Exchange-Rate Stabilization Policy and Monetary Target with Endogenous Expectations

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1. Introduction

This paper is concerned with a specific aspect of the conduct of monetary policy in a country which has adopted a flexible exchange rate. It attempts to determine what should be the role of interventions in the foreign-exchange market by a central bank which is bound by a rule for the growth rate of the money supply. Although some brief remarks will be offered regarding the choice of a fixed versus a floating exchange rate and regarding the desirability of a rule for the growth rate of the money supply, these two problems are not at issue here. Instead we are concerned with the desirability of interventions in the foreign-exchange market by countries like Germany and, until recently, Switzerland which let their exchange rates float and establish annual targets for the rate of growth of their money supplies. Will such interventions succeed in smoothing exchange-rate movements? What is the effect of the interventions on the variability of domestic prices and output? How are expectations regarding future values of the exchange rate movements affected by the intervention strategy combined with the monetary rule, and how do these expectations in turn influence the strategy itself? These are some of the questions which will be addressed in the following analysis which begins by recalling some of the arguments in the debate over the desirability of a money supply growth target as a guideline for monetary policy in a closed economy. Section three briefly brings out some of the conclusions of the fixed versus flexible exchange rate debate, and discusses the case for smoothing short-run fluctuations in exchange rates.

The main body of the paper is contained in section four. The most important conclusions of the numerous cases analyzed there are summarized in a final section of the paper which also points out some possible extensions of the analysis.

2. Interest-Rate Smoothing Versus Stable Growth of the Money Supply

Some of the conclusions of closed-economy analysis of monetary stabilization policy are directly relevant to the questions raised in this paper. This is particularly the case for the controversy over the relative virtues of an interest-rate stabilization and a money-supply stabilization policy. As Poole (1970) showed, the answer to this question depends on the source of the shock with which the economy is faced, in
particular whether it is of a "monetary" or a "real" nature. To prove this assertion it is sufficient to employ the familiar IS-LM framework and to consider two kinds of disturbances, a "monetary" one affecting only the LM curve and a "real" one affecting the IS curve. These two situations are shown in Figure 1, panels a and b respectively. In the case of a monetary disturbance an interest-rate stabilization policy would result in stability of income at $y_0$ whereas a money supply stabilization rule would lead to a decrease in income to $y_1$. The opposite is seen to be true in the case of the real disturbance in panel b. There interest rate fixing leads to a larger decrease in income, from $y_0$ to $y_2$, than does a money supply stabilization rule under which income would fall only to $y_1$.

If monetary policy is geared to reducing the variance of output around the full-employment level $y_0$ then it is clear from this strand of analysis that partial interest-rate smoothing will be optimal if fluctuations are random and of unknown source.

Two reservations have traditionally been advanced against this conclusion. One is that private speculators are likely to perform the function of interest-rate smoothing if monetary policy is aimed at stabilizing the money supply thus removing the

1 An alternative way of stating this conclusion is that a stock disturbance such as a change in the demand for money is most efficiently countered by a stock-oriented policy, a change in the supply of money, whereas a flow disturbance requires a flow-oriented (interest-rate) policy.
need of government interventions. The other reservation concerns the fear that, with an active interest rate oriented policy, the growth of the money supply may become unstable for relatively long periods which may in turn generate undesirable inflationary effects. Recently Poole (1976) has questioned the appropriateness of interest-rate smoothing at a more fundamental level. Using an "efficient market" framework he argues that the central bank will not be able to reduce yearly fluctuations in interest rates unless it sacrifices control over yearly movements in the money supply. The model which leads him to this conclusion is quite simple and, as it can be readily adapted to deal with exchange-rate smoothing, it is useful to repeat it here.

\[
\begin{align*}
\mathbf{R}_1 &= \mathbf{R}_0 + \omega_1 \\
\omega_1 &= -\beta \Delta \mathbf{M}_1 + u_1 \\
\Delta \mathbf{M}_1 &= \lambda \omega_1 \\
\Delta \mathbf{M}_2 &= -\Delta \mathbf{M}_1
\end{align*}
\]

where

\[
\begin{align*}
\mathbf{R} &= \text{the interest rate} \\
\mathbf{M} &= \text{the money supply} \\
u &= \text{a random variable} \\
\omega_1 &= \mathbf{R}_1 - \mathbf{R}_0.
\end{align*}
\]

