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On the Case for International Monetary Cooperation

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Over the last few years it has been repeatedly suggested that currency substitution makes demands for single currencies unstable. Furthermore, because of asymmetric non-sterilized intervention, 1/ currency substitution was held to contribute importantly to swings in the world money stock, which could ultimately produce world inflation or deflation. A number of proposals have been made to reduce destabilizing effects associated with currency substitution. One of these would amount to establishment of a target for world money growth to assure that currency substitution only affects the composition of the world money stock and not its level. Under the proposed scheme individual central banks would not pursue a fixed rate of monetary growth individually; rather they would stand ready to accommodate any swing in the demand for domestic money by non-sterilized intervention designed to protect fixed exchange rates.

The purpose of the paper is to evaluate the analysis as well as the empirical evidence from which the above proposal follows; the focus is on the work of Ronald McKinnon. Section I presents an overview of such work. Section II recalls the main conclusion of the empirical literature on currency substitution. It shows that the hypothesis that demands for individual currencies are quite unstable because of currency substitution receives little support in past research. However, the case for international monetary cooperation does not rest solely on the hypothesis of currency substitution. Indeed, Section III demonstrates that complete monetary independence with flexible exchange rates occurs only under a very restrictive set of assumptions. Whenever monetary dependence results on account of currency substitution or other factors, both domestic and world money turn out to enter as determinants of domestic output and

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1/ Non-sterilized intervention is asymmetric if either the country gaining reserves lets its money supply expand or the country losing reserves (or acquiring official external liabilities) lets its money supply contract, but both countries do not undertake such mutually reinforcing action simultaneously.

prices. The implication of these theoretical deductions and of the empirical evidence presented in Section IV is that central banks should not subordinate control of domestic money to control of a world monetary aggregate, although external effects generally arise from the policies pursued by each country. Specifically, Section V stresses that the world demand for M1 does not appear to be stable enough to justify the move towards world monetary targets. There are alternative ways of achieving greater stability even for countries which experience instability in the demand for their currency under fixed exchange rates.

I. An Overview

The purpose of this paper is to look into the analysis as well as the empirical evidence which lie behind the policy suggestions McKinnon has repeatedly put forward over the last few years (McKinnon 1981, 1982a, 1982b). 1/ The three major building blocks of his model are the following:

(a) The demand for domestic currency is highly sensitive to the expected changes in the exchange rate. Since expectations about the future behavior of the exchange rates have become more volatile with the adoption of flexible rates and since, to a great extent at least, they are exogenous to the money market, the demand for any single currency is also subject to significant and unpredictable shifts.

(b) Central banks (other than the U.S. Federal Reserve) are not prepared to let their exchange rates go as currency substitution takes place; rather they intervene without sterilizing so that their monetary base is often affected by economic agents' expectations about the behavior of the U.S. dollar over the relevant future period. Furthermore, since those banks keep their foreign exchange reserves in short-term U.S. government bonds, the induced changes in their supplies of base money are not matched by changes in the U.S. monetary base in the opposite direction. All in all, currency substitution translates into a loss of control over the world money stock.

(c) The demand for world money is stable and world (as opposed to domestic) money is a better predictor of domestic inflation.

With these building blocks, McKinnon derives certain money supply and intervention rules designed to stabilize prices in individual countries. These rules involve (1) advance determination of the rates of growth of the national money supply that would be compatible with low or zero inflation in each country in the absence of money demand shocks, and (2) in-course modification of these rates through symmetric non-sterilized intervention designed to counter any unexpected exchange rate pressures that may arise.

1/ For an earlier exposition of much the same ideas see McKinnon (1973).

Empirically these rules would be applied as follows:

Given the trend rate of change in output, in the income velocity of money, and in the money multiplier, each country will be able to ascertain what rate of growth of high-powered money should be consistent with approximate stability in the domestic price level. Each country could agree to fix the rate of growth of base money tentatively at that rate. Then if exchange rate pressures occur, non-sterilized symmetric intervention would be used to counter them. For instance, if there is upward pressure on the deutsche mark because of incipient inflationary tendencies in the United States, the German authorities would buy dollars for deutsche mark claims on the Bundesbank. The dollars so acquired by the Bundesbank would be deposited with the Federal Reserve so that the monetary base would be reduced in the United States by as much as it increased in Germany. If the money multipliers, specifically with respect to M1, are identical, world money supply would be unchanged. If M1 velocity is also the same in Germany and the United States, the incipient percentage fall in money and prices produced in the United States by the non-sterilized intervention operation just described multiplied by U.S. GNP would be equal to the (larger) incipient percentage rise in money and prices multiplied by the (smaller) GNP of Germany. If the incipient inflationary tendencies in the United States that caused the intervention in the first place were due to a shift in money demand from the United States to Germany, i.e., to currency substitution, so that there was incipient deflation in the latter country, these tendencies would be forestalled through non-sterilized symmetric intervention. Each country would achieve its price objective precisely because both deviated from their tentative money supply growth targets to counter shifts in the distribution of money demand that left the demand for world money unaffected. 1/

1/ Of course if the money multiplier and/or velocity are greater in Germany than in the United States, the shift in the distribution of base money could be inflationary. Although the growth of base money would be unchanged in the aggregate, world money supply could then grow faster than initially planned.

Shocks to money demand that arise for reasons other than a desire for currency substitution are less readily countered under such rules. For instance, if the demand for money increased in Germany at a given level of income and interest rates, without falling spontaneously in the United States, there would be a deflationary tendency that would be shared by both countries after a smaller amount of non-sterilized intervention had occurred to support the dollar than in the previous case. Similarly if the demand for money fell in the United States at a given level of income and interest rates without rising spontaneously in Germany, there would be an inflationary tendency in both countries after nonsterilized intervention had led to an increase in the money supply in Germany and to a reduction in the U.S. money supply from the level that was tentatively targeted, but by less than the fall in demand. In each instance, shocks that affect only the money demand in one country would

The major and striking implication that follows is that central banks should cease to aim at fixed rates of monetary growth. What is needed is a de facto world central bank which makes sure that, in spite of currency substitution, the "world" monetary base grows at an agreed-upon fixed rate. This could be achieved by having the central banks of the major industrial countries shift their main foreign exchange reserve assets from U.S. government securities to deposits with the Federal Reserve system and begin to systematically and passively accommodate any swing in the demand for domestic money by non-sterilized intervention designed to protect fixed exchange rates.

Such analyses and proposals which, in part at least, are also shared by others (Laffer (1977), Miles (1978, 1981), and Brittain (1981)) raise a number of analytical and empirical problems. For instance, a short-run partial equilibrium approach is usually taken, 1/ some of the key empirical assumptions are not tested 2/ and no distinction is drawn between currency substitution and capital movements in some studies. 3/ Rather than dwell on these points, we will later examine the empirical evidence on currency substitution and ask whether phenomena other than currency substitution also call for international monetary cooperation with or without surrender of domestic monetary autonomy.

First, however, three prior findings will be brought to mind. First, the hundreds of empirical papers on the demand for money which have become available over the last 25 years tend to show that, by and large, once a scale variable and a domestic interest rate are employed as explanatory variables, very little unexplained variance is left over. Second, that same literature suggests that the elasticity of money demand with respect

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1/ (footnote continued from page 3) be offset only partly and in a fashion that would interfere with the price stability objectives of the other country. Disturbances to aggregate supply that do not change money demand and prices equally in both countries would also lead to exchange market pressures, calling for symmetric non-sterilized intervention.

