From Monetary to Exchange Rate Targets

The experience of monetary targeting, in the United Kingdom as elsewhere, has led to a perception that such policies can impose excessive and unacceptable costs on the economy, by way of excessive appreciation of the real exchange rate. Indeed Vaubel (1980) has suggested that this perception is now sufficiently widely shared as to amount to an "implicit emergency clause" in the announcement of monetary targets, threatening their suspension in the face of excessive exchange rate appreciation; experience in West Germany, Switzerland and, now, the United Kingdom seems to support his view. The cynic is bound to remark that if excessive real appreciation is the signal for the abandonment of monetary targeting, the threat of excessive depreciation is what seems often to have prompted the adoption of such targets in the first place. This is, most clearly, an unsatisfactory state of affairs, and is bound to lead to a reconsideration of the rationale for monetary targets. In particular, the suggestion that the behaviour of the exchange rate is what governs the appeal of monetary targets, leads to the question whether policy would not be better formed on a target for the exchange rate.

In Section I below, we consider the case for such a switch of targets on the basis of a static analysis of monetary and exchange rate targets. In the deterministic form of this model (Artis and Currie 1981a, 1981b), there are none of the dynamic features which give rise to the real exchange rate costs of monetary targets mentioned above; the relative efficiency of exchange rate and monetary targets is assessed by reference to their performance in the face of a variety of disturbances, the criterion being the minimization of the variance of prices around their target value. The results indicate that in such a world exchange rate targets are at least as good as monetary targets and on balance probably rather better, though overall evaluation depends on an assessment of

the probability distribution of stochastic disturbances and empirical judgements about relative parameter values. The balance could be swung the other way if monetary targets were accompanied by interest equalisation taxes.

In Section II, we examine a recent contribution by Buiter and Miller (1981) which focusses explicitly on the dynamics of adjustment, following earlier contributions by Liviatan (1980) and Dornbusch (1976, for example) among others. This clarifies the nature of the costs to which monetary targeting may give rise in a deterministic framework, and also shows how interest equalisation taxes may improve matters.

The models examined in Sections I and II assume superneutral equilibrium of the economy, but many observers have traditionally assumed that "hysteresis" effects are highly significant in this area. The costs of alternative forms of policy are thus not necessarily appropriately treated as transitory or as arising only from concentration in time or location. Long run growth paths may be affected. No formal analysis of this point is attempted, but Section III enlarges somewhat on this issue and goes on to examine informally other aspects of the case for exchange rate targets.

In Section IV we briefly raise the question whether, if the case for exchange rate targeting is convincing, this also supplies an argument, other than a second-best argument derived from specific political circumstances, for UK membership of the EMS. The conclusion is sceptically reserved on this issue.

I

The model used in Artis and Currie (1981b) is employed here to illustrate the issues arising between exchange rate and monetary targets in an economy subject to stochastic disturbances. The model (set out formally in the Appendix) comprises specifications of the IS function and LM function which are standard. It is assumed that the exchange rate cannot be set indipendently of domestic policies and clears the market in foreign exchange, with perfect capital mobility implying interest parity net of exchange risk. The non-standard part of the model, which gives the leverage on which the results depend, is the specification of pricing behaviour. As explained more fully elsewhere (Artis and Currie 1981a in particular), this specification is designed to mimic the

empirical specifications to be found in macroeconometric models of the UK economy, in which prices respond indirectly via cost markups to wages and complementary import prices and directly (by way of "Law of One Price" considerations) to competitive import prices. As a result, exchange rate/import price variations have significant direct leverage over domestic prices. The specification of the wage equation provides for the absence of money illusion. Finally, all expectations are formed "rationally".

In the deterministic form of this model, the exchange rate and money supply are duals of each other. Output gravitates to its "natural" level, and with exchange rates effectively set by monetary policy, a solution in output and the price level involves a unique exchange rate-money supply combination. Deterministically, that solution could be described equivalently as reached via the appropriate money supply target, with endogenous exchange rate or via an exchange rate target with endogenous money supply. The analysis then proceeds by way of examining the impact of stochastic disturbances in key relationships. Thus, we consider, successively, shocks to aggregate demand, money demand, aggregate supply, capital flows and the foreign price level. Figure 1 provides a graphical frame of reference for the analysis in price/output space. The schedule DD represents the aggregate demand schedule, whose slope reflects the effects of the real interest rate and the terms of trade: a rise in p raises real rates and reduces real competitiveness, thus reducing aggregate demand (see equation (1) of the Appendix). The MM schedule (see equation (2) of the Appendix) depicts the money demand schedule, with a negative slope dependent on the (inverse of the) income elasticity of demand for money.[1] SS is the aggregate supply schedule, in which output responds positively to current (unforeseen) price level increases.

Unanticipated disturbances will cause the schedules to shift from their equilibrium positions, thus inducing departures from the equilibrium price and output levels (targets). However, the difference between the two regimes is that under exchange rate targets, the money supply adjusts passively to shifts in the DD and SS schedules, whereas in a regime of monetary targets the exchange rate adjusts, inducing shifts in all three schedules.

---

[1] Evidently, MM may cut DD from above or below. In the short run, we might reasonably expect MM to intersect DD from above; in the longer run, it could easily be the reverse. This is only critical, however, for the case of aggregate supply shocks.

