two independent policy instruments.

The special role of the exchange rate should also be noted. In our framework the exchange rate (and thereby the price level) is determined to a large extent by considerations of asset market equilibrium. This characteristic is in accord with the recent developments of the theory of exchange rate determination.

An important characteristic of the approach is that the choice of an exchange rate regime is an integral part of a general optimization process. It calls, therefore, for an explicit specification of the objective function as a prerequisite to the analysis. This feature is emphasized since such a specification of the objective function has been neglected by much of the writings in the area.

A limitation of the analysis is that except for the discussion in section II.6, the model did not incorporate explicitly the implications of an integrated world capital market which reflects itself in the capital account of the balance of payments and which prevents insulation from stochastic shocks to world interest rates. It should be emphasized, however, that the mere access to world capital markets and the ability to borrow are unlikely to alter the essentials of our analysis since they are unlikely to eliminate the occasional need for using international reserves. Most countries cannot expect to be able to borrow any amount at a given rate of interest. Rather, the borrowing rate is likely to rise when the country's net debtor position rises. This rise reflects the deterioration of the quality of the loans which is due to the deterioration of the economy's credit worthiness. As a result, countries will find it useful to hold and use international reserves in order to reduce the likelihood of facing a steeply rising cost of borrowing. In that sense, the holdings of international reserves may be viewed as a form of forward borrowing that is likely to continue even when capital markets are highly integrated.

It should be noted that the present specification of the nature of the shocks is somewhat biased in favor of government intervention since to some extent the shocks have been presumed to originate from the instability of the private sector rather than from the actions of government policies. Furthermore, the concept of the optimal intervention index that is implied by the optimal managed float was developed as a policy prescription for the monetary authorities. This was motivated by realism and could be rationalized in terms of the presumption that, compared with the private sector, the monetary authorities possess superior information concerning their own actions. In principle, however, much of the optimal mix could also be performed by the private sector.

Finally, it is relevant to note that as a practical matter it is unlikely that a policymaker will be capable of implementing policies with sufficient precision so as to distinguish between cases in which, for example, $\gamma^* = 0.2$ and those for which $\gamma^* = 0.3$. Thus, when the optimal intervention index turns out to be about 0.3 or less, it is likely that the practical policy would be that of a fixed exchange rate; likewise, when the optimal intervention index turns out to be about 0.7 or more, it is likely that the practical policy would be that of flexible exchange rates. In that sense the choice of an exchange rate regime may be viewed as the outcome of the search for a second-best solution and the analysis in this paper should be interpreted as providing a qualitative guide for such a choice.

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