1/ The following quotations from McKinnon (1982a) may illustrate this point. "A complete picture of international inflation would link money creation to realized price and possibly output increases with differing variable lags. Such a complex process cannot be captured within a simple analytical framework. Focus instead on the much narrower problem of how changing exchange rate expectations immediately influence the demand for rowa [rest of world money] relative to dollars and the total supply of world money (p. 324). Under this approach, "fluctuations in s [the expected change in the exchange rate] are given exogenously to the model" (p. 325).

2/ One example is given by the assumption of a stable world money demand. All the reader comes across is the following passage, "The world demand for money seems relatively stable. By considering a wide index of a "world" money supply... the two great outbreaks of international price inflation in the 1970's become explicable" (McKinnon (1982), p. 323).

3/ On this see our discussion of the studies by Miles in the Appendix.

to a domestic interest rate is already on the low side (Laidler (1977b)). Third, even those studies which look into the specific problem of the instability in money demand over the 1970's do not find it particularly helpful to turn to foreign interest rates or expected changes in the exchange rates as further regressors; indeed, it is interesting to notice that in their recent survey of that literature, Judd/Scadding (1982) do not even mention the open economy.

II. The Empirical Evidence on Currency Substitution

Turning now to the specific empirical literature, the questions we are seeking to answer are the following: Is a statistically significant cross-elasticity effect easy to detect? Are cross-elasticities very high in absolute value and, at any rate, how do they compare with the estimated own-elasticities? Is the hypothesis of a stable world demand for money supported by the empirical evidence on currency substitution? What is the pattern of the signs of cross-elasticities that can be detected and does it clearly indicate which countries could benefit most from the creation of a monetary union? Do such countries happen to be the United States, Germany, and Japan?

From the point of view of our present discussion it is perhaps more convenient to distinguish between, and deal separately with, two sets of empirical papers according to whether they simply estimate the effects of currency substitution on the demand for one or more currencies, or go further and also purport to show that the world demand for money is stable. The former set of studies includes both single equation estimates 1/ and portfolio models; 2/ furthermore, it covers quite a few countries 3/ under both fixed and flexible exchange rates. A fair description of this literature would be that:

(a) Currency substitution is never found to be close to infinite, or just high, not even in the case of two highly integrated economies like the United States and Canada (Alexander (1980), Bordo/Choudhri (1982)) or of countries with no constraint at all on capital movements like Switzerland (Vaubel (1980), Howard/Johnson (1982)).

(b) Statistically significant cross-elasticities are not at all easy to detect. To quote from Brillembourg/Schadler (1979), "Of the off-diagonal terms of the matrix [of elasticities] only about one-fifth are significantly different from zero at the 95 per cent confidence level . . ."

1/ Hamburger (1977), Hamburger/Wood (1978), Boughton (1979), Vaubel (1980), Alexander (1980), Johnson (1982), Howard/Johnson (1982), Bordo/Choudhri (1982).

2/ Chrystall (1977), Brillembourg/Schadler (1978).

3/ United States, Germany, United Kingdom, Switzerland, France, Italy, Japan, Canada, Denmark.

(c) Generally speaking (see Chrystall (1977) for a few exceptions) the estimated values for the cross elasticities are so low that they tend to fall between 1/4 and 1/10 of those for the own elasticities.

(d) It is not quite clear what the pattern of currency substitution is. However, if the most weight is attached to the results by Brillembourg/ Schadler (1979), one could infer that demands for U.S. dollars and Japanese yen are relatively unaffected by changes in the rates of return on foreign currencies while there appears to be some degree of complementarity 1/ between the U.S. dollar and the deutsche mark. Hence the case for a monetary union between the United States, Japan and Germany is far from obvious.

The second set of studies is particularly interesting in that it includes papers by Miles (1978, 1981) and Brittain (1981), both strong advocates of the need to switch to world monetary targets. The Appendix deals fairly thouroughly with such papers and the interested reader may refer to it for the details. Here we will simply state that none of the two hypotheses the papers were meant to support--that money demand is very sensitive to open-economy variables and that its instability disappears with aggregation--can be said to have been tested in a meaningful way or to have survived whatever tests were pertinent.

The upshot of the discussion so far then is that perhaps all a central bank should do under the present circumstances is to pay some attention to possible international shifts in the demand for money when formulating its monetary target (Vaubel (1980)). Those who disagree with this conclusion and insist on the call for international monetary cooperation are nevertheless still faced with the difficulties that were raised in the previous section. International monetary cooperation is certainly not easy to implement; the form it will take must ultimately depend upon what the most pressing problem is seen to be. Even if we do believe that currency substitution is menacing there are still other problems that could also call for monetary cooperation. Second, no matter what the problem is, what is the rationale behind the suggestion that domestic monetary control be given up entirely? More explicitly, why should central banks have to choose between domestic or world money? The rest of the paper will deal mainly with these issues.

III. The Insultation Properties of Flexible Exchange Rates and the Case for International Monetary Cooperation

The analytical tool that will be employed is the rational expectations version of the Mundell (1961), Fleming (1962), and Laidler (1977a) model of an open economy. The aggregate demand function has the ratio of actual to permanent (equilibrium) output depend upon domestic monetary disequilibrium and the ratio of world to domestic prices. Monetary dis-

1/ This result is also obtained by Kouri/de Macedo (1978) in a study of demands for securities in five major countries.

equilibrium is defined to be the ratio of nominal money supply and demand which, in its turn, is homogeneous of degree one in permanent income and prices. The aggregate supply curve is of the Lucas (1973) type. The aggregate supply equation is of the Lucas (1973) type. The balance of payments equation makes the change in the stock of international reserves (equal to zero under flexible exchange rates) depend upon the ratio of world to domestic prices and monetary disequilibrium. The money supply is supposed to follow a steady, known path. Finally, two more functions are needed to describe the equilibrium in the goods market and the expectations formation process. All variables are in natural logarithms, permanent income is assumed to be constant and is set equal to one so that its logarithm goes to zero and the demand for money becomes identically equal to the domestic price level.

$$(1) \qquad y^d = \alpha_1(m_s - p) + \alpha_2(\pi + \varepsilon - p)$$

$$(2) \qquad y^s = (1/\eta)(p - p^e)$$

$$(3) \qquad y^d = y^s = y$$

$$(4) \qquad 0 = \gamma_1(m_s - p) + \gamma_2(\pi + \varepsilon - p)$$

$$(5) \qquad X^e = E(X|I)$$

where y^d and y^s indicate the deviations of real output from its permanent (zero) level, m_s the nominal money stock, p the domestic price level and the demand for money, π world prices, ε the exchange rate and X^e the expected value of variable X, which depends upon all the available information (I) at time t; for the time being we will ignore the stochastic terms, for their presence would not add in any meaningful way to the results.

What we are going to show is that (a) it is only under a fairly extreme set of assumptions that an open economy can insulate itself from foreign nominal shocks and thus obviate the need for international monetary cooperation; (b) currency substitution is only one of the hypotheses which, in spite of flexible exchange rates, translates into a link between domestic and world prices; and (c) domestic money turns out to affect domestic prices even when complete monetary independence is not achieved, so that there is little justification for giving up its control entirely.