Equations (1) and (2) state that in the absence of monetary policy the interest rate is a random walk. Monetary policy, which has the usual influence on interest rates [eqn. (2)] is assumed to be conducted with the aim of smoothing interest rate changes in period 1 [eqn. (3)]. In period 2 (the second half year) monetary policy is constrained by the need to keep the money supply constant over the two periods taken together [eqn. (4)]. Under these assumptions it can easily be shown that

\[
\begin{align*}
\mathbf{R}_1 - \mathbf{R}_0 &= \frac{1}{1 + \beta \lambda} u_1 \\
\mathbf{R}_2 - \mathbf{R}_1 &= \frac{\beta \lambda}{1 + \beta \lambda} u_1 + u_2
\end{align*}
\]

which proves that while interest-rate smoothing in the first period does in fact reduce the movement of the rate in that period, it increases the change in the second period. The variance of the interest rate over the two periods taken together, \(\mathbf{R}_2 - \mathbf{R}_0\), is left unaffected by the policy. We shall see in section four that an analogous argument can be made regarding the effect of interventions in the foreign exchange market in the presence of a constraint on the growth rate of the money supply.
3. Rationales for Interventions in the Foreign-Exchange Market

The desirability of interventions in the foreign-exchange market to stabilize the exchange rate is of course the issue which lies behind the debate over fixed versus flexible exchange rates. While we do not intend to survey the vast literature on this topic it might be worth noting that recent theorizing about floating exchange rates seems to cast doubt upon many of the intuitively attractive criteria which have been proposed in this context. It is in particular the insulating properties of a flexible exchange rate which are being questioned. If foreign disturbances get transmitted to the domestic economy even if the exchange rate is allowed to float then the stability of domestic economic policy relative to that in the rest of the world will not necessarily be as useful a criterion for an individual country as one might have thought. Likewise, the assertion that a fixed exchange rate is preferable when foreign disturbances are of a real nature, and a floating rate is superior in dealing with foreign monetary shocks has also been questioned on the basis of evidence that (unexpected) price level variations may have substantial real effects (Fisher [1977]).

While many aspects of the fixed versus flexible rates debate still are unsettled a virtual unanimity reigns concerning the freedom a flexible rate allows with regard to the independence of inflation policies. With this freedom (it might be thought of as a lack of external discipline for some countries) domestic monetary policy must assume the role of controlling domestic inflation. But, it may be argued, since the relationship between the rate of inflation and the rate of monetary growth is not a quarter-to-quarter one but rather a longer term association, short-run stability of the money supply can be foregone in order to intervene in the foreign exchange market to smooth out movements in the exchange rate. Several rationales have been proposed for such a smoothing. One is the maintenance of orderly conditions in the foreign-exchange market in order to reduce risk and thereby allow trade and capital flows to be determined by "fundamental" factors. Another related justification is that smoothing would reduce the likelihood of "destabilizing" expectations arising from bandwagon effects and extrapolations of short-run fluctuation in spot rates. A third rationale is that intervention is needed to prevent the exchange rate from deviating substantially from purchasing power parity in the short run, a situation which could have undesirable consequences for trade flows and profitability of the different sectors of the economy. Finally one might see smoothing as a means

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2 See Johnson (1969) and Kindleberger (1969) for discussions of some of the most important issues in this context.
3 A representative sample of articles on the recent asset-market approach to exchange-rate determination can be found in No. 2 of the 1976 issue of the Scandinavian Journal of Economics.
5 See J. Artus and A. Crockett (1978)
to prevent the emergence of vicious circles of currency depreciation, inflation, a further depreciation, etc...

It would certainly be possible to propose other relatively plausible rationales for short-run exchange-rate management but, as in the case of the above four, all of them could be subjected to criticism and doubt. Not wishing to devote a considerable amount of space to the arguments for and against a smoothing policy per se, we simply take it as given that some countries do in fact intervene in the foreign-exchange market for this purpose. This allows us now to turn to the analysis of the effectiveness of interventions in the foreign-exchange market in the presence of a monetary policy based on a growth rate target for the money supply.

4. Exchange-Rate Smoothing in the Presence of a Target Growth Strategy for the Money Supply

Whatever their theoretical justification, several countries have adopted both flexible exchange rates for their currencies and monetary policy strategies which call for maintaining the growth rate of the domestic money supplies close to a target growth rate fixed in advance, usually on a yearly basis. Since the latter policy almost certainly presupposes the former it is of interest to find out if a policy aimed at smoothing short-run movements in the exchange-rate is advisable in the presence of a monetary policy of that type. The doubt arises because interventions in the foreign exchange market to prevent, say, an appreciation of the domestic currency involve purchases of foreign currency for domestic and thus an increase in the domestic money supply which may not be consistent with the target increase in the latter. Under certain circumstances it might be possible to sterilize the effect of the foreign-exchange market intervention on the money supply by selling domestic assets of the central bank or by tightening discount-rate or reserve-requirement policies. Empirical evidence drawn from the fixed exchange-rate period suggests that this possibility is of limited quantitative importance.

