Gold, Dollars, Euro-Dollars, and the World Money Stock under Fixed Exchange Rates

By ALEXANDER K. SWOBODA*

In a rapidly inflating domestic economy, explanation of the inflationary process must of necessity focus on the determinants of the money supply. By analogy, in a closely integrated world economy under fixed exchange rates the behavior of the sum of individual countries' money stocks—the "world money stock"—should play an important role in determining the behavior of the "world price level" (an index of national price levels). This is recognized in analytical models of the international monetarist variety where, under the assumption that all goods are traded (or more generally that relative prices are not affected in the long run by monetary disturbances), the world price level adjusts to equate the world demand for money with the supply.

Strictly fixed *exchange rates* imply that national money stocks can be treated as components of a Hicksian composite commodity, the world money stock, since exchange-stabilization operations prevent variations in the relative values of national currencies. Closely integrated *capital markets* insure that the world money stock is redistributed rapidly from country to country in response to payments disequilibria of monetary origin, thus ensuring a tendency towards rapid return to *balance-of-payments equilibrium* (which can, of course be frustrated by systematic attempts at neutralization of reserve flows). Closely integrated *goods markets* insure that the *price levels* of various countries move in harmony—abstracting of course, from divergent trends in productivity and/or tastes that may cause changes in relative prices, including both the terms of trade and the ratio of the price of nontraded to traded goods. In such a world, one can view the world stock of money as determining the world price of a composite commodity, the components of which are national output levels. Though far too simple for many purposes, this Humean or Ricardian view of the world economy is instructive in periods dominated by disturbances of monetary origin.

For this type of analysis to be complete, however, the question of what determines the supply of money in the world must be answered. This paper seeks to answer this question within the confines of a conceptually (though not necessarily algebraically) very simple model. The world is assumed to be divided into two parts, Europe and the United States. National money stocks consist of commercial bank liabilities only, and the world money stock is defined as the sum of the money balances held by the public of each country.[1] Various institutional arrangements are considered, including a gold standard, a dollar standard, and the Euro-dollar system. The model provides a first answer to such questions as: does it make any difference to inflation whether monetary expansion originates in one region or the other; what asymmetries does a dollar standard introduce into the international monetary system; what determines the size of the Euro-dollar market and in what sense, if any, is its growth inflationary?

Two key assumptions are used to answer these questions, namely, 1) that reserve

*Professor of international economics, Graduate Institute of International Studies, Geneva, and visiting professor of economics, Harvard University. The original version of this paper was prepared for the Money Study Group's Oxford Seminar in honor of James Meade, September 25–27, 1974. It includes material developed in connection with a research project on "National Economic Policy and the International Monetary System" at the Graduate Institute of International Studies under a grant from the Ford Foundation.

[1] To sum national money stocks, they must of course be expressed in terms of the same currency, existing fixed exchange rates providing the required conversion factor.

flows take place until balance-of-payments equilibrium is reestablished and 2) that payments equilibrium requires that the money stocks of the two regions stand in given proportion to each other. These assumptions are not arbitrary. They underlie the Hume-Senior-Ricardo demonstration that the natural distribution of specie (here the natural distribution of the world money stock) tends to assert itself through the specie flow (here the reserve flow) mechanism. With these assumptions it is possible to analyze the world money supply process under fixed exchange rates in a manner that is strictly analogous to the analysis of closed-economy monetary systems characterized by various stable asset-preference ratios. The model thus integrates, in simplified fashion to be sure, the money supply analysis pioneered by James Meade (1934) with balance-of-payments theory to which he has contributed so much.[2]

It should be evident that the two assumptions above are particularly useful when analyzing a world of strictly fixed exchange rates where spot rates are not expected to change and are equal to forward rates. The present paper is confined to this case on several grounds. In the first place, this is not a bad assumption to make when interpreting, in broad and global terms, the evolution of the international monetary system until the breakdown of the "Bretton Woods system." Second, the analysis developed below should help throw light on the issues involved in designing a fixed exchange rate system, should the world return to such a system; furthermore, it remains relevant to the extent that managed floating retains elements of fixed rates and that holdings of foreign-currency assets by the public and authorities introduce elements of interdependence among national banking systems even under formally floating exchange rates.[3] Be that as it may, the virtue of the procedure adopted in this paper is that it makes possible the analysis of problems that have not been solved satisfactorily hitherto. For instance, the determinants of the base of Euro-dollar expansion are usually assumed to consist of exogenously determined flows of deposits to that market, these flows depending in turn, in the more sophisticated existing analyses, on exogenously given payments disequilibria. In the present paper these flows are made endogenous. The only exogenous variables are the quantities of domestic assets of central banks (these are policy variables) and the world stock of outside assets (gold).