FIGURE 1

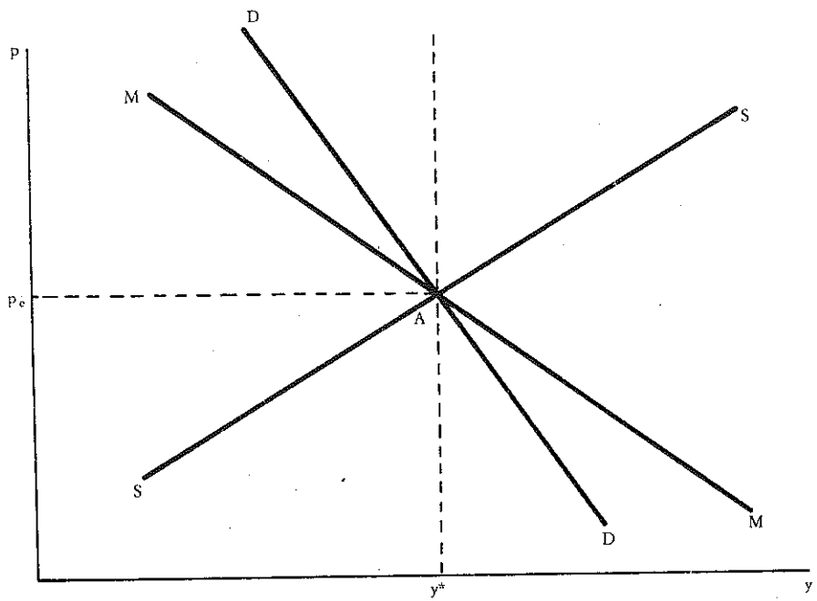
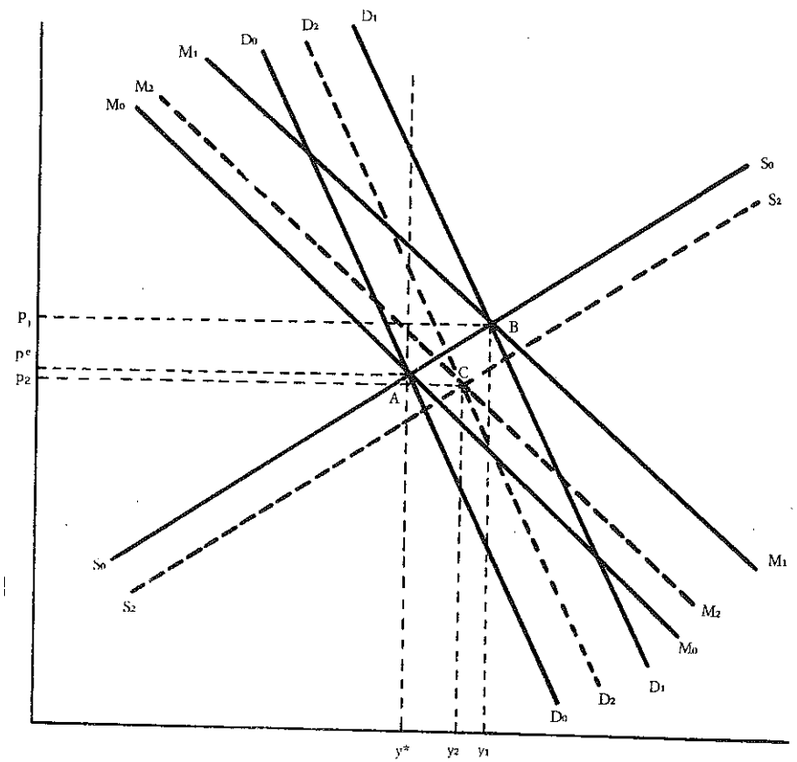


Figure 2 illustrates for the case of an aggregate demand shock. We summarize the results for other shocks subsequently.

Suppose, then, that an unanticipated shock to aggregate demand occurs. This shifts the DD schedule (for a positive disturbance) from D_0D_0 to D_1D_1 as shown. Under an exchange rate target regime, the new equilibrium is at B, on the intersection of D_1D_1 with S_0S_0. The excess demand for money implied by point B relative to the M_0M_0 schedule induces an accommodating increase in the money supply, shifting M_0M_0 to M_1M_1, as the authorities move to offset the appreciation of the exchange rate that would otherwise occur through the rise in interest rates induced by the excess demand for money. If, however, the money supply is targeted, the "virtual" equilibrium at B implies that the exchange rate will appreciate as interest rates rise, and this will in turn induce (i) a downward shift in DD (competitiveness) (ii) a downward shift in SS (via the effects of the appreciation on prices) (iii) a shift to the

FIGURE 2

AGGREGATE DEMAND DISTURBANCE



right of MM (as domestic interest rates rise in light of the current expectation of expected future depreciation). In this case, monetary targets are unambiguously superior for output stabilization, but may yield a higher variance of prices (the case shown in Figure 2). This is the more likely, the greater the effects of exchange rate changes on domestic prices (the larger the shift of SS), the less responsive are domestic prices to aggregate demand (the flatter the slope of SS) and the more interest-inelastic the demand money (the smaller the shift of MM).