In the last five to six years of the Bretton Woods era several countries tried unsuccessfully to pursue independent monetary policies while, at the same time, keeping exchange rates fixed. Germany, for instance, which consistently tried to conduct a less expansionary monetary policy than its main trading partners found that capital inflows equally consistently frustrated this attempt. Sterilizing open market operations, imposition of increasingly strict reserve requirements on non-resident deposits and other measures designed either to stem the capital flows or to limit their effect on the domestic money supply were effective only in the very short run. Other countries had similar experiences. In a floating rate environment evidence from this

period indicates that a country cannot simultaneously have independent exchange-rate and money-supply policies. Arguments according to which this is possible due to the existence of non-traded assets are, in our view, quantitatively not very important at least for time periods longer than two quarters. In the case of foreign-exchange markets where expectations of future exchange-rate movements are crucial determinants of current spot rates it can even be argued that with some rationality of expectations even the short-run possibility for sterilization is severely limited. For this reason we shall proceed on the assumption that foreign-exchange-market interventions have a direct effect on the money supply so that the two policies, general monetary policy and interventions in the foreign-exchange market, merge to one. The analysis will be carried out with the help of successively more complicated (although still quite simple) models designed to draw attention to crucial assumptions and specifications.

Poole’s Analysis Adapted to Exchange-Rate Smoothing

As an illustration of the possible conflict between foreign-exchange-market intervention and money-supply stability consider Poole’s model of interest-rate stabilization described above. Since there exists evidence suggesting that floating exchange rates follow random walks, Poole’s model is directly applicable to the case of exchange-rate smoothing. We only need to replace \( R_t \) in equation (1) by \( e_t \), the exchange rate measured as the price, in domestic currency units, of foreign exchange and realize that the coefficients \( \beta \) and \( \lambda \) will be negative. The rest of the model can be borrowed as it stands and the solutions for the exchange rates in the two half-years will be

\[
e_1 - e_0 = \frac{1}{1 + \beta \lambda} u_1
\]

and

\[
e_2 - e_1 = \frac{\beta \lambda}{1 + \beta \lambda} u_1 + u_2.
\]

As with the case of an interest-rate stabilization policy the movement in the exchange rate is diminished in the first period by interventions in the foreign-exchange market, but the movement in the second period is augmented. The total variance over the two periods is unchanged. If the aim of the smoothing policy was to minimize the average one-period variance of the exchange rate then the optimal amount of intervention would be defined by \( \lambda = 1/\beta \) and the average variance of the

\[\text{See, for instance, Giddy and Dufay (1975).}\]
exchange rate would be reduced by 25%\textsuperscript{8}. The price paid for this stabilization is of
course a destabilization of the money supply which will behave according to (7).

\[ M_1 - M_0 = -(M_2 - M_1) = \frac{\lambda}{1 + \lambda \beta} u_1. \quad (7) \]

Even though there appears to be some scope for exchange-rate smoothing in the
presence of a monetary growth target, questions must be raised concerning the ef­
fects of an increased variance of the money supply on the formation of expectations
and on real output. To analyze these possibilities a slightly more “structural” model
of the economy is needed.

\textit{A Monetary Model of Exchange-Rate Determination}

The model which we will utilize in the following analysis is a simplified version of
that developed in Dornbusch (1976). Its main elements are the money demand func­
tion (8) and the interest parity condition (9)\textsuperscript{9}.

\[ M_t - P_t = \alpha \bar{y} - \beta i_t \quad (8) \]
\[ i_t - i^* = E_t(e_{t+1}) - e_t \quad (9) \]

where \( M_t \) is the money supply at time \( t \), \( P_t \) is the price level, \( i \) and \( i^* \) the domestic and
foreign interest rates. It is assumed that the demand for money depends on perma­
nent income, \( \bar{y} \), which is held constant throughout the analysis. It is also assumed in
(9) that the forward exchange rate is equal to the expected future spot rate so that
the interest rate differential can be equated to the expected depreciation or appreci­
ation of the domestic currency.

The equilibrium price level, \( \bar{P} \), can be defined as the price level which will equate
the nominal demand and supply of money when the latter is at its target or equilib­
rium level \( \bar{M} \), and when the nominal interest rate is equal to the given real rate
of interest \( \bar{r} \)\textsuperscript{10}. Thus,

\[ \bar{P} = \bar{M} - \alpha \bar{y} + \beta \bar{r}. \quad (10) \]

\textsuperscript{8} See Poole (1976), p.22.