The analysis begins with the discussion of a simple gold standard model and of a number of key assumptions. A more general model is then presented; its complexity motivates the procedure adopted in subsequent sections of discussing specialized versions of the basic general model. These versions include the dollar standard and introduce the Euro-dollar market. The role of neutralization operations is emphasized throughout and the importance of institutional arrangements for the effectiveness of monetary policy is illustrated with a number of numerical examples in Section V. For instance, on not entirely unlikely assumptions as to the magnitudes of behavior parameters, a \$1 open-market purchase of securities in the United States increases the world money stock by some \$5.9, whereas an equivalent purchase originating in the rest of the world increases the world money stock by only some \$3.5. If the United States neutralizes all reserve flows, these figures are changed to 10 and 0, respectively. The concluding section of the paper discusses a number of implica-

[2]Money supply analysis of the multiplier variety has since become a standard feature of textbooks in money and banking: for some of the main contributions to its development see, among others, Philip Cagan, Milton Friedman and Anna Schwartz, and Karl Brunner and Alan Meltzer. The *locus classicus* of Meade's contribution to balance-of-payments theory is of course his *The Balance of Payments.*

[3]Analysis of such interdependence can, however, become quite complex. The determinants of the demand for foreign-currency holdings are not easy to specify and much depends on the specific assumptions made as to the *modus operandi* of foreign-exchange intervention by central banks. There are, however, some obvious extensions of the analysis of Section IV below; these are left to the reader.

tions of the analysis.[4] For convenience, a list of symbols and of the main behavioral relationships and balance sheet identities is provided in the Appendix.

I. The World Money Stock under a Gold Standard

The world is assumed to consist of two countries, the United States (country 1) and Europe (country 2). Variables pertaining to Europe are identified by an asterisk. The exchange rate between the two currencies is assumed to be strictly fixed (both spot and forward), without margins, and is assumed for convenience to be equal to 1. This allows us to reckon all amounts in dollars.[5] The world money stock is defined as the sum of the money supplies *in the hands of the public* resident in each country.[6] Commercial bank liabilities are the only type of money held by the public. No distinction is made between demand and time deposits. Commercial banks hold a fixed ratio of reserves against their deposit liabilities. We thus neglect the effect of a change in money supplies on interest rates and the feedback to desired reserve ratios; this is not a serious defect from our point of view since the qualitative results hold under variable interest rates as long as the latter are stable functions of money supplies and as long as reserve ratios are stable functions of interest rates.

The method of analysis is that of comparative statics. An initial equilibrium is disturbed by a change in an exogenous variable or by an autonomous shift in a behavior parameter, and the new equilibrium is compared with the initial one. There are three exogenous variables in the system—two policy variables, namely, the domestic assets held by the United States (A) and the European (A^*) central banks and a "nature-given" variable, the world stock of gold (G). Behavior parameters reflect desired or compulsory reserve ratios of commercial banks, and asset preferences of the public. An increase in A represents an expansionary monetary policy by the *U.S.* central bank, that is, an open-market purchase of securities: an increase in A^* represents a similar policy by the European central bank. Endogenous variables include the world money stock, its distribution among the residents of the two countries, and the distribution of foreign-exchange reserves among the two central banks.

Equilibrium is defined by equality of the demand and supply of money in each country and by payments equilibrium. In the simple static models of this paper equilibrium obtains when the asset preferences of the public are satisfied and the world money stock has been distributed among the residents of the two countries in the proportion required for payments equilibrium. This proportion is assumed to be fixed and is denoted by β (to be discussed in the next paragraphs). Endogeneity of foreign-exchange reserves makes attainment of this equilibrium proportion possible; the implicit dynamic mechanism of adjustment is that reserves flow until the distribution of the world money stock compatible with payments equilibrium has been reached.

As the existence of such an equilibrium distribution of the world money stock is crucial to the analysis, a brief discussion of its meaning is in order here: β is defined as the ratio of the first country's money stock to the world money stock. In equilibrium the demand for money is equal to the supply in both countries. Algebraically, equations (1), (2), and (3) below define, respectively, the

[4] I have made use of a similar general analytic technique in a previous paper. That paper, however, suppresses the algebra made explicit in the present one and addresses itself to a separate though related set of questions. In a recent paper, Hans Genberg and I have estimated a simple, simultaneous two-region model of worldwide inflation under the dollar standard for the period 1957–71. This model which contains a rudimentary world money supply process confirms the asymmetries noted in the present paper, and offers some evidence as to the process of adjustment from short to long run.