Whilst this illustrates how the results may depend on relative parameter values, there are two cases where the results for both output and price stabilization are unambiguous (and intuitively obvious). If the shock is to money demand, then exchange rate targeting is unambiguously better since the regime response is simply to accommodate the demand shock by a corresponding change in supply. If on the other hand the shock is to the foreign price level, then the monetary targeting regime is superior, as maintaining a constant money supply acts to dampen (though it does not completely remove) the effect of the shock.

The full set of results, obtained as the economy is subjected to independent, one-at-a-time, shocks in aggregate demand, money demand, the foreign price level, aggregate supply and capital flows, is given in the Appendix Table A, where four regimes are distinguished — an exchange rate regime, a simple monetary target regime, and two more complex forms of the latter involving interest equalization taxes. Table 1, however, summarizes the results for the two simple regimes in terms of the objective of minimizing the variance of prices, and in terms both of an open choice of relative parameter values and of a judgment that would be applicable to a short run (temporary shock) and to an economy in which the influence of foreign prices on domestic prices is relatively large and that of aggregate demand correspondingly fairly small.[2]

TABLE 1

SOURCE OF DISTURBANCE AND CHOICE OF REGIME (EXCHANGE RATE TARGET, ET; MONETARY TARGET, MT) TO STABILIZE PRICES

		Preferred Regime	
Disturbance	*Impact Effect*	*"Open Choice"*	*"Judgment"*[(a)]
Aggregate Demand	DD	ET/MT	ET
Money Demand	MM	ET	ET
Aggregate Supply	SS	ET/MT	MT[(b)]
Foreign Price Level	DD, SS	MT	MT
Foreign Capital Flow	DD, MM	ET/MT	ET

(a) Temporary shock; large influence of foreign over domestic prices.
(b) Difference probably rather small.

[2] In graphical terms, the judgment is that the DD schedule cuts MM from above, whilst SS is both fairly flat and shifts strongly as a result of exchange rate changes.

The table suggests that the choice of regime is a fairly even-handed matter but one that leans towards exchange rate targeting for the judgment suggested; if, as the material in the Appendix table allows, the comparison were to be drawn between an exchange rate and a monetary target accompanied by an interest equalization tax adjusted so as to stabilize the nominal exchange rate, then the balance of advantage — hardly surprisingly — swings in favour of the monetary target. The detailed results also give evidence that in the face of some shocks (aggregate demand and foreign capital flow), the price effects may go in different directions under the two simple regimes (exchange rate and simple monetary target), suggesting that a conditional or combinatorial policy would be preferable to either.

However, the principal import of this analysis is that, even judged solely in relation to price stabilization and ignoring the troublesome dynamic effects associated with monetary targets, an exchange rate target regime seems just as appealing, and plausibly more so, than a purely monetary target regime. A monetary target regime with an interest equalization tax adjusted in the light of the exchange rate, or a combinatorial or conditional regime would be preferable to either, though these alternatives might be subject to qualifications, in terms of their practicability or clarity, which do not apply to the simple regimes. A key requirement for the superiority of an exchange rate regime is, of course, that the foreign price level should not be the overwhelmingly favourite candidate for stochastic disturbances.

The key point of this analysis, then, is that it establishes that the exchange rate could well be preferred to the money supply as a target even on the criterion, which is the "home ground" of the case for monetary targets, of minimising the variance of prices. That this is not the immediate criterion on which critics of monetary targeting base their case is of course obvious. But those who criticize monetary targets on account of their exchange rate implications need not, if the foregoing arguments are correct, be concerned that the exchange rate would form an inferior target for price stabilization purposes.

However, we now turn to an analysis which is more directly concerned with the exchange rate implications of monetary targets when the dynamics of the adjustment paths are taken into account.

II

The analysis concerned is that of Buiter and Miller (1981).[3] They illustrate their argument on the basis of a model which in many respects makes concessions to a monetarist viewpoint: the economy has a superneutral equilibrium; the monetary growth rate enters directly into domestic inflation expectations. The consequent adjustment path illustrates what is meant by "transitory" over-appreciation of the exchange rate. The key to the results is that neither prices (wages) nor the money supply is a jump variable (the latter because monetary policy is formed in growth rate terms), in strong contrast to the exchange rate, which is. All the results essentially flow from this. The superneutrality property of the economy requires a constant real rate of interest in all inflationary equilibria, and by reason of the "Fisher relation" nominal interest rates vary point for point with the inflation (and hence the monetary growth) rate across such equilibria. This implies that a successful reduction of the inflation rate between two equilibria must require across the transition period an average inflation rate less than the monetary growth rate. In this way, real balances can increase, as they must given that the demand for real money balances depends (inversely) on the nominal interest rate. Since the actual rate of inflation is governed by an "augmented" Phillips curve in which inflation responds positively to the deviation of output from its natural level and, one-for-one, to the expected monetary growth rate, this means that output must fall below its natural level during the transition. In an open economy, Buiter and Miller argue, this deflation is accomplished by a shock appreciation of the exchange rate (and decline in competitiveness) which is then gradually reversed over the transition period. Figure 3 illustrates the argument that transition must feature a period of falling real money supply; the reduction in monetary growth announced and initiated at time t_0 produces a new equilibrium at t_α with the inflation rate in line with the new (lower) monetary growth rate. Real balances will be larger at the lower inflation rate and the average inflation rate over the transition period must be lower than the monetary growth rate.