\textsuperscript{9} In what follows, all variables with the exception of the interest rates are expressed as natural
logarithms. The expression \( E_t(e_{t+1}) \) indicates the expected value, formed at time \( t \), of the exchange rate at
time \( t + 1 \).

\textsuperscript{10} The latter condition must hold since we assume a zero rate of inflation in equilibrium.
Combining (8), (9) and (10) it is possible to derive an expression for the current spot exchange rate as a function of deviations of M and P from their equilibrium values, the expected future spot rate and the foreign interest rate. If we assume that the latter can be written as \( i^\ast_t = \bar{r} + u_t \), i.e. as the sum of a real rate of interest (equal to the domestic one) and a random disturbance term, \( u_t \), the final equation for the spot exchange rate takes the form

\[
e_t = \frac{1}{\beta} (M_t - \bar{M}) - \frac{1}{\beta} (P_t - \bar{P}) + E_t(e_{t+1}) + u_t.
\] (12)

For \( P_t = \bar{P} \) and \( E_t(e_{t+1}) = \bar{e} \) this relationship can be represented by the positively sloped AA locus in Figure 2. To illustrate the effect of exchange-rate smoothing in the presence of a money supply target consider the consequences of an increase of the foreign interest rate in period \( t + 1 \). In the absence of smoothing the money supply stays on target in period \( t + 1 \) and the exchange rate increases to \( e_{t+1} \). When the temporary increase in the foreign interest rate disappears, the exchange rate returns to \( \bar{e} \). If the monetary authorities instead attempt to moderate the depreciation of the home currency in period \( t + 1 \) by reducing the money supply to \( M'_{t+1} \) the disturbance will be spread out over two periods since the money supply must be increased to \( M'_{t+2} \) in period \( t + 2 \) in order for the monetary target to be met on the average over the year (two periods). While it is possible to reduce the variance of the corresponding exchange rates, \( e'_{t+1} \) and \( e'_{t+2} \), around the equilibrium level \( \bar{e} \) by a suitable amount of intervention in the foreign exchange market, this reduction is achieved by an increase in the intra-year deviation of the money supply from the target level. This increased variance of the money supply may be detrimental to output stability. If the deviation of current output from the equilibrium level depends on both the difference between the exchange rate and its purchasing-power-parity level and the difference between the current rate of interest and the real rate as in (13) \(^{11}\), it is possible that exchange-rate smoothing increases the instability of output.

\[
X_t \equiv y_t - \bar{y} = \theta \{e_t - (P_t - P^\ast)\} + \phi (\bar{r} - i_t) = \theta \{e_t - (P_t - P^\ast)\} + \phi \{(M_t - \bar{M}) - (P_t - \bar{P})\}.
\] (13)

This possibility is illustrated in Figure 3 where equation (13), for \( x_t = 0 \), has been drawn as the downward sloping \( \bar{y} \bar{y} \) locus on the assumption that \( P_t = \bar{P} \) and \( P_t - P^\ast_t = \bar{e} \). Strict adherence to the monetary target in the face of a random shift in AA would lead to inflationary pressure in period \( t + 1 \) as short-run equilibrium is established at point \( T_1 \). In period \( t + 2 \) there will be a return to full-employment output.

\(^{11}\) A similar equation has been utilized by Niehans (1979).
With exchange rate smoothing it may happen that the average variance of $y$ around $\bar{y}$ over the two periods is increased if the reaction of the money supply to the initial disturbance is strong; cf. short-run equilibrium points $S_1$ and $S_2$ in Figure 3.

So far we have assumed that the future spot exchange rate is expected to be equal to the equilibrium exchange rates and that the price level is fixed at $\bar{P}$. In the remainder of this section these restrictive conditions will be replaced by two alternative scenarios. In one of these the public is assumed to know the monetary target of the central bank and is assumed to form expectations about the future course of the exchange rate in a rational manner given their knowledge about the current money
supply. In another scenario we suppose that the public does not know the target of the monetary authorities and forms expectations with respect to the future money supply adaptively. As will become apparent, these modifications can lead to substantially different conclusions concerning the feasibility and advisability of exchange-rate smoothing. In some cases the central bank will be powerless in its stabilizing attempts, in others it may be destabilizing on the average over the year as a whole. The basic reason for these conclusions is still to be found in the trade-off between exchange-rate stability and monetary stability.