[5] For some purposes, notably the analysis of devaluation, the exchange rate can easily be introduced in the formulae developed below.

[6] Holdings of foreign-currency denominated money by the public are ignored in this section. One special form of such holdings, Euro-dollar deposits of the European public, is discussed in subsequent sections.

equality of the demand and supply of money in countries 1 and 2, and the equilibrium distribution β of the world money stock:

$$(1) \quad M = L(Y,i)\cdot P$$

$$(2) \quad M^* = L^*(Y^*,i^*)\cdot P^*$$

$$(3) \quad \beta = \frac{M}{M_w} = \frac{M}{M + M^*} = \frac{L(Y,i)\cdot P}{L(Y,i)\cdot P + L^*(Y^*,i^*)\cdot P^*}$$

where M is the money stock, L is the demand for money, Y is output, i is the rate of interest, and P the price level. The subscript w identifies world variables.

It is obvious that in the equilibrium of a classical static world where Y, Y^*, i, i^* are given and where P and P^* are equalized through trade (or change in proportion in the absence of long-run changes in relative prices) β can take on one and only one value (the world price level adjusts to changes in the world money stock). More generally, however, it can be shown that β will, for a large class of models, be invariant to the origin of money supply disturbances and that it will either be invariant with respect to a change in M_w or be systematically and predictably related to such a change. Differentiating (3) and denoting percentage changes in a variable by capping it with a hat, one obtains:

$$(4) \quad \hat{\beta} = (1 - \beta)\{(\eta_{LY}\hat{Y} - \eta^*_{L^*Y^*}\hat{Y}^*) + (\eta_{Li}\hat{i} - \eta^*_{L^*i^*}\hat{i}^*) + (\hat{P} - \hat{P}^*)\}$$

where η_{yx} denotes the elasticity of y with respect to x. In a fixed price two-country model of the Keynesian variety, it can be shown that β will still be independent of the national origin of a world money stock change.[7] In addition $\hat{Y} = \hat{Y}^*$ if the income elasticity of the demand for imports is unity in both countries and payments equilibrium requires that $\hat{i} = \hat{i}^*$ (if capital flows are a function of the ratio of interest rates). In these circumstances, β does not change in response to a change in the world money stock if the income and interest elasticities of the demand for money are the same across countries. Otherwise, an expansion of the world money stock will raise β if $\eta_{LY} > \eta^*_{L^*Y^*}$ and if $\eta_{Li} < \eta^*_{L^*i^*}$.

In what follows, it will be assumed for simplicity that, in equilibrium, β can be treated as exogenous, its long-term changes being governed by such factors as different rates of growth of income and productivity across countries and sectors. Such changes in β due to changes of nonmonetary origin occur continuously in the real world but will be abstracted from in this paper.[8] Of course, β will only be established in the long run, that is, after complete payments adjustment has taken place. At any point in time, the actual value of β is subject to short-run changes due to variations in monetary policy. It tends back to its initial equilibrium through a complex adjustment mechanism which involves reserve flows, changes in the world and national money stock, and variations in interest rates, prices, and income levels. The relevance of the analysis depends partly on the speed of that adjustment mechanism—which is likely to be quite rapid in a world of integrated goods and capital markets.[9]

With these assumptions, analysis of the determinants of the world money stock is straightforward. Consider, first, a version of the gold standard. The only international

[7] This is demonstrated, and is shown to hold independently of the degree of capital mobility, in the author and Dornbusch.

[8] This need not be a cause of great concern here since 1) the purpose of the analysis is to trace the consequences of various institutional arrangements for disturbances of monetary origin, 2) adjustment in an integrated world economy tends to be fairly rapid in chronological time as noted in the introduction, 3) the consequences of a change in β due to changes in relative prices or differential growth rates can be readily traced, 4) the analysis is designed, in part, to illuminate adjustment in times dominated by disturbances originating on the supply side of the monetary process.