[3] Upon writing this Section, my attention was drawn (by Marcus Miller) to the analysis which appears in Dornbusch (1980). The no-intervention case examined there (chapter 12) is in exactly the same spirit as the Buiter-Miller analysis, though the latter is adorned with various ingenious side-swipes at UK monetary policy practice (circa 1980).

FIGURE 3

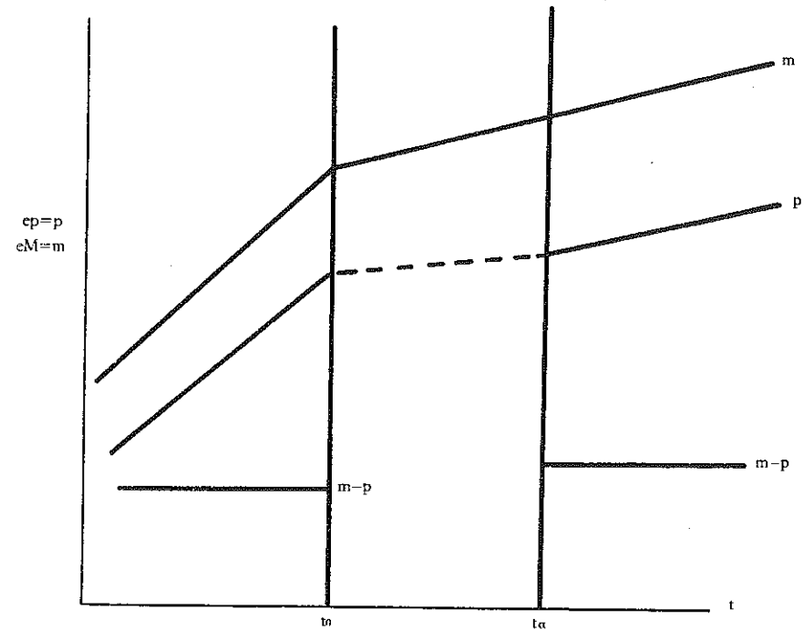


Figure 4 shows the system as a whole corresponding to the equation system set out below.

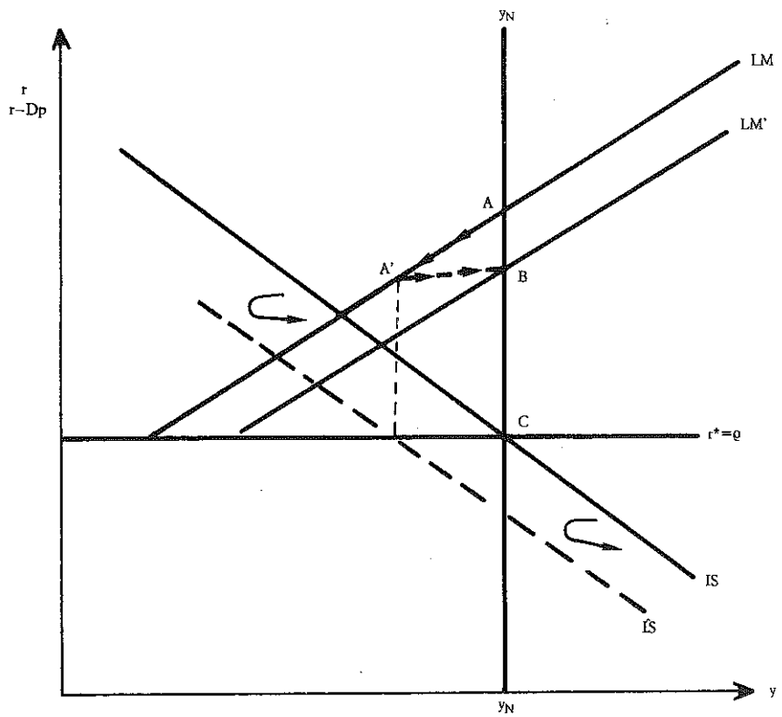
The Buiter-Miller system [4]

(1) $m = ky - \lambda r + p$ (LM curve)
(2) $y = -\gamma (r - Dp) + \delta (e - p)$ (IS curve)
(3) $Dp = \phi y + \mu$ (Phillips curve)
(4) $De = r - r^*$ (Exchange rate)

[4] Terms in North Sea Oil production, "own" rates of interest and indirect taxes are dropped from the original for convenience.

where (in logs)
m = nominal stock
p = domestic price level
y = output
e = exchange rate (domestic currency in terms of foreign)
μ = monetary growth rate
and
r,r* = domestic and foreign (*) interest rates.
D is the differential operator, e.g. $\mu = Dm = dm/dt$.

FIGURE 4



The effect of an announced reduction in the monetary growth rate on these assumptions can be conveyed by reference to Figure 4. Here

the initial equilibrium corresponds to point A; the IS schedule is drawn against the real rate of interest (r – Dp) and (with zero foreign inflation) the distance AC represents the rate of inflation and the rate of depreciation. A decline in monetary growth yields LM' in equilibrium, a reduction in the rate of inflation and of depreciation of AB. The impact effect of the announcement of the new lower monetary growth rate is to reduce actual inflation below the new equilibrium rate and by causing a jump appreciation in the exchange rate to shift the IS schedule to the left, output falling below y_N. Competitiveness thereafter, however, gradually improves and IS shifts to the right.