**Rational Expectations**

When the monetary authorities announce that they intend to follow a monetary policy based on a published target for the money supply it must be assumed that the private sector uses this information in forming expectations about the future. Two alternative policy strategies may be distinguished. In one case the policy target is respected only at the end of the year so that

\[ M_2 = \bar{M} \]  

where \( M_2 \) represents the money supply in the second half of the year. With this end-of-period strategy, the private sector always expects that the money supply will be on target in period 2 no matter what value it takes in period 1. Under the alternative policy where the target is expressed as an average over the whole year we have

\[ \frac{1}{2} (M_1 + M_2) = \bar{M} \]  

so that

\[ M_2 - \bar{M} = -(M_1 - \bar{M}). \]

Here an increase in the money supply above the target in the first half of the year will lead to the expectation, and the actual occurrence, of a contraction in the second half. The two kinds of targets have different implications for exchange-rate smoothing and will be analyzed in turn. In both cases we assume that the price level is equal to \( \bar{P} \), the equilibrium level consistent with the target money supply, throughout the year. We also assume that exchange-rate expectations are formed rationally, i.e. on the basis of equation (12) and with full knowledge of the target strategy of the monetary authorities.
a) End-of-Period Target

With this strategy the expected money supply at the end of each year, i.e. in even-numbered periods, is equal to zero. Thus,

\[ E_{2t-1}(M_{2t}) = \bar{M} = 0. \]  \hspace{1cm} (17)

The expected money supply for each beginning half-year as viewed from the end of the previous year is likewise equal to \( \bar{M} \) since the disturbances \( u \) are assumed to be serially uncorrelated and have mean zero.

Therefore

\[ E_{2t}(M_{2t+1}) = \bar{M} = 0. \]  \hspace{1cm} (18)

Taking expected values of both sides of equation (12) we now get

\[ E_{2t-1}(e_{2t}) = E_{2t-1} E_{2t}(e_{2t+1}) = \bar{e}. \]  \hspace{1cm} (19)

Inserting (19) in the expression for \( e_{2t-1} \) given by (12) yields

\[ e_{2t-1} = \frac{1}{\beta} M_t + u_{2t-1} \]  \hspace{1cm} (20)

where we have set \( \bar{e} = \bar{P} = 0 \) for simplicity. Similarly we get

\[ e_{2t} = u_t. \]  \hspace{1cm} (21)

Exchange-rate smoothing by the central bank can be formulated as

\[ M_{2t-1} = -\gamma e_{2t-1} \]  \hspace{1cm} (22)

which states that the money supply is reduced automatically in the first part of each year if there is a tendency for the currency to depreciate and vice versa for an appreciation. The final values of the exchange rate and the money supply are

\[ e_{2t-1} = \frac{1}{1 + \frac{\gamma}{\beta}} u_{2t-1}, \quad M_{2t-1} = -\frac{\gamma}{1 + \frac{\gamma}{\beta}} u_{2t-1} \]

\[ e_{2t} = u_{2t}, \quad M_{2t} = \bar{M} = 0. \]

From this it can easily be seen that to minimize the average variance of the exchange rates in the two periods the intervention parameter \( \gamma \) should be set so as to keep the exchange rate fixed in the first six months. With the more sensible criterion of minimizing the average yearly variance of output given by (13) it can be shown that the optimum value of \( \gamma \) is given by the ratio of the exchange-rate sensitivity of
output to its interest rate sensitivity, i.e. $\gamma^* = \theta/\phi$. Some “leaning against the wind” of exchange-rate changes is therefore always useful as long as output is sensitive to such fluctuations.

b) Average Yearly Target

Given (16), (18) and (12) this type of target implies

$$E_{2t-1} (e_{2t}) = \frac{1}{\beta} (M_{2t-1} - \bar{M}) + \bar{e}$$

and

$$E_{2t} (e_{2t+1}) = \bar{e}.$$

The spot exchange rate in the two halves of a representative year is therefore given by

$$e_{2t-1} = \frac{1}{\beta} (M_{2t-1} - \bar{M}) - \frac{1}{\beta} (M_{2t-1} - \bar{M}) + \bar{e} + u_{2t-1} = \bar{e} + u_{2t-1} = u_{2t-1}$$  \hspace{0.5cm} (23)

and

$$e_{2t} = \frac{1}{\beta} (M_{2t-1} - \bar{M}) + u_{2t} = \frac{1}{\beta} (M_{2t-1} + u_{2t})$$  \hspace{0.5cm} (24)

Note that the exchange rate in the first part of each year is independent of the money supply and that the exchange rate in the second part of each year depends on the deviation of the money supply from the target in the previous six months. From this it follows that any amount of attempted exchange rate smoothing is detrimental to exchange-rate stability and, a fortiori, to output stability.