[9] Empirical evidence on the speed of adjustment is provided in Genberg and the author. The mean time lag of the adjustment of β to its equilibrium value is estimated to be two quarters in a simple simultaneous two-region model of the industrialized world for the period 1957–71, which incorporates a rudimentary world money supply process.

reserve asset held by central banks is gold, the world stock of which is assumed to be given exogenously. In the particular version of the gold standard that follows, it is assumed that central banks do not keep a fixed ratio of gold to the national money stock. Instead, they exercise a certain amount of policy independence by engaging in open-market purchases and sales of domestic assets.[10] The structure of the system is given in the balance sheets below.

United States

Fed		Commercial Banks	
Assets	Liabilities	Assets	Liabilities
A	R	R	M
αG		L_l	

Europe

European Central Bank		Commercial Banks	
Assets	Liabilities	Assets	Liabilities
A^*	R^*	R^*	M^*
$(1-\alpha)G$		L_l^*	

In addition to the symbols already defined above, R represents commercial bank reserves with their central bank, L_l loans and investments of commercial banks, and α the proportion of the world's gold stock G, held by the *U.S.* central bank (the Fed). Note that α is an *endogenous* variable. Three further definitions are required:

$$(5) \qquad r = \frac{R}{M} = \frac{1}{m}$$

$$(6) \qquad r^* = \frac{R^*}{M^*} = \frac{1}{m^*}$$

$$(7) \qquad \beta = \frac{M}{M_w} = \frac{M}{M + M^*}$$

$$= \frac{m(A + \alpha G)}{mA + m^*A^* + m^*G + (m - m^*)\alpha G}$$

[10]That independence is, obviously, limited by the requirement that gold holdings be positive. Other versions of the gold standard can readily be worked out. For instance, one could easily develop a model in which national money supplies are, in the long run, proportional to central banks' holdings of gold and where central banks' portfolios of domestic assets are varied according to some stock adjustment rule towards that proportion in the short run.

Equations (5) and (6) define the reserve ratios of the two commercial banking systems (assumed to be fixed and equal by definition to the inverse of the national money supply multipliers m and m^*). Equation (7) restates the definition of β, the equilibrium distribution of the world money stock.

Suppose that the Fed carries out an expansionary open-market operation, increasing A by dA. The *impact* effect is to increase M, and hence M_w, by mdA. This is not the end of the story, however, since, other things equal, the open-market operation has created an excess supply of money in the United States. That country experiences a payments deficit; as a consequence gold flows to Europe, increasing the money supply there and decreasing it in the United States. To obtain the *final* effect on the world money stock and other variables after reserve flows have restored payments equilibrium, it is convenient to solve for M_w in terms of exogenous variables and behavior parameters to yield:[11]

$$(8) \qquad M_w = \frac{A + A^* + G}{r\beta + r^*(1 - \beta)}$$

A number of important conclusions are immediately apparent from this expression. First, and most important, the effect on the world money supply of an equal size increase in A, A^*, or G is exactly the same: the final effect on M_w of an increase in "base money" is independent of its national origin. A "world money base" $(A + A^* + G)$ can meaningfully be defined. There is a basic symmetry in a gold standard system which insures that an open-market operation has the same effect on the world money stock—and, hence, on the world level of economic activity or prices—wherever it originates. Redistribution of gold through the payments adjustment mechanism insures that monetary policy becomes internationalized in symmetric fashion. Second, the "world money multiplier" (1 over the denominator on the right-hand side of equation (8)) is a weighted

[11]The derivation of expression (8) is given in fn. 26.

TABLE 1

	General Case	Equal Reserve Ratios $\left(r = r^* = \frac{1}{m} = \frac{1}{m^*}\right)$	Neutralization by Country 1	
$\frac{dM_w}{dA} = \frac{dM_w}{dA^*}$	$\frac{1}{r\beta + r^*(1-\beta)}$	m	$\frac{dM_w}{d\bar{B}} = \frac{m}{\beta}$	$\frac{dM_w}{dA^*} = 0$
$\frac{dM}{dA} = \frac{dM}{dA^*}$	$\frac{\beta}{r\beta + r^*(1-\beta)}$	$m\beta$	$\frac{dM}{d\bar{B}} = m$	$\frac{dM}{dA^*} = 0$
$\frac{dM^*}{dA} = \frac{dM^*}{dA^*}$	$\frac{(1-\beta)}{r\beta + r^*(1-\beta)}$	$m(1-\beta)$	$\frac{dM^*}{d\bar{B}} = \frac{(1-\beta)}{\beta} m$	$\frac{dM^*}{dA^*} = 0$
$\frac{dIR^*}{dA}$	$\frac{r^*(1-\beta)}{r\beta + r^*(1-\beta)}$	$(1-\beta)$	$\frac{dIR^*}{d\bar{B}} = \frac{(1-\beta)}{\beta}$	
$\frac{dIR^*}{dA^*}$	$\frac{-r\beta}{r\beta + r^*(1-\beta)}$	$-\beta$		$\frac{dIR^*}{dA^*} = -1$

average of national money multipliers, the weights being the relative economic sizes of the two countries, β and $(1-\beta)$. This result appeals to common sense. Suppose the United States to be very large relative to Europe: β tends towards 1. Any open-market operation will tend to change mainly the money supply of the United States and hence its multiplier should dominate.