The expected values of the relevant variables 1/ ε and p, are obtained from (1) and (4), and turn out to be

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1/ $E(y) = 0$ by construction.

$$(6) \qquad \varepsilon^e = m - \pi^e$$

and

$$(7) \qquad p^e = m.$$

The solution of the whole system in terms of deviations from expected values is as follows:

$$\begin{vmatrix} y \\ p-p^e \\ \varepsilon-\varepsilon^e \end{vmatrix} = \frac{1}{|D|} \begin{vmatrix} -\gamma_2/\eta & -\gamma_2(\alpha_a + \alpha_2) + \alpha_2(\gamma_1 + \gamma_2) & -\alpha_2/\eta \\ -\gamma_2 & \gamma_2 & -\alpha_2 \\ -(\gamma_1 + \gamma_2) & (\gamma_1 + \gamma_2) & -(\frac{1}{\eta} + \alpha_1 + \alpha_2) \end{vmatrix} \begin{vmatrix} \alpha_2(\pi-\pi^e) \\ 0 \\ -\gamma_2(\pi-\pi^e) \end{vmatrix}$$

where

$$(8) \qquad |D| = -\gamma_2(1/\eta + \alpha_1 + \alpha_2) + \alpha_2(\gamma_1 + \gamma_2),$$

and hence,

$$(9) \qquad y = 0$$

$$(10) \qquad p - p^e = 0$$

$$(11) \qquad \varepsilon - \varepsilon^e = \pi^e - \pi$$

In words, the domestic economy appears to be completely insulated with respect to any monetary shock that takes place in the rest of the world. This result is the joint product of three hypotheses, namely that there is no currency substitution, P.P.P. holds all the time and economic agents are endowed with perfect foresight. The first can be found in the absence of say a $-b\varepsilon^e$ term from the demand for money function, the others in the $\varepsilon - \varepsilon^e = \pi^e - \pi$--the exchange rate acts as a perfect shock absorber with respect to any changes in world prices--and $p^e = m$ results.

What deviations from P.P.P. do is easy to see. If we start off with a system that is the same as the one we have worked with so far except the exchange rate equation (4) is now replaced by

$$(4') \qquad \varepsilon = p - \pi + c(\dot{p} - \dot{\pi})$$

the solution becomes

$$\begin{vmatrix} y \\ p-p^e \\ \varepsilon-\varepsilon^e \end{vmatrix} = \frac{1}{|D'|} \begin{vmatrix} -(1/\eta) & \alpha_2 c - \alpha_1 & 0 \\ -1 & 1 & 0 \\ -(1+c) & (1+c) & -(1/\eta) + \alpha_2 c - \alpha_1 \end{vmatrix} \begin{vmatrix} -\alpha_2 c(\pi-\pi^e) \\ 0 \\ -(1+c)(\pi-\pi^e) \end{vmatrix}$$

Since

$$(12) \qquad |D'| = (-1 + \eta\alpha_2 c - \eta\alpha_1)/\eta$$

we have the following:

$$(13) \qquad y = [\alpha_2 c/(1 + \eta\alpha_2 c - \eta\alpha_1)](\pi - \pi^e) \neq 0$$

$$(14) \qquad p - p^e = [\eta\alpha_2 c/(-1 + \eta\alpha_2 c - \eta\alpha_1)](\pi - \Pi^e) \neq 0$$

$$(15) \qquad (\varepsilon - \varepsilon^e)/(\pi - \pi^e) = (\alpha_1\eta + c\alpha_1\eta + 1 + c)/(-1 + \eta\alpha_2 c - \eta\alpha_1) \neq 1$$

which, of course, reduce to (9), (10) and (11) as c goes to zero.

The point then is that even with perfect foresight and no currency substitution *any deviation from P.P.P. implies a loss of monetary* independence; the economics of this result is so evident that we do not have to comment on it.

Next we introduce an asymmetry into the information gathering process by making the assumption that at time t the exchange rate is the only known variable or, in other words, that the speed with which expectations about exchange rates are revised is greatest. To deal with this case we are forced to bring the distubances into the picture and write

$$(16) \qquad y^d = \alpha_1(m_s - p) + \alpha_2(\pi + \varepsilon - p) + u_1$$

(17) $m^d = p + u_2$

(18) $y^s = (1/\eta)(p - p^e) + u_3$

where $u_{1,2,3}$ are random variables with zero mean and σ_1^2 variance. Once again no currency substitution is considered; as for the exchange rate, the absolute version of the P.P.P. is imposed so that if monetary dependence eventually results, it will have to be attributed entirely to the particular hypothesis about the information gathering process that we are making here. So we set

$$\varepsilon = p - \pi.$$

Formally, the assumption about the information gathering process is the following:

$$X^e = E(X|I_{-1}, \varepsilon),$$

which says that at time t the only current information economic agents are endowed with consists of observations of the exchange rate. The expected level of world prices at time t will be given by

$$\pi^e = E(\pi|I_{t-1})$$

while its actual value may be written as

$$\pi = \pi^e + u_4 \qquad u_4 \sim N(0, \sigma_4^2).$$

The same is true of domestic prices; here we have

$$p^e = E(p|I_{t-1})$$

and

$$p = p^e + u_5 \qquad u_5 \sim N(0, \sigma_5^2),$$

where u_4 and u_5 are independently distributed random variables which also satisfy the orthogonality conditions. 1/

The solution for the expected endogenous variable pe is now obtained through the recursive projection formula, 2/ which in this case will be:

$$E(p|I_{-1},\varepsilon) = E(p|I_{-1}) + E[(p - E(p|I_{-1}))|(\varepsilon - E(\varepsilon|I_{-1}))].$$

Since

$$p - E(p|I_{-1}) = p - p^e = u_5$$

and, by the P.P.P. relationship,

$$\varepsilon - E(\varepsilon|I_{-1}) = u_5 - u_4$$

our expected price variable can be written as

$$E(p|I_{-1},\varepsilon) = E(p|I_{-1}) + E(u_5|u_5 - u_4) = p^e + E(u_5|u_5 - u_4).$$

In forming expectations about p economic agents face a signal extraction problem since they have to form expectations about u_5 by observing the variable $u_5 - u_4$. If they are rational they will project the dependent variable u_5 on the "explanatory" variable $u_5 - u_4$ in order to find the least square estimator of the relationship. So our problem is to find a coefficient that minimizes the sum of the squared errors of the $u_5 = y$ variable. The estimated regression coefficient db of $x = u_5 - u_4$ is

$$db = [E(xy)/Ex^2] = \sigma^2_5/(\sigma^2_5 + \sigma^2_4)$$

Hence,

$$E(p|I_{-1},\varepsilon) = p^e + db(u_5 - u_4)$$

1/ Orthogonality means that the error term vector is perpendicular to the vector of the independent variables so that π^e and p^e are the true least squares solutions to the problem.

2/ See Sargent (1979), p. 208.

Going back to the aggregate supply relationship and solving for output yields:

$$y = (1/\eta)[p - p^e - db(u_5 - u_4)] + u_3$$

which can also be written as

$$(19) \qquad y = (1/\eta)[(1 - db)u_5 + dbu_4] + u_3.$$

Turning to the expression for domestic prices, by substituting the result we just arrived at into the aggregate demand equation (18) while keeping in mind that we are imposing P.P.P. and solving for p we get

$$(20) \qquad p = m - (1/\alpha_1)\{(1/\eta)[(1-db)u_5 + dbu_4] + u_3 - u_1\}.$$

Once again then any shock to world prices enters the expressions for domestic prices and output. Furthermore the db value lies between zero and one, and tends to one as σ_5^2 rises relative to σ_4^2; this means that the greater the variance of world prices the lower the impact of a foreign nominal shock on domestic output and prices and vice versa, a fairly uncontroversial proposition in rational expectations theory. 1/ The economics of this result which, incidentally, was also put forward a few years ago by both David Laidler (1977a) and Stephen Turnovsky (1979) in the context of an analysis of adaptive expectations, is the following: as long as the exchange rate is the only variable to be perfectly forcasted any unexpected increase in world prices will translate into a drop in domestic prices and hence into excess real money balances which, in its turn, will trigger output and (further) price changes.