The somewhat surprising finding that a smoothing policy has no effect on the exchange rate during the period it is attempted can be explained by considering the influence of such a policy on exchange-rate expectations. When the central bank reacts to an appreciation of the currency by increasing the money supply, the private sector realizes that the quantity of money must sooner or later be contracted to meet the annual target. Market operators also understand that this future contraction will engineer an appreciation of the currency in the future and they consequently increase the demand for domestic money in order to reap a capital gain. The increased money demand exactly offsets the increase in the supply which will accordingly be without effect on the current exchange rate.$^{12}$

$^{12}$ It should be noted that this result in no way depends on dividing the year into only two periods. It can easily be shown that if intervention was attempted in, say, the three first quarters of a year it would be without effect as long as the monetary target is expressed as an annual average.
Adaptive Expectations

In order to prevent the reactions of the private sector from neutralizing the effects of its intervention policy the Central Bank may decide not to publish its monetary target. In this case the relationships determining the exchange rate will be modified as a result of the uncertainty which the private sector faces concerning the future course of the money supply. One may for instance hypothesize that expectations regarding the target will be formed adaptively according to equation (25).

\[ E_t(M) = qM_t + (1 - q)M_{t-1}. \]  

Variations in the expected future money supply also implies variations in the expected future equilibrium price level and exchange rate. We shall assume that economic agents set prices in the next period equal to their estimate of the equilibrium price level in that period. This implies

\[ P_{t+1} = E_t(M). \]  

We also assume that exchange-rate expectations are formed in a manner consistent with this price equation and with the purchasing-power-parity principle so that

\[ E_t(e_{t+1}) = P_{t+1} = E_t(M). \]  

With these assumptions the exchange rate can be expressed as a function of only current and past levels of the money supply and of a random factor. Inserting (26) and (27) into equation (12) for the exchange rate one obtains

\[ e_t = \frac{1}{\beta} M_t - \frac{1}{\beta} \left\{ qM_{t-1} + (1 - q)M_{t-2} \right\} + qM_t + (1 - q)M_{t-1} + u_t \]

or

\[ e_t = \left( \frac{1}{\beta} + q \right) M_t + \left\{ 1 - q \left( 1 + \frac{1}{\beta} \right) \right\} M_{t-1} - \frac{1}{\beta} (1 - q) M_{t-2} + u_t. \]  

Note that the two-period lag in this equation reflects the two-period lag of prices behind the money supply assumed in (26), and that the parameters \( \beta \) and \( q \) both determine the shape of the lag profile. For instance the coefficient \( \frac{1}{\beta} + q \) attached

\(^{13}\) The decision of the Swiss National Bank not to publish a target growth rate for its money supply in 1979 after having done so during the period 1974–1978 may be interpreted in this light.

\(^{14}\) For simplicity we assume that \( \bar{y} = \bar{r} = 0 \) so that \( P = M \) from equation (10).
to the current money supply measures the degree of "overshooting" associated with a monetary expansion.

As before we now proceed to analyzing a monetary policy strategy of the Central Bank which consists on the one hand of intervention in the foreign-exchange market in the first part of each year in order to moderate movements in the exchange rate and on the other hand of a return to the money supply target in the second part of the year. Letting odd-numbered subscripts represent the former periods and even-number ones the latter the intervention strategy may be expressed as

\[ M_{2t-1} = -\delta u_{2t-1} \]  

(29)

and the target strategy for the money supply as

\[ M_{2t} = -M_{2t-1}. \]  

(30)

With these two equations determining the evolution of the money supply it is possible to use equation (28) to derive an expression for the exchange rate. Since a different policy strategy reigns in the first part of each year as compared to the second part we obtain one equation (31), for the exchange rate during odd-numbered periods and one equation (32), for even-numbered periods.

\[
e_{2t-1} = \left\{1 - \delta \left(\frac{1}{\beta} + \varrho\right)\right\} u_{2t-1} + \delta \left\{1 - \varrho \left(1 + \frac{1}{\beta}\right) + \frac{1}{\beta} (1 - \varrho)\right\} u_{2t-3} \]

(31)

\[
e_{2t} = \delta \left\{\frac{1}{\beta} + 2\varrho + \frac{\varrho}{\beta} - 1\right\} u_{2t-1} - \delta (1 - \varrho) \frac{1}{\beta} u_{2t-3} + u_{2t}. \]

(32)

Since the movement of the exchange rate in the period without intervention can be seen to depend not only on the current random disturbance but also on those from the two previous odd-numbered periods, a policy of exchange-rate smoothing must take into account the fact that a too ambitious intervention strategy may increase the average yearly variability of the exchange rate.