Clearly the assumption that inflation responds immediately to the new monetary growth rate is not particularly realistic; neither is it enjoined by rational expectations. It seems intuitive that more slowly adapting inflation expectations will result in greater adjustment costs as the integral of required output declines will be larger; with imperfect capital mobility, more of these costs will fall on the non-trading sector. However, a rigorous exploration of the taxonomy of adjustment costs and their distribution between the traded and non-traded goods sector falls outside the purview of this review. The point of the analysis reviewed here is that it highlights the vulnerability of the traded goods sector in a world of speedy capital movements to programmes of inflation control via monetary targeting policies.[5]

III

Neither of the models discussed in Sections I and II captures the issue which diverts many critics of monetary targeting, that the adjustment path may involve irreversibilities of various kinds, so that equilibrium capital stock and output are reduced by the monetarist experiment, rather than remaining invariant. This can perhaps be regarded as a 'weak' form of the doctrine of "cumulative causation" used among others by Kaldor in particular as an argument in favour of a policy of calculated undervaluation of the exchange rate. The decline in popularity of this view has been associated with the increasing tendency to suppose that exchange rate devaluations cannot be made effective, as wage-price responses rapidly wipe out any attempt to gain competitive

[5] The problem exemplified by Figure 3 can be removed if the money supply is a jump variable and a reduction in the monetary growth rate is accompanied by a jump increase in the money supply. It is hard to imagine such a package being credibly presented, though some might argue that the sloppiness of monetary growth practice allows such jump to be smuggled in.

advantage. However, the symmetry of such responses, which would be called for to remove the fear that cumulative causation may work "in reverse" is not empirically well-founded. In particular, there seems to be a species of downward wage rigidity (uprated one derivative) which endows wage inflation processes with a strong autoregressive bias, perhaps due to the influence of relativities in wage bargaining, and this suggests that wage-price responses are not, in significant time periods, symmetrical for devaluation and appreciation. If so, and particularly when exchange rate "jumps" occur, firms in the trading sector of the economy are likely to encounter sharp falls in profitability. There is good reason to believe that the set up costs of foreign trade are quite heavy, a consideration which cuts both ways. Current profitability may be allowed to decline as relative export price rises by less than current cost competitiveness falls (as seems to have happened in the UK), in token of the reinvestment cost that would be incurred by a decision to quit the market in the expectation of re-entering later on; whilst this helps sustain output and employment, it also betokens the existence of irreversibilities when viewed over quite lengthy horizons.

This kind of consideration adds to the case for limiting exchange rate variability; without it, the case rests on an evaluation of the disutility of adjustment costs which assigns exponential weighting to per-period adjustment costs, or on the evidence of some non-linearities (e.g. in the Phillips curve) which reduce the integral of adjustment costs over the transition period.[6]

Taking together the considerations raised in this and earlier Sections of the paper, it seems that a good case for targeting the exchange rate exists.[7] However, granted that reduction of inflation is an important policy objective, it is important to spell out how an exchange rate target could be effective in achieving such an objective. This requires some discussion of the role of intermediate targets.

The point of *announcing*, as opposed to merely pursuing "in secret" an intermediate nominal target is to provide private sector expectations with some kind of anchor. In this respect, it is clear that an important

[6] In the Buiter-Miller model, linearity appears to ensure invariance of the integral of adjustment costs, so that 'the case for gradualism' there must rest on an argument that the distribution over time of the total cost is significant (in utility terms) for either the policy-makers (facing election) or for society as a whole. A per period quadratic disutility function in adjustment costs defined in terms of $y-y^*$ would suffice.

[7] An alternative is the combination of capital import taxes with monetary targets. However, such taxes are widely argued to be ineffective.

test of a candidate variable is whether the announcement of a target for it seems at all likely to provide such an anchor. As different sets of agents are involved, it may be that a target will convince some markets and not others. At this level, it is widely agreed in the United Kingdom that monetary targets have little or no direct significance for the labour market, although the foreign exchange and gilt-edged markets by contrast are thought to pay some attention to them. A variety of reasons is given: for the public sector, general market conditions are of less obvious relevance in any case; trade unionists wilfully disbelieve the "model" implicit in monetary targeting *or* trade unionists do believe the model, but do not believe in the immortality of the government which lays them down; or, finally, even if the targets and the implicit model are given some credit, the "public goods" quality of wage restraint acts to prevent the internalization of this belief to individual union bargaining posture. An exchange rate target would not obviously do worse in these respects and would be visible to individual bargaining units in the private trading sector in a way which monetary targets *per se* are not. Of course there is no question that the announcement of an exchange rate can in and of itself reinstate the attitudes of the 1950s and 1960s when the exchange rate was thought to be as much an Act of God or Law of Nature as a price which could change! But this is a problem of credibility which is shared by monetary targets. It can be argued that unconditional targets of either kind invite a risk of lack of credibility which would not be shared to the same extent by targets of a more conditional (or combinatorial) nature. The difficulty with this latter class of rule is that their complexity might invite the change of chicanery.[8]