Finally we consider currency substitution by writing

$$(21) \qquad m_d = p - b\dot{\varepsilon}^e$$

1/ As σ_5^2 goes to infinity u_5 becomes perfectly predicted by $u_5 - u_4$, hence by u_5. This means that p^e acts as a perfect shock absorber with respect to domestic price shocks which then cannot affect output via the aggregate supply curve. At the same time however the fact that u_4 goes "unnoticed" means that any shock to world prices (which is not captured by pe) is bound to hit the domestic economy. Equations (19) and (20) say just that.

The two expressions for the expected endogenous variables turn out to be 1/

$$(22) \qquad \varepsilon^e = [1/(1-b)](m - \pi^e - b\varepsilon_{-1})$$

and

$$(23) \qquad p^e = [1/(1-b)][m - b(\pi^e + \varepsilon_{-1})]$$

which, of course, as b goes to zero, reduce to equations (6) and (7) that were obtained under P.P.P., perfect foresight and no currency substitution. Solving the system in terms of deviations from expected values yields:

$$\begin{vmatrix} y \\ p-p^e \\ \varepsilon-\varepsilon^e \end{vmatrix} = \frac{1}{|D''|} \begin{vmatrix} -(1/\eta)(\gamma_2+\gamma_1 b) & (1-b)(\alpha_2\gamma_1-\alpha_1\gamma_2) & -(1/\eta)(\alpha_2+\alpha_1 b) \\ -(\gamma_2+\gamma_1 b) & (\gamma_2+\gamma_1 b) & -(\alpha_2+\alpha_1 b) \\ -(\gamma_1+\gamma_2) & (\gamma_1+\gamma_2) & -(1/\eta - \alpha_1 - \alpha_2) \end{vmatrix} \begin{vmatrix} \alpha_2(\pi-\pi^e) \\ 0 \\ -\gamma_2(\pi-\pi^e) \end{vmatrix}$$

and hence

$$(24) \qquad y = (1/|D''|)[(1/\eta)b(\alpha_1\gamma_2 - \gamma_1\alpha_2)](\pi - \pi^e) \neq 0$$

$$(25) \qquad p - p^e = (1/|D''|)[b(\alpha_1\gamma_2 - \gamma_1\alpha_2)](\pi - \pi^e) \neq 0$$

$$(26) \qquad (\varepsilon - \varepsilon^e)/(\pi - \pi^e) = (1/|D''|)[(1/\eta)\gamma_2 + (\alpha_1\gamma_2 - \gamma_1\alpha_2)] \neq -1$$

For the third time in a row, then, we encounter a situation where flexible exchange rates do not completely insulate the domestic economy from foreign nominal shocks, the reason here being that every time the exchange rate moves to counter the foreign shock the demand for money shifts, thereby bringing about changes in domestic output and prices. 3/

1/ Previous equations (1) and (4) now become

$$y^d = \alpha_1(m_s - p + b\dot{\varepsilon}^e) + \alpha_2(\pi + \varepsilon - p)$$

and

$$0 = \gamma_1(m_s - p + b\dot{\varepsilon}^e) + \gamma_2(\pi + \varepsilon - p)$$

Once $\dot{\varepsilon}^e$ has been set equal to $\varepsilon^e - \varepsilon_{-1}$ the two-equation system gives ε^e and p^e.

2/ $|D''| = -(1/\eta)(\gamma_2 + \gamma_1 b) + (1-b)(\gamma_1\alpha_2 - \gamma_2\alpha_1)$.

3/ At first sight this result is hard to understand in the sense that any unexpected shock to world prices only affects the actual exchange rate and hence leaves money demand unchanged. However, it is also the case that such change in the actual exchange rate will show up in the definition of the expected exchange rate at time t+1 and money demand will have to react.

Of course, one could go on along these lines by considering capital movements, wealth effects, 1/ etc.; what we have done so far, however, suffices to support a few considerations which are relevant to the present discussion. The expressions we just arrived at plus the facts that (a) deviations from P.P.P., no matter where they come from, (b) differences in the costs of gathering information about exchange rates on one side and domestic and world prices on the other, and (c) currency substitution, according to some people at least, are all undisputed features of the world around us (Genberg (1978) and Frenkel (1981)) suggest that, notwithstanding the presence of flexible exchange rates, one single country can hardly expect to enjoy complete monetary independence, and hence be able to fully control its domestic price level. The consideration of capital mobility, wealth effects, etc. reinforces such conclusions and adds to the case for international monetary cooperation. From this point of view McKinnon's implicit criticism of much of the (theoretical) literature on the open economy under flexible exhange rates is correct.

At the same time, however, just because there are several potential sources of a link between domestic and foreign prices that cannot all be taken care of by one single form of international monetary cooperation, the question arises as to which of them is the most relevant. From this point of view, for instance, many would be prepared to argue that phenomena such as deviations from P.P.P. or poor and costly information gathering processes across countries are more disturbing than currency substitution. If that were indeed the case, then it would be difficult to accept the idea of an international monetary cooperation which is restricted to the case of very few countries (the currencies of which happen to be substitutes in demand) and which is based on the adoption of fixed exchange rates and world monetary targets. Finally, no matter what the rationale for having some sort of international monetary cooperation, and even when currency substitution is the source of the loss of monetary independence, the analysis does show that both domestic and world monetary

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1/ It is clear that by not having capital flows one of the channels through which foreign nominal shocks might affect the domestic economy gets closed, which should be kept in mind, particularly in the light of the results put forward in studies such as Mussa (1979), that shows that in Keynesian models flexible exchange rates provide complete insulation from foreign shocks when capital mobility is ruled out, or Turnovsky/Bhandari (1982), where one reads, "It is clear from the P.P.P. relationship that if the spot rate were to appreciate exactly in proportion to the foreign price level increase, then the domestic price and income levels would be unaffected by foreign price movements; . . . this will occur if either the domestic demand for money is independent of the nominal interest rate or if there is zero capital mobility." Also, by assumption, domestic economic agents do not hold interest and/or non-interest-bearing assets denominated in foreign currency; this too, by ruling out any wealth effect of changes in the exchange rate, helps strengthen the insulation properties of the flexible rate system (Dornbusch (1973), Boyer (1976), Turnovsky (1979)).

variables always appear in the price equation at the same time. This amounts to saying that the alternative is not between controlling domestic or world money, but rather between controlling domestic or domestic plus rest of world money. From this point of view, McKinnon's argument that world money is a better predictor of domestic inflation and hence is the only variable that is worth controlling does not appear to be supported by the theory. What will be done next is to show that its empirical foundations are lacking also.

IV. A Reassessment of McKinnon's Emprical Evidence.

Since the beginning of the flexible exhange rate period and the first oil shock, a considerable amount of empirical evidence has become available which indicates that, no matter what the fitted equations, the sample periods, the estimation techniques, or the countries involved are, world nominal shocks always seem to affect the domestic rate of inflation in a significant fashion; 1/ on average, the estimated elasticities 2/ tend to fall in the 0.2 - 0.5 range.