This would occur if the increased variance in the second half of the year more than offset the moderated movement in the first. The trade-off between variance in the first and second part of each year implies that there exists a finite optimum value of \(\delta\), the intervention parameter, which would lead to a minimum average variance in the two periods. This optimum value is in general greater than zero which implies that some, even if small, degree of intervention is better than none.

A difficulty in the implementation of an intervention strategy based on the random disturbances as postulated in (29) is of course that these are not observable.

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15 We continue to assume that \(\bar{M} = 0\).

16 The optimum value of \(\delta\) is of course different if fluctuations in output is the concern rather than fluctuations in the exchange rate.
It may for this reason be more realistic to assume that the Central Bank uses actual movements in the exchange rate as a trigger for its intervention strategy. Such a policy reaction can be described by

\[ M_{2t-1} = -\gamma e_{2t-1}. \]  

(33)

While this kind of intervention is relatively simple to carry out, it introduces the danger that fluctuations in the exchange rate may grow continuously if the influence of past interventions on the current exchange rate do not diminish over time. The system may then become explosive as a result of the policy of smoothing. Introducing the new policy reaction function into the equation for the exchange rate yields, for the odd-number periods,

\[ e_{2t-1} = \gamma AZ e_{2t-3} + Z u_{2t-1} \]  

(34)

where

\[ A = \frac{1}{\beta} - 2 \frac{\theta}{\beta} + 1 - \theta, \quad Z = \frac{1}{1 + \gamma B} \quad \text{and} \quad B = \frac{1}{\beta} + \theta. \]

It is readily seen that stability requires \(|\gamma AZ| < 1\). For \(0 < \gamma AZ < 1\) \(e\) would approach \(\bar{e}\) asymptotically after a once-and-for-all disturbance, while for \(-1 < \gamma AZ < 0\) the approach would be cyclical. The system would be unstable if \(\theta = 0\) and \(\gamma = 1\) regardless of the value of \(\beta\).

As before, smoothing in the first part of each year influences the exchange rate in the second part. In this case the result is

\[ e_{2t} = \gamma (D e_{2t-1} - C e_{2t-3}) + u_{2t} \]  

(35)

where

\[ D = \frac{1}{\beta} + \frac{\theta}{\beta} - 1 + 2\theta \quad \text{and} \quad C = \frac{1}{\beta}(1 - \theta). \]

Even if the system is stable the possibility thus exists that the average variance of \(e_{2t-1}\) and \(e_{2t}\) will be larger with intervention than without. In other words, the reduction in the variance during odd-numbered periods \((\sigma^2_{\text{odd}})\) may not be sufficient to offset the increase in the variance during even-numbered periods \((\sigma^2_{\text{even}})\). The outcome depends in a complicated manner on the relative size of the parameters \(\gamma\), \(\theta\) and \(\beta\). Table 1 contains some numerical examples chosen to illustrate the importance of each of them.

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17 Remember that \(\hat{c} = \bar{P} = \bar{M} = 0\).
Table 1

The Influence of Alternative Parameter Values on the Average Variance

<table>
<thead>
<tr>
<th>$\beta$</th>
<th>$\varphi$</th>
<th>$\gamma$</th>
<th>$\frac{\sigma^2_u}{\sigma^2_u}$</th>
<th>$\frac{\sigma^2_e}{\sigma^2_u}$</th>
<th>$\frac{\sigma^2_i}{\sigma^2_u}$</th>
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<tr>
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<td>.5</td>
<td>.5</td>
<td>.33</td>
<td>1.19</td>
<td>.76</td>
</tr>
</tbody>
</table>

Notes: $\sigma^2_u = \text{average variance of } e_{2t} \text{ and } e_{2t-1}$.

$\sigma^2_e = \text{average variance without intervention.}$

The general formulae for the variances are:

$$\sigma^2_u = \frac{Z^2}{1 - (\gamma AZ)^2} \sigma^2_u$$

$$\sigma^2_i = (\gamma^2 ADZ - \gamma C)^2 \sigma^2_u + [(\gamma DZ)^2 + 1] \sigma^2_u.$$

The first thing to notice in the table is that an increased amount of intervention does not necessarily mean a more stable exchange rate on the average. To the contrary, with $\beta = .2$ and $\varphi = .5$ the minimum value of $\sigma^2_u$ was reached with $\gamma = .1$. As $\gamma$ is increased to .5 the average variance becomes larger than what it would be with no intervention, which means that this amount of smoothing is detrimental to exchange-rate stability. Turning to $\varphi$, the parameter determining the expectations concerning the future money supply, it should be noted that as $\varphi$ increases so does the average variance. The reason for this is that the higher is $\varphi$ the more current movements in the money supply are taken as an indicator of the future monetary target. This in turn means that the public amplifies movements in the exchange rate during even-numbered periods caused by the need to re-establish the monetary target. For a contraction, say, in the money supply, which in and of itself tends to appreciate the currency, is taken as a signal that the future monetary policy will be restrictive which in turn increases the demand for money and hence appreciates the currency further.