On the basis that if inflation matters it is absolute inflation and not inflation relative to that of the rest of the world which counts, an exchange rate target need not, and preferably would not, be a target for a fixed (dollar or effective) rate. It would presumably be worked out on the basis of estimates of foreign inflation rates and designed to "deliver" an appropriate domestic rate of inflation. Thus the charge that exchange rate targets only deliver the "foreign" rate of inflation applies strictly only to the fixed rate form of such a target; though it would certainly be true that the actual rate of inflation experienced domestically would vary from the desired level as foreign inflation rates departed from the path foreseen at the time the target was laid down. This is a problem mainly for the

[8] Though it is difficult to see why proponents of rational expectations should charge only modestly complex targets with impenetrability!

longer term setting of the target: on the plausible assumption that our ability to forecast foreign inflation deteriorates with the length of the forecast horizon, the setting of "medium term" exchange rate (path) targets becomes a dubious exercise; it would certainly *look* more dubious than the setting of medium term monetary targets and would be better not done. It might be more appropriate in this light to set out the desired medium term reduction in inflation and then to set nominal exchange rate paths for shorter intervals, on a crawling (up or down) pattern.

IV

We close with some brief comments on the case for joining the EMS in the light of the foregoing.

It seems clear that, in a first-best world, if such an abstraction can be allowed, the case for exchange rate targeting is quite distinct from any case for joining a particular currency bloc at a *fixed* exchange rate, for this rules out the option of selecting a gliding parity. Moreover, in the absence of a target for the rate of exchange at which the bloc currency will float against the rest of the world, the fixed exchange rate against the bloc countries does not aumont to a clear fixed effective parity. For a country (such as the UK), in which trading links with countries outside the bloc remain significant, this must rob the commitment to a fixed exchange rate against the bloc of some, perhaps a very significant part, of its desired demonstration effect. Moreover, to complement the fixed bloc exchange rate with a commitment from the bloc about its exchange rate vis-à-vis the rest of the world is both to ask a great deal and to provoke the n-1 problem. Not every country, nor both blocs in a two-bloc world can have an independent exchange rate target.

The logic for joining the EMS must either be based on other arguments altogether, or else use the arguments in favour of exchange rate targeting in a roundabout, partial and indirect manner. There is always a danger, here, of succumbing to second best arguments based on tactical political considerations. For example, it may be true to say that had the UK joined the EMS, the damaging recent experience of sterling's appreciation would not have happened, and this would be a good thing. But this is to say that the "monetarist experiment" could not have happened: or else, that the UK would have left the bloc or revalued within it more than a few times. Of course, one of the arguments deployed by advocates of joining the EMS has always been

the (to me, dubious) political one that such membership would discipline "irresponsible" governments — only such advocates usually have in mind a definition of "irresponsibility" that equates it with "disposed to inflationary finance". To use the same argument in the present context must mean redefining "irresponsibility" as "carelessness about employment levels"! Be that as it may, it is still not very appealing in its implied assumptions that democratic governments both can and should be advised to enter into arrangements which prevent them doing what they would otherwise prefer to do.

In a recent analysis, Allen (1980) has highlighted the role of "asymmetric disturbances" in governing the desirability of joining a monetary union. The argument is that in resigning the ability to formulate independent exchange rate policy, union members lose a degree of freedom to adjust to asymmetric disturbances. It is true that the value of this lost degree of freedom is highly inversely correlated with the degree to which the union members meet the customary criteria of an optimum area (e.g. a high degree of substitutability between member countries' goods, mutual trade of a large proportion of member national products, free movement of the factors of production) but those criteria are rarely closely met in practice and not at all closely approached in the case of the UK and EMS. This implies that the frequency of asymmetrical disturbances must also be taken account of; in a truly optimal currency area it might indeed be supposed that such disturbances would be absent. In the practical case in question, however, this is surely far from the case: to mention only two issues of particular importance, asymmetrical supply (wage push) shocks and capital flow shocks seem to be, historically, of considerable significance within the membership (actual and potential) of the EMS. Since this consideration is on a par with the methodological prejudice of the first section of this paper, it seems a good note on which to conclude. Adjustment to shocks is the traditional stuff of discretionary policy and important enough not to be forgotten. The pursuit of relatively simple unconditional intermediate targets has its purposes, but it has no place in a long run setting and the disappointing results of following one such rule are not a good basis for embracing another one, at least if the alternative is not capable of reappraisal at appropriate intervals. It seems (to me) that whilst the experience of monetary targeting in the UK and the case for exchange rate targeting both lean in the direction of advocacy of the EMS, they are much less than decisive as arguments for doing so and indeed might well be misleading.

M. J. Artis

APPENDIX

Our formal model may be set down as follows:

$$y = -\beta(r - p^e_{+1} + p) + \phi(\pi_1 + \varepsilon - p) + u_1 \quad (1)$$

$$m = ky + \eta r + p + u_2 \quad (2)$$

$$p = \theta_1 (y - y^*) + \theta_2 (\pi_1 + \varepsilon) + \theta_3 (\pi_2 + \varepsilon) + \theta_4 (\pi^e_1 + \varepsilon^e) + \theta_5 (\pi^e_2 + \varepsilon^e) + \theta_6 p^e + u_3 \quad (3)$$

$$r = \varrho + \varepsilon^e_{+1} - \varepsilon + \tau + u_4 \quad (4)$$

where all variables are expressed in logarithms except for the rate of interest which is a proportion and where:

y = real output
y^* = full employment real output
r = nominal interest rate
p = price level
m = nominal (high-powered) money stock
π_1 = price of imported competitive goods
π_2 = price of imported complementary goods
ϱ = world nominal interest rate
ε = exchange rate (units of domestic currency per unit of foreign currency)
u_i = random disturbance, $i = 1,...,4$
$+i$ = lead of i periods
e = subjective expectation
τ = interest equalisation tax.