Because of this, and given the purposes of the paper, there is no need to specify and estimate a set of structural or even semi-reduced form equations for various countries; rather, domestic inflation rates will be regressed on distributed lags of domestic and/or world money growth. There are two major gains from doing so. First of all, as a by-product of the exercise, the view that world money is a better predictor of domestic inflation is directly tested in the same way as is done in McKinnon (1982b); second, since the ultimate cause of world price shocks is world money, and world money could affect domestic money via the reaction function of the domestic monetary authorities--see Gordon (1977), Gandolfi/Lothian (180), Cassese/Lothian (1982), Bordo/Choudhri (1982)--having world money rather than world prices appear in the domestic price equation should eliminate part of the bias that may be present in some of the standard equations.

We consider the countries that make up the World of Ten and for each of them three equations are fitted. The first one is the "closed economy" version in which domestic prices are regressed on domestic money. The second has the "rest of the world" money appear as a second regressor, as theory suggests; while the last one, where domestic prices are regressed on world money, represents McKinnon's hypothesis.

We make use of quarterly (deseasonalized and centered on mid-quarter) data; rates of change are taken to be the first difference in natural logarithms. Two alternative money definitions, M1 and M2, are tried out; the world and the rest of the world money stock is computed on the basis

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1/ Modigliani and Papademos (1976), Keran/Riordan (1976), Spitaeller (1978), Bruno (1978), Gramlich (1979), Cagan (1980), Gandolfi/Lothian (1980), von Furstenberg/White (1980), Bordo/Choudhri (1982a)

2/ We are talking about elasticities of domestic to foreign prices.

of the current exchange rate and expressed in terms of domestic currency units. As for prices, both wholesale prices 1/ and GNP (GDP) deflators are employed; because of lack of data on quarterly GNP, no regression with the GNP deflator as a dependent variable can be run for Belgium, Sweden or the Netherlands.

A third-degree Almon polynomial with both end and beginning period constraints imposed is employed in each case and allowance is made for 12 lags, starting at t-2; the constant term is systematically suppressed and the Cochrane-Orcutt technique utilized. The sample is restricted to the period of floating, 2/ 1973:I - 1980:IV, with the crucial 1973-74 period included in the sample.

Because dealing with ten countries at the same time and with different combinations of dependent and independent variables translates into just over 100 regressions and because the overall explanatory power of the three alternative hypotheses is of most interest, we thought the most effective and least space consuming procedure would be to give the R^2 generated by each of those regressions; they appear in Table 1. 3/

There is little need for a detailed comment on the results on a country-by-country or a variable-by-variable basis; the general message is that (a) except for France, domestic money performs better than world money alone, and (b) the inclusion of the rest of the world money translates into an increase in the $\bar{R}^2$ for almost all countries. Therefore, the empirical evidence seems to be in line with what theory suggests, namely, when explaining the inflation rate under flexible exchange rates, the first thing to do is to look at the growth of the domestic money stock, and then to supplement the model with some proxy for world nominal shocks; under no circumstances should one use world money only.

One further point is that McKinnon argues that, at least as far as the U.S. economy is concerned, there are well defined periods, 1973-74 and 1979-80, over which domestic money is expected to generate a particularly poor fit and considerably underpredict the actual inflation rate. In Chart 1 we have plotted the residuals generated by the equations with U.S. wholesale prices and, alternatively, U.S. and World M1. If anything, up to the end of 1974 world money performs worse. Subsequently, domestic and world money overpredict and underpredict, respectively; in 1978-79 that situation reverses itself, but once again world money is not found to fare any better than domestic money.

The last step is to take a close look at the exact kind of empirical evidence McKinnon (1982b) provides. Basically, the reader is presented with a set of regressions of annual changes in the U.S. wholesale price

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1/ In the case of Sweden, consumer prices had to be used.

2/ To estimate our equations we need some observations prior to 1973:I to construct the appropriate lags.

3/ Besides, the R^2 criterion has been adopted in McKinnon (1982b).

Chart 1

Residuals from the Regression of U.S. Wholesale Prices
on U.S. (——) or World (---) M1

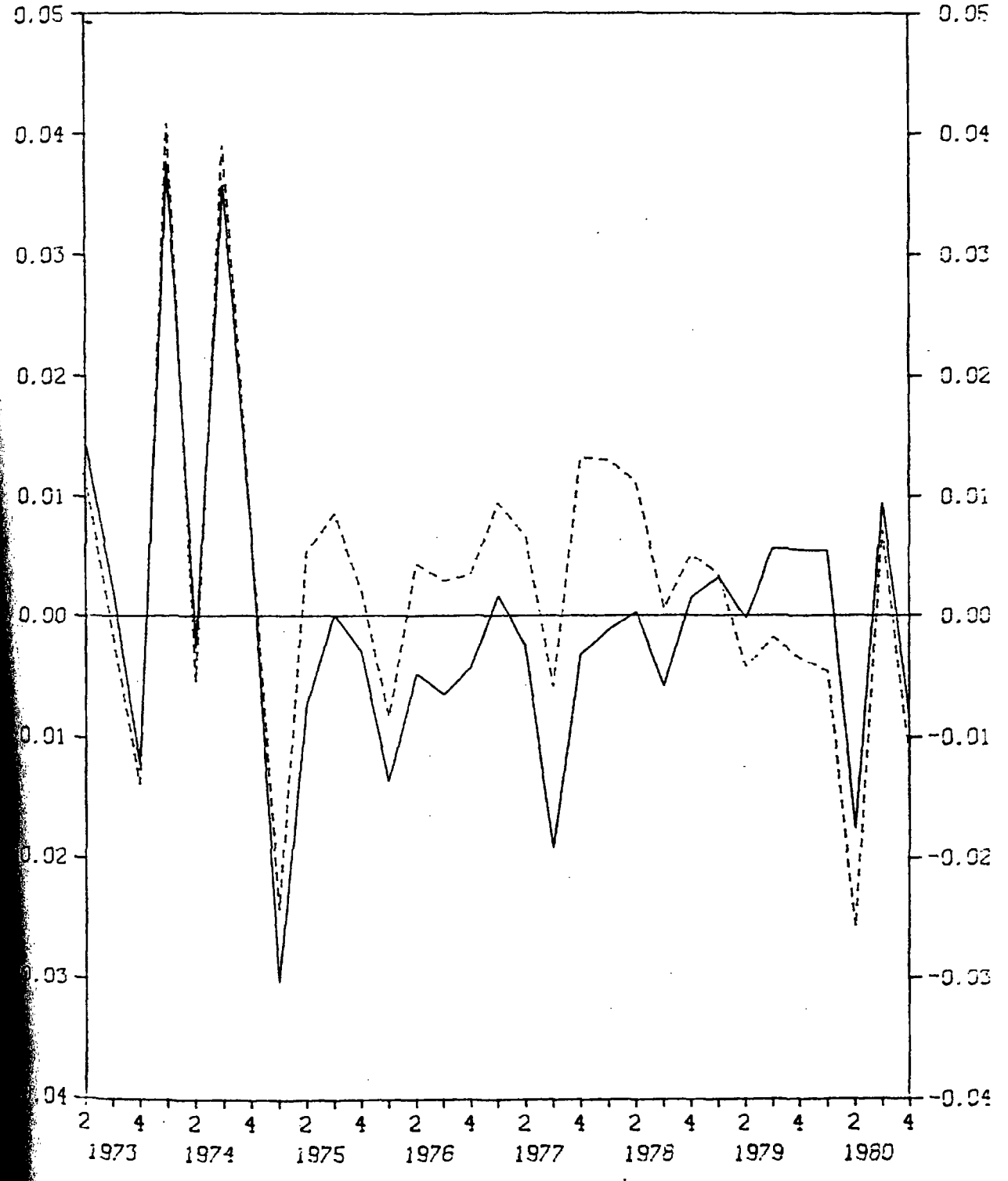

Table 1. Explanatory Power ($\overline{R}^2$ around the origin) of (1) Domestic Money, (2) Domestic and Rest of World Money, and (3) World Money