As the three last lines in Table 1 show the effect of an increase in $\beta$ is to reduce the average variance of the exchange rate. The explanation this time is that the higher $\beta$ the lower will be the influence of the destabilization of the money supply during the second part of each year on the exchange rate. Recalling that $\beta$ measures the interest
sensitivity of the demand for money it is possible to conclude that conditions are not favorable for exchange-rate smoothing in Switzerland where this sensitivity is generally believed to be small. If, in addition, we assume that \( q > \frac{1}{2} \), the room for stabilizing intervention by the National Bank in the foreign exchange market will be extremely limited unless it is prepared to forego the goal of relative price stability. Taking into account the adverse effects on output of increased fluctuations in interest rates and the money supply, the case for exchange rate smoothing will be a very weak one under these conditions.

5. Conclusions

When the Central Bank intervenes to stabilize the exchange rate it necessarily destabilizes the money supply. A policy of short-run exchange-rate smoothing combined with a yearly growth target for the money supply will therefore lead to a situation where the exchange rate may be stabilized during the period of intervention but is destabilized during the period when the monetary target is restored. In the preceding analysis it has been shown that, when the monetary target is known by the public and when expectations are formed rationally, the destabilizing effect always dominates so that intervention in the foreign-exchange market is counter-productive. If the target is not known and expectations are adaptive, some intervention is usually better than none from the point of view of exchange-rate stability, but the amount of intervention must be kept small in order to prevent destabilization even here. In addition, it should be kept in mind that if the money supply in effect proves to follow a constant growth rate, expectations are likely to become rational as time passes. The case for exchange-market intervention in the presence of a money-supply rule is then a fairly weak one. The Central Bank may want to keep one of the two policies but should be cautious in attempting both.

The above conclusions have been reached with a model incorporating a number of simplifying assumptions. Some of them are likely to bias the case against intervention and others will bias the case in favor. Relaxing the assumption of perfect capital mobility, for instance, is likely to make smoothing a more attractive policy. On the other hand, considering permanent as well as temporary shocks will add another possible source of destabilizing intervention. Further research in these two directions appears necessary. The real side of the present model can also stand some elaboration particularly as concerns the influence over time of changes in the exchange rate and the interest rate. Here the distinction between anticipated and unanticipated movements is likely to be important.

18 The interest elasticity for the demand for money can be shown to be equal to \( \beta \cdot i \).
References


Zusammenfassung

Wechselkurs-Stabilisierungspolitik und Geldmengenziele im Fall von endogenen Erwartungen


Résumé

Politique de change et objectifs monétaires en présence d'anticipations endogènes

Cette étude présente une analyse de l'efficacité d'une politique d'intervention sur le marché des chan- ges menée par une Banque centrale qui, par ailleurs, est liée par un objectif de croissance de la masse monétaire. Si l'objectif monétaire est connu du public, ses anticipations rationnelles neutralisent l'in- fluence des interventions sur le marché des changes et peuvent même rendre leurs effets pervers. Lorsque l'objectif monétaire n'est pas publié, les anticipations du public quant à l'objectif monétaire sont suppo- sées être adaptatives. Dans ce cas, des interventions appropriées ont un effet stabilisateur en atténuant les fluctuations des taux de change. Cependant, si les interventions courantes influencent fortement l'objec- tif monétaire anticipé ou si l'élasticité de la demande de monnaie par rapport au taux d'intérêt est faible, la politique d'intervention peut accroître l'instabilité du marché des changes.

Summary

Exchange-Rate Stabilization and Monetary Target with Endogenous Expectations

This study analyzes the effectiveness of interventions in the foreign-exchange market by a Central Bank which also is bound by a rule for the growth rate of the money supply. It is shown that, when the monetary target is known and when expectations are rational, the reactions of the private sector may completely neutralize the effect of the interventions which may even become detrimental to the stability of the exchange rate. If the monetary rule is not made public and if expectations regarding the future money supply are adaptive there is some scope for stabilizing interventions. The scope will however be severely limited if current movements of the money supply influence strongly its expected future level, and if the interest elasticity of the demand for money is small.