Equation (1) is the aggregate demand schedule, where aggregate demand depends negatively on the expected real interest rate and the price of domestic goods relative to competitive world prices. Equation (2) is a standard money demand function where the demand for real money balances depends positively on real income and negatively on the nominal rate of interest. Equation (3) is the aggregate supply schedule. This is a reduced form equation from a complete wage-price model, the details of which are given in Artis and Currie (1981a). Domestic prices are determined by a mark-up, varying with the state of demand, over costs, made up of wage costs of complementary imports; while nominal wages are determined by the level of demand and the consumer price

index, which is in turn a weighted average of domestic prices and prices of competitive imports. Long run homogeneity requires that $\sum_{i=2}^{6} \theta_i = 1$, but in general $\theta_6 \neq 1$, so that there may exist a short run trade-off between domestic prices and output even when prices are fully anticipated. (See Buiter (1979), Artis and Currie (1981).)

Equation (4) is based on the assumption of perfect capital mobility, so that expected returns (adjusted for exchange rate changes) on assets denominated in sterling and other currencies are equalised. We include in (4) a tax τ on foreign holders of sterling assets (and a corresponding subsidy on domestic holders of foreign assets), which we later consider as a possible instrument available for purposes of stabilisation.

All four equations include a random disturbance term u_i to capture the effect of unforeseen shocks to the system.

A variety of possible informational assumptions can be made in this model. The assumptions embodied in (1)–(4) are that agents have information on current prices (including the exchange rate) when determining their demands for money and goods;[1] but that wage settlements are negotiated prior to such information becoming available. This gives rise to a conventional upward sloping short run aggregate supply schedule.

To solve the system, we take expectations of the system, subtract the resulting equations from equations (1)–(4), and then solve for the endogenous variables. Thus for exchange rate targets (A), where ε is constant, we have that

$$\begin{bmatrix} 1 & (\phi + \beta) \\ -\theta_1 & 1 \end{bmatrix} \begin{bmatrix} y - y^* \\ p - p^e \end{bmatrix} = \begin{bmatrix} u_1 + \phi(\pi_1 - \pi^e_1) - \beta(\varrho - \varrho^e) - \beta u_4 \\ \theta_2 (\pi_1 - \pi^e_1) + \theta_3 (\pi_2 - \pi^e_2) + u_3 \end{bmatrix} \quad (5)$$

while under monetary targets (B), we obtain:

$$\begin{bmatrix} 1 & (\phi+\beta) & -(\phi+\beta) \\ -\theta_1 & 1 & -(\theta_2 + \theta_3) \\ k & 1 & \eta \end{bmatrix} \begin{bmatrix} y - y^e \\ p - p^e \\ \varepsilon - \varepsilon^e \end{bmatrix} = \begin{bmatrix} u_1 + \phi(\pi_1 - \pi^e_1) - \beta(\varrho - \varrho^e) - \beta u_4 \\ \theta_2 (\pi_1 - \pi^e_1) + \theta_3 (\pi_2 - \pi^e_2) + u_3 \\ \eta(\varrho + \varrho) + \eta u_4 - u_2 \end{bmatrix} \quad (6)$$

[1] The assumptions made by Artis and Currie (1981a) differ slightly in that agents are not endowed with knowledge of the current aggregate price level when forming their inflation expectations. This modification gives rise to small differences in what follows.

With an interest equalisation tax, the level of the tax, τ, becomes an endogenous variable. Thus under (C), we have that $(\pi_1 + \varepsilon - \varrho)$ is constant, so that

$$\begin{bmatrix} 1 & 0 & \beta \\ -\theta_1 (1-\theta_2-\theta_3) & 0 \\ -k & -(1+\eta) & \eta \end{bmatrix} \begin{bmatrix} y-y^* \\ p-p^e \\ \tau-\tau^e \end{bmatrix} = \begin{bmatrix} -\beta(\varrho-\varrho^e) - \beta u_4 - \beta_1 (\pi_1 - \pi_1^e) + u_1 \\ \theta_3 (\pi_2 - \pi_2^e - \pi_1 + \pi_1^e) + u_3 \\ -\eta (\varrho-\varrho^e) - \eta u_4 - \eta (\pi_1 - \pi_1^e) + u_2 \end{bmatrix} \quad (7)$$

while under (D) we have that

$$\begin{bmatrix} 1 & (\phi+\beta) & \beta \\ -\theta_1 & 1 & 0 \\ -k & -1 & \eta \end{bmatrix} \begin{bmatrix} y-y^* \\ p-p^e \\ \tau-\tau^e \end{bmatrix} = \begin{bmatrix} -\beta(\varrho-\varrho^e) - \beta u_4 - \phi (\pi_1 - \pi_1^e) + u_1 \\ \theta_2 (\pi_1 - \pi_1^e) + \theta_3 (\pi_2 - \pi_2^e) + u_3 \\ -\eta (\varrho-\varrho^e) - \eta u_4 + u_2 \end{bmatrix} \quad (8)$$

We may now solve (5)-(8) for the change in p and y resulting from exogenous disturbances. We consider five types of stock: an aggregate demand disturbance (u_1); a money demand disturbance (u_2); an aggregate supply disturbance (u_3, $\pi_2 - \pi_1 - \pi_2^e + \pi_1^e$); a capital flow disturbance ($\varrho - \varrho^e$, u_4); and a foreign price level disturbance ($\pi_1 - \pi_1^e = \pi_2 - \pi_2^e$).[2] The resulting variances are reported in Table 1.