		M1		M2	
		Wholesale Prices	GNP Deflator	Wholesale Prices	GNP Deflator
United States	(1)	0.646	0.936	0.591	0.571
	(2)	0.692	0.936	0.796	0.897
	(3)	0.440	-0.059	0.452	-0.018
Germany	(1)	0.316	0.767	0.321	0.885
	(2)	0.297	0.792	0.566	0.899
	(3)	-0.001	-0.056	0.151	0.073
Japan	(1)	0.243	0.436	0.164	0.299
	(2)	0.282	0.492	0.282	0.239
	(3)	-0.056	-0.067	-0.065	-0.053
United Kindom	(1)	0.339	0.409	0.629	0.719
	(2)	0.461	0.448	0.681	0.787
	(3)	0.365	0.441	0.631	0.726
Canada	(1)	0.686	0.808	0.495	0.536
	(2)	0.844	0.915	0.769	0.776
	(3)	0.178	0.103	0.335	0.193
France	(1)	0.107	0.921	0.065	0.902
	(2)	0.273	0.923	0.162	0.948
	(3)	0.279	-0.001	0.096	0.223
Italy	(1)	0.296	0.753	0.396	0.860
	(2)	0.308	0.706	0.403	0.851
	(3)	0.238	0.558	0.270	0.728
Belgium	(1)	0.114	--	0.136	--
	(2)	0.175	--	0.362	--
	(3)	0.023	--	0.200	--
Sweden	(1)	0.856	--	0.818	--
	(2)	0.881	--	0.887	--
	(3)	0.121	--	0.200	--
Netherlands	(1)	0.209	--	0.460	--
	(2)	0.259	--	0.790	--
	(3)	0.014	--	0.316	--

index (XWPUS) on a constant and on changes in U.S. M1 (XM1US) or world M1 (XM1WORLD), both lagged once and twice. The regressions show that, that, over the sample period 1970-81, world M1 generates a higher $\overline{R}^2$, as is confirmed by the first two equations in Table 2 where we replicate the experiment.

There are two basic reasons which suggest that this finding is not robust. By looking at the residuals generated by equations (1) and (2), the first question that arises is whether world money performs systematically better than domestic money over the whole decade. This is a crucial point since, thanks to the debate over the cost-push in the late 1960s and early 1970s and, of course, to the development of the literature on rational expectations, we have learned that an effort has to be made to distinguish between systematic and nonsystematic impulses in studying inflation. In the present instance the relative performance of the two equations appears to depend to a great extent on just one observation, for 1974, so that it would be interesting to find out what happens when we introduce a dummy variable to take out that particular observation. This is done in equations (3) and (4). The Durbin-Watson statistic of the equation with domestic money now becomes acceptable and both money lagged once and money lagged twice are significant and have reasonable coefficients. The explanatory power of the equation is such that one can no longer say that world money is a better predictor of domestic inflation.

A fairly dramatic change in the picture also occurs as the GNP deflator replaces wholesale prices as the dependent variable, a perfectly legitimate substitution, of course. Equations (1') through (4') suggest that whether correction for first order autocorrelation is made or not, domestic money always wins. 1/

The message of this section is twofold. First, the view that, in spite of flexible exchange rates, individual countries do not fully control their domestic price level stands up to the data. Hence countries could benefit from an internationally concerted action against either inflation or the problems that generate monetary dependence. Second, it does not seem to make much sense to say that under the present circumstances no monetary independence at all is enjoyed by individual countries, that domestic inflation is driven just by world money, and hence that world money is the only variable that ought to be controlled.

V. The World Demand for M1 and Domestic Credit Expansion Targets

As pointed out in of Section I, McKinnon's reader is never presented with any direct empirical evidence pertaining to the nature of the world demand for money function. Rather, the stability of such function is

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1/ To stress the peculiarity of the combination of annual data and wholesale prices it should also be added that in this case the dummy variable does not turn out to be significant.

Table 2. Further Results on the Relationship Between Prices, Domestic and World Money

(t-statistics in parentheses)

Equation Number	Dependent Variable	Constant	XM1US(-1)	XM1US(-2)	XM1WORLD(-1)	XM1WORLD(-2)	DUMMY74	D.W.	ρ	$\bar{R}_2$
(1)	XWPUS	-6.048 (-1.418)	0.819 (1.528)	1.583 (3.049)				1.006	--	0.520
(2)	XWPUS	-6.437 (-1.646)			-0.140 (-0.421)	1.880 (5.048)		1.845	-	0.686
(3)	XWPUS	-4.521 (-1.380)	1.015 (2.464)	1.041 (2.371)			8.312 (2.772)	1.760	--	0.725
(4)	XWPUS	-4.987 (-1.240)			-0.030 (-0.087)	1.569 (3.484)	4.093 (1.177)	1.568	--	0.698
(1')	XDEFUS	3.002 (1.470)	-0.047 (-0.183)	0.682 (2.746)				1.173	--	0.340
(2')	XDEFUS	6.476 (2.553)			-0.370 (-1.711)	0.419 (1.737)		1.145	--	0.207
(3')	XDEFUS	5.038 (3.379)	-0.429 (-2.135)	0.807 (4.604)				2.230	0.200	0.668
(4')	XDEFUS	9.612 (4.204)			-0.447 (-2.450)	0.203 (1.126)		1.795	0.435	0.327

asserted in the ex-post interpretation of past developments. Since it is also a key prerequisite for the successful working of the plan, this assumption has been scrutinized in a separate paper (Spinelli (1983)) which suggests that results are sensitive to aggregation procedures. In particular, world 1/ demand for M1 turns out to be relatively stable when both world money and income are computed on the basis of current exchange rates. If, however, a base-period exchange rate is employed for income and hence any spurious correlation between the two variables is removed, world money demand appears to be quite unstable. Hence both the specific empirical evidence and a careful look at McKinnon's own analysis 2/ seem to imply, once again, that the suggestion that individual countries give up monetary independence entirely and switch to a world monetary target is not justified.

The problem, however, could be even more difficult in that it is not entirely clear whether stability in the world demand for money is a sufficient condition for the successful working of a plan based on a world monetary growth rule which is simple to define and to apply. The way McKinnon describes the past as well as the future reveals that somehow he happens to believe that it does not make any difference which component of the world money stock is shrinking and which is growing; as long as their variations match and total demand is stable the world price level should be unaffected. Many sensible people would maintain that that, too, has to be proven. 3/

Finally the question arises whether fixed exchange rates should be seen as the only way out of the present problems, and what would then be the appropriate monetary target. McKinnon does not make clear why cleanly floating rates, as an alternative to the current system of managed floating, would not take care of much of the problem by severing the link between currency substitution and swings in the world money stock. He also does not address the more general and fundamental question of whether or not currency substitution necessarily forces us to go back to fixed exchange rates, or whether it simply weakens the case against fixed

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1/ The world is defined to be U.S., Germany, and Japan.