[2] Since a rise in the price of complementary imports relative to other import prices has an effect identical to a supply shock, it is convenient to take the foreign price level shock to be a general equiproportionate change in the price of all imports.

TABLE 1

PRICES AND OUTPUT FLUCTUATIONS

Regime / Shock	Exchange Rate Target		Monetary Targets					
			No interest equalisation tax		Interest equalisation tax, constant real exchange rate		Interest equalisation tax, constant nominal exchange rate	
	price	output	price	output	price	output	price	output
Aggregate Demand	$\theta_1 D_1^{-1}$	D_1^{-1}	$(\theta_1\eta - kc_1)D_2^{-1}$	$(\eta+c_1)D_2^{-1}$	$\eta\theta_1 D_3^{-1}$	$\eta(1-c_1)D_3^{-1}$	$\eta\theta_1 D_4^{-1}$	ηD_4^{-1}
Money Demand	—	—	$-(c_2+\theta_1\beta)D_2^{-1}$	$-(\phi+\beta)(1-c_1)D_2^{-1}$	$-\beta\theta_1 D_3^{-1}$	$-\beta(1-c_1)D_3^{-1}$	$-\beta\theta_1 D_4^{-1}$	$-\beta D_4^{-1}$
Aggregate Supply	D_1^{-1}	$-(\phi+\beta)D_1^{-1}$	$(c_3+k\phi)D_2^{-1}$	$-(c_4+\phi)D_2^{-1}$	$c_3 D_3^{-1}$	$-\beta(1+\eta)D_3^{-1}$	$c_3 D_4^{-1}$	$-c_4 D_4^{-1}$
Capital Flows	$-\theta_1\beta D_1^{-1}$	$-\beta_1 D_1^{-1}$	$(c_2\eta+c_1k\beta)D_2^{-1}$	$(\eta\phi-c_1c_4)D_2^{-1}$	—	—	—	—
Foreign Prices	$c_2 D_1^{-1}$	$(\phi-c_1(\phi+\beta))D_1^{-1}$	$(c_2\eta+c_1k\beta)D_2^{-1}$	$(\eta\phi-c_1c_4)D_2^{-1}$	—	—	$(c_2\eta+c_1k\beta)D_4^{-1}$	$(\eta\phi-c_1c_4)D_4^{-1}$

$D_1 = 1+\theta_1(\phi+\beta)$. $D_2 = (\theta_2+\theta_3)(1-k(\phi+\beta))+(\phi+\beta)(k+\theta_1)+\eta D_1$. $D_3 = (\eta+\beta k)(1-\theta_2-\theta_3)+\beta\theta_1(1+\eta)$. $D_4 = \beta(\theta_1+k)+\eta D_1$.

$c_1 = \theta_2+\theta_3$. $c_2 = \phi\,\theta_1+c_1$. $c_3 = \eta\phi+\beta$. $c_4 = c_3+\beta\eta$. $c_5 = \eta+\beta k$.

BIBLIOGRAPHY

ARTIS, M. J. and CURRIE, D. A. (1981a) "Monetary and exchange rate targets" in (eds.) A. Courakis and R. L. Harrington, *Monetarism: Traditions, Theory and Policy,* Macmillan.

ARTIS, M. J. and CURRIE, D. A. (1981b) "Monetary targets and the exchange rate: a case for conditionalizing", *Oxford Economic Papers,* (forthcoming).

ALLEN, P. R. (1980) "Increased wage or productivity differentials in a monetary union", paper presented for the *Conference on European Monetary Union,* Salford University, September.

BUITER, W. (1979) "Unemployment-inflation trade-offs with rational expectations in an open economy", *Journal of Economic Dynamics and Control,* Vol. I, pp. 117-141.

BUITER, W. and MILLER, M. (1981) "Monetary policy and international competitiveness" in (eds.) A. Courakis and R. L. Harrington, *Monetarism: Traditions, Theory and Policy,* Macmillan.

DORNBUSCH, R. (1976) "Exchange rate dynamics", *Journal of Political Economy,* pp. 1161-1176.

DORNBUSCH, R. (1980) *Open Economy Macroeconomics*, Basic Books, New York.

LIVIATAN, N. (1980) "Anti-inflationary monetary policy and the capital import tax", *Warwick Economic Research Paper,* No. 171.

VAUBEL, R. (1980) "International shifts in the demand for money, their effects on exchange rates and price levels and their implications for the pre-announcement of monetary expansion", *Weltwirtschaftliches Archiv,* pp. 1-14.