2/ In fact we are told that there are two channels through which currency substitution manifests itself; as the expected exchange rate varies, economic agents switch directly from one currency to another and from domestic currency into domestic bonds (and vice versa in the other country) because of the changes in interest rates induced by exchange rate expectations. To the extent that the latter channel is the major one (McKinnon, 1982a, p. 326) and, as all the available empirical evidence seems to suggest, the interest elasticities of the national demands for money differ from one another, any change in the expected exchange rate is bound to translate into a shift in the world demand for money.

3/ Here we are thinking of both the developments in the field of the index number theory and the problem of the different behavior of velocity in different countries and of different components of money within countries.

exchange rates, as many would argue (Vaubel (1977)). These are perfectly legitimate questions because the case for flexible exchange rates has never been predicated on the absence of any measurable degree of currency substitution.

All that having been said, let us, however, suppose that a good case for a return to fixed exchange rates has been made. Here we would find a dog chasing its own tail, in the sense that it is well known that as a small open economy has its money demand determined exogenously (permanent income, prices and interest rates are given), the monetary authorities must not pursue a monetary target that is defined in terms of rates of change of the domestic monetary base. If they did, then any shift in money demand would translate into a permanent disequilibrium in the money market as well as in swings in the world money stock, i.e., it would give rise to the very same problem discussed. A solution to such problem was found a fairly long time ago in the definition of Domestic Credit Expansion (DCE), which can be seen as an alternative to McKinnon's plan. 1/

The implementation of such an alternative is not without problems particularly in view of the asymmetry it introduces in the treatment of the reserve and non-reserve currency countries. Those in the latter group, unable to finance deficits forever, have to react to any monetary shock, whether of domestic or foreign origin, and therefore have no choice but to bear part of the cost of adjustment. On the contrary, the reserve currency country, by taking the acquisitions or sales of the domestic reserve currency by foreign monetary authorities above or below the line, i.e., by defining DCE in one way or another, can either insulate from or make the domestic money stock depend on foreign developments. This implies that there could be situations where the whole burden of the adjustment process is forced on the non-reserve currency countries (Day (1977)). The problem of determining the origin of the money shock is also quite basic. A touchy question could be: Is the domestic interest rate too low or is the foreign rate too high? So there certainly are problems with DCE; however, one can hardly ignore this solution as a possible alternative to other proposals.

1/ For instance, suppose that once the domestic monetary target has been set money demand shifts down. The country will lose money to the rest of the world and the process will continue unless the monetary target is brought into line with demand. But this means that the variable that should be targeted is not money but money plus the absolute value of the balance of payments deficit, i.e. DCE. Therefore, if under fixed exchange rates instability in money demand comes into the picture, we are going to face much the same problem McKinnon has in mind, making DCE targeting another alternative to McKinnon's plan.

VI. Conclusions

A number of conclusions emerge from this paper. First, it is certainly the case that under flexible exchange rates the individual country still does not enjoy complete monetary independence and it is not in full control of the domestic price level. Once we depart from unrealistic sets of assumptions, models of the open economy were shown to predict that domestic prices are also affected not only by domestic but also by world variables. This, in turn, implies that there certainly exists a good case for having some form of international monetary cooperation.

However, what kind of monetary cooperation should be provided? Here we find McKinnon's analysis weak in that it ignores all but one of the several causes of a link between domestic and world prices without ever showing that that is the most relevant one, and misjudges the relative roles of domestic and world variables in the explanation of domestic inflation. In particular, the suggestion that a world central bank be created and national policy independence given up is the product of several hypotheses: (a) monetary interdependence is mainly caused by currency substitution, (b) the world demand for money is stable, and (c) world money is all that matters. Each of them has been shown not to stand up to the data or to the scrutiny of the already available empirical evidence. The paper also points to the existence of alternative solutions to the problem of currency substitution--cleanly floating rates, domestic monetary targets net of expected shifts in the demand for money, and fixed exchange rates cum DCE targets--which by and large have all been ignored in recent discussions.

APPENDIX

A Discussion of Miles (1978, 1981) and Brittain (1981) and a Few More Results on Currency Substitution

Previous studies, Miles and Brittain are the only ones, among the advocates of the need to switch to world monetary targets, to present some empirical evidence not only on the relationship between currency substitution and instability in the demand for single currencies but also on the alleged stability of the world money demand functions. Since their results appear to be mentioned fairly often, detailed discussion may be useful.

Miles (1978, 1981) regresses the relative demands for domestic and foreign currency by Canadian, U.S. and German economic agents on the ratio of foreign to domestic interest rates. He finds that the two variables are positively and significantly related to each other, and winds up arguing in favor of the hypothesis of a stable world money demand and calling for an end to the adoption of monetary targets by individual countries. Two studies by Bordo/Choudhri (1982b) and Laney/Radcliffe/Willet (1982) examine these results and show that while in the case of Canada they do not survive further tests, in the case of the United States, even when taken at face value, they point to a currency substitution which "has an influence on the order of 1/50 of the impact of the domestic interest rates", which is much in line with some of the conclusions by Brillembourg/Schadler (1977) mentioned in the text (Section II).

Apart from all this, however, there is one more general and fundamental criticism of the way Miles interprets his results. The positive coefficient on the interest rate ratio is taken to imply that "if the opportunity cost of holding real balances denominated in currency A rises relative to the opportunity cost of holding those denominated in currency B, all of these individuals will be assumed to reduce their real balances denominated in currency A and to increase . . . their holdings denominated in currency B" (Miles (1978)). Considering the implied relationship between relative interest rates and exchange rates, it is not difficult to find out what is wrong with this analysis. Basically Miles overlooks the fact that the way he extends Christ's (1963) analysis is not correct. Christ regresses the ratio of the overall demand for currency to bonds on the interest rate differential, he obtains a negative coefficient and (correctly) infers that, as interest rates move, economic agents switch from currency into bonds and vice versa. In that case there is no reason to expect a change in the portfolio size, i.e., in the sum of currency plus bonds. Miles, on the other end, regresses the ratio of two components of money demand on the domestic-foreign interest rate (on bonds) differential. The negative relation between these variables cannot be identified as being due solely to the changing composition of a given total demand for currency; in this case it is less reasonable to assume that the

portfolio size, i.e. currency i plus currency j, is left unchanged. 1/ In other words, if domestic and foreign bonds are brought into the picture, a rise in the foreign interest rate would cause residents to switch out of both domestic and foreign currency. It will therefore take no more than a greater elasticity in the demand for foreign currency with respect to foreign interest rates to generate a positive coefficient on the interest rate ratio. This represents both the economics that lie behind some of the formal points raised by Bordo/ Choudhri (1982) in their re-appraisal of Miles' analysis and a criticism of the way in which some of the literature on the determinants of exchange rates also tends to be interpreted vis-á-vis the currency substitution problem. 2/ Taken on their own, the two papers by Miles, provide only indirect tests of currency substitution which suggest that world money demand is unstable.

Brittain's (1981) study is specifically aimed at showing that for several countries the inclusion of a foreign portfolio variable adds significantly to the overall performance of a standard demand for money function, and this is seen as an intermediate step towards stressing the stability of world demand. The results presented in his text show, however, that in five out of ten instances the coefficient on the domestic interest rate variable is positively signed, in nine the coefficient on the portfolio variable is no greater than 0.01. Furthermore, the equations for the United States do not look any better than the ones we have been struggling with for quite some time now. 3/

1/ See also Chetty (1969) on this. In the context of this discussion we should also add that, as a metter of fact, when M3 is employed, no currency substitution is detected (Miles (1981)). Much the same criticism applies to Levy/Sarnat (1978). What they do is to compute mean and variances of the exchange rate changes of a basket of currencies vis-a-vis the U.S. dollar, and then ask the questions as to what a U.S. investor would do in order to maximize the return on his investment given the level of risk. The problem with this approach is that, as the authors themselves recognize, it does not explain the total demand for any currency over time; what it does explain is the portfolio portion of total demand. A second and major point is that by ignoring the alternative represented by bonds denominated in domestic currency, which gives a positive yield at no risk, even the portfolio component of the demand for the domestic currency (and hence for all currencies) is biased upwards.

2/ See, for instance, Bilson (1978), where the coefficient on the interest rate differential in the exchange rate equation is seen as a proxy for currency substitution.

3/ For instance, the coefficient on the lagged dependent variable continues to be equal to one. The reader might also want to take a look at Boughton (1979) and Vaubel (1980) where the inclusion of open economy variables does not turn out to add much to the results.

On the whole then the papers that we have discussed here do not appear to mark a turning point in the debate over the empirical relavance of the currency substitution phenomenon.

Extensions. In the existing empirical literature on currency substitution there is no study which combines the following four features: (a) M1 is the dependent variable, (b) the expected change in the exchange rate appears explicitly as an independent regressor,1/ (c) the data sample covers the flexible exchange rate period only, and (d) a portfolio approach is taken. The first three characteristics can be appreciated with McKinnon's work in mind.

In order to fill the gap, a small portfolio model is set up and fitted to the period 1971(4) - 1980(4) by full information maximum likelihood. Four currencies are considered: the U.S. dollar (USD), deutsche mark (DM), Japanese yen (JY), and British pound (BP); their desired stocks (denoted by M_i^*, i = USD, DM, JY, BP) depend on just a scale variable, W, defined to be the sum of the four actual stocks, and on a vector of expected changes in the exchange rate which are proxies by the 90-day premium on the U.S. dollar. Three further equations make the adjustment in the actual stocks of DM, JY, and BP a function of the gaps between both the own and the USD desired and actual stocks. To close the system, an identity is added which defines the actual change in the stock of USD to be equal to itself, or to the difference between the total change in W and the actual change in the other three currencies. The U.S. dollar is included in the three adjustment equations to make sure that, via the demand for it, any disequilibrium in the market for one currency gets transmitted to the rest of the portfolio. The use of an identity in the case of the adjustment function for the U.S. dollar reveals that basically we tend to consider the world of currencies to be the sum of two subsets, the U.S. dollar, which takes up all the slack, and the remaining currencies. Formally,

$$M_i^* = A\dot{\epsilon}^e + BW \qquad \text{for all i's}$$

$$M_i - M_{i_{-1}} = \lambda_{i,i}(M_i^* - M_{i_{-1}}) + \lambda_{i,USD}(M_{USD}^* - M_{USD_{-1}}), \quad i \neq USD$$

$$M_{USD} - M_{USD_{-1}} \equiv \Delta W - \Sigma(M_i - M_{i_{-1}}), \quad i \neq USD$$

where $\dot{\epsilon}^e$ indicates the vector of expected changes in the exchange rate
$W = \Sigma M_i$, all i.
A is a 4 x 4 symmetric matrix will all columns adding up to zero,
B is a vector of weights adding up to one, and
$\lambda_{i,i}$ and $\lambda_{i,USD}$ are the speeds of adjustment with respect to the difference between actual and desired values of the own and of the USD stocks.

1/ Usually $\dot{\epsilon}^e$ is assumed to be given by the interest rate differential.

APPENDIX

Results are the following (t-statistics in parentheses): 1/

$$\begin{vmatrix} M^*_{USD} \\ M^*_{DM} \\ M^*_{JY} \\ M^*_{BP} \end{vmatrix} = \begin{vmatrix} 0.697 & -0.166 & -0.489 & -0.041 \\ (1.22) & (1.17) & (1.17) & (1.66) \\ & 0.016 & 0.160 & -0.009 \\ & (0.33) & (1.51) & (0.43) \\ & & 0.351 & -0.021 \\ & & (1.13) & (0.80) \\ & & & 0.072 \\ & & & (2.83) \end{vmatrix} \begin{vmatrix} 0 \text{ 2/} \\ \dot{\epsilon}^e_{DM,USD} \\ \dot{\epsilon}^e_{JY,USD} \\ \dot{\epsilon}^e_{BP,USD} \end{vmatrix} + \begin{vmatrix} 0.370 \\ (3.12) \\ 0.156 \\ (5.23) \\ 0.401 \\ (4.60) \\ 0.073 \\ (13.19) \end{vmatrix} W$$

$\lambda_{DM,DM} = 0.482$ (9.64) $\quad \lambda_{JY,JY} = 0.721$ (7.63) $\quad \lambda_{BP,BP} = 0.151$ (3.37)

$\lambda_{DM,USD} = 0.118$ (7.04) $\quad \lambda_{JY,USD} = 0.506$ (5.93) $\quad \lambda_{BP,USD} = -0.002$ (0.37)

By focussing on the A matrix we notice that one elasticity out of ten is significant by conventional standards, three t-statistics are less than 1.0, while the remaining ones tend to fall into the 1.15-1.65 interval. Own and cross elasticities are all positive and negative, as theory suggests, except for the DM-JY case where complementarity seems to dominate. 3/ The B and λ values seem to be reasonable and significant; it is only in the case of the British pound that the gap between desired and actual U.S. dollars does not seem to affect the adjustment process and the own adjustment parameter appears to be on the low side. 4/

1/ Money is expressed in real U.S. dollars, a weighted average of the four GNP deflators is used to deflate nominal money balances, which are also centered on mid-period. The reader will notice that the program we have used estimates both the parameters and the constraints.

2/ Here we should be careful to distinguish between mathematics and economics. 0 replaces the variable $\dot{\epsilon}^e_{USD,USD}$.

3/ This partially contradicts previous results by Brillembourg/Schadler, who obtained a positive cross-elasticity between the U.S. dollar and the deutsche mark.

4/ The reader might wonder about the relative values of b_{USD} and b_{JY}. The fact that they appear to be off-the-mark is due to the particular behavior over time of the two stocks; the real per capita stock of U.S. dollars is a declining function of time (297,565 in 1967:I, 281,451 in 1981:IV) while the stock of yen has been growing rapidly (54,384 and 212,564). Given the purpose of the exercise we thought there was no need to take care of the problem.

APPENDIX

This effort has yielded another piece of evidence supporting the conclusion, given in the text, that while there is some currency substitution, it is also the case that we should not overstate its quantitative consequences on the demand for individual currencies. To stress this we have computed some elasticity values that are implied by our results: 1/

USD-DM : -0.019

USD-JY : -0.004

USD-BP : -0.004

DM-JY : +0.006

JY-JY : -0.005

BP-BP : +0.062

They are so low that they speak for themselves.

1/ Computation was limited to the cases where a t-statistic greater than one was obtained. Elasticities are defined as $d \log M_i^* / d \varepsilon_{i,j}^e$.

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