The symmetry noted above as well as the role of size is brought out very clearly in Table 1, which lists the effects of a change in A and A^* on M, M^*, M_w, and on IR^*, the stock of international reserves held by country 2, here gold. The first column of the table gives results for the general case, the second for the special case where the money multipliers are the same in the two countries and the common multiplier and reserve ratio are denoted by m and r, respectively (ignore the third column for the moment).

Equality of dM_w/dA and dM_w/dA^* is the one conclusion from which all other results in Table 1 follow. This equality obtains even if domestic money multipliers differ. Suppose, for instance, that $m^* > m$. A European open-market purchase of securities dA^* increases the world money stock by more than a corresponding purchase in the United States dA, *before* reserves flow (at impact). But, when A^* increases, Europe experiences a payments deficit that reduces Europe's money supply by more than it increases America's, and vice versa when A increases. This is why $dM_w/dA = dM_w/dA^*$ even if $m \neq m^*$. It immediately follows that the *final* effect of an open-market operation on individual national money stocks (M and M^*) is independent of its origin; for, the given change in the world money stock is distributed among countries 1 and 2 in the fixed proportions β and $1-\beta$, respectively, that is, in proportion to their relative economic size. Reserve changes are also proportional to size, but depend in addition on money multipliers when the latter differ. The higher r (given r^*) and the lower r^* (given r), the smaller will be the *U.S.* reserve loss attendant on an American open-market purchase of securities of given size: a high r reduces the initial excess supply of money created by dA and a lower r^* implies that a small redistribution of *reserves* towards Europe suffices to produce a large increase in the European *money supply.* For similar reasons, the higher r^* (given r) and the lower r (given r^*), the smaller will be the European reserve loss attendant upon expansionary European monetary policy.

The role of size is highlighted by considering the case where money multipliers are equal. Open-market purchases of securities increase the domestic money supply in proportion to the country's relative economic size. They cause reserve losses that are inversely proportional to the country's relative economic size. Consider the special case where Europe becomes negligibly small relative to the United States, that is, β tends towards unity. A European open-market purchase (sale) results in an equal loss (gain) of foreign-exchange reserves. As a corollary, a European open-market operation fails to affect the money supply of a sufficiently small Europe. The explanation is simple: an open-market operation becomes generalized and serves to increase the world money supply—the small country only retaining (or receiving) its infinitesimally small share of the total change. Our model thus demonstrates, in slightly different guise, the standard conclusion of analyses of the small open economy, namely, that, except in the short run, the monetary authorities of such economies have no control over the national money stock, an open-market sale or purchase resulting in a countervailing reserve loss. How short the short run is, is, of course, of crucial importance for the conduct of monetary policy. For a very small open economy, in a world of closely integrated goods and capital markets, it is likely to be quite short in chronological time.[12]

Neutralization operations by the monetary authorities in one country effectively reduce the role of monetary policy in the other to what it would be were that other country infinitesimally small. Suppose that the United States buys (sells) an equivalent amount of securities in the open market whenever it loses (gains) gold. Consider the effect of an open-market purchase of securities by the European central bank under this assumption. The increase in A^* results initially in an increase in M^* and an outflow of gold to the United States. American authorities, however, prevent this reserve gain from affecting the *U.S.* money supply by decreasing A in step. A new equilibrium is reached when A has decreased by the same amount as A^* initially increased, and Europe has lost an equivalent amount of gold to the United States. Formally, neutralization can be modelled by letting $\overline{B} = A + \alpha G$, where $\overline{B}$ is the level at which the *U.S.* monetary authorities maintain the monetary base. This implies that A becomes an endogenous variable and that $dA = -d\alpha G$. The reserves of the *U.S.* commercial banking system are kept equal to $\overline{B}$, and the world money supply formula (8), for the case where $m = m^*$ becomes:

$$(8') \qquad M_w = \frac{m}{\beta} \cdot \overline{B}$$

In equilibrium, the world money stock is determined entirely by the level at which the neutralizing authorities choose to keep their money stock ($m\overline{B}$) together with the latter's share in the world money supply, that is, by the neutralizing country's relative economic size. The last column of Table 1 lists results for the case where the United States neutralizes reserve flows and confirms the conclusion that neutralization by the United States confines European open-market operations to effecting offsetting reserve flows and robs them of any effect on the European money stock.[13] In contrast, the *U.S.* monetary policy becomes quite powerful. An increase in the *autonomous* component $\overline{B}$ of domestic assets held by the Fed raises the world money stock by the American domestic money multiplier

[12] Both analytical and empirical reasons underlie the statement in the text. For empirical evidence on high though not unitary offset coefficients, see, for instance, Pentti Kouri and Michael Porter. In Genberg and the author, it is estimated that it took an average of two years during the 1957–71 period for monetary policy in the non-*U.S.* industrialized world as a whole to be completely offset by flows of international reserves when the United States pursued a policy of neutralizing foreign influences on the American monetary base. This is not to deny that even a small country can maintain for some time a money stock that implies a payments disequilibrium. The required neutralization operations, however, are likely to become extremely large and unsustainable in practice in a world of integrated goods and capital markets, if the policy is pursued systematically over time unless it is designed to smooth out short-run variations in the demand and supply of money that tend to cancel out over time (the cycle).

[13] The derivatives in the table have to be reinterpreted as being taken with respect to $d\overline{B}$ and not dA in the case of neutralization.

times $1/\beta$. The total increase in A is of course larger since the United States neutralizes the reserve loss attendant on an increase in $\bar{B}$.[14] The smaller the United States is relative to Europe, the larger will be the reserve loss, and hence, the required neutralization operation. The latter tends to infinity as the neutralizing country becomes negligibly small relative to the rest of the world. This is in accord with yet another standard result of theorizing about small open economies, namely, that neutralization becomes impossible when the mobility of capital is perfect. Here, however, it is not the *rate* of neutralization operations per unit of time but the absolute size of the neutralization operation compatible with full equilibrium that becomes infinite and this conclusion is established independently of the degree of capital mobility.[15]

The ability of countries to increase their money stock and to neutralize the resulting payments deficit does depend of course on the size of their stock of international reserves, and, under the gold standard, that stock is limited. Furthermore, both countries can play the neutralization game. If they do, monetary equilibrium in the world economy cannot obtain, except perchance. The return to equilibrium that would be brought about by the effect of redistribution of reserves on national money supplies after any monetary disturbance is resisted by both countries. Neither country is willing to accept the burden of international adjustment, payments imbalances become self-perpetuating, and the world economy enters what Robert Mundell has called "the international disequilibrium system."

II. A More General Model of World Money Stock Determination

The gold standard model set out above is a very special case of the more general one presented in this section. The gold standard model was analyzed in some detail since its very simplicity reveals clearly some of the features of world money stock analysis that underlie results derived from the more general model but whose essential movitation is hidden by the latter's greater complexity. A detailed description of the algebraic relationships that define the more general model is relegated to the Appendix as its structure can be grasped intuitively from a study of the balance sheet pattern it assumes and from a few words of explanation.

United States

Fed		Commercial Banks	
Assets	Liabilities	Assets	Liabilities
A	R	R	M'
αG	D^*	L_I	D_2^*
			DEB

Europe

European Central Bank		Commercial Banks	
Assets	Liabilities	Assets	Liabilities
A^*	R^*	R^*	M'^*
$(1-\alpha)G$		L_I^*	ED^*
D^*		DEB	ED
D_2^*			CED
CED			

This model differs from the gold standard one principally by recognizing that Europe's central bank can hold a variety of dollar assets as foreign-exchange reserves in addition to gold and by allowing for the existence of the Euro-dollar market. As six new types of asset holdings are introduced, six new behavior relationships (or equilibrium conditions) must be added to the preceding ones in order to obtain a determinate equilibrium value of the world money stock and of its distribution.

The European central bank can hold its foreign-exchange reserves in four forms: gold, $(1-\alpha)G$, as before; dollar deposits with the Fed, D^*; dollar deposits with *U.S.* commercial banks, D_2^*; dollar deposits in the Euro-dollar market, that is, with European commercial banks, CED. It is assumed that the European central bank

[14] As a matter of fact, $dA/d\bar{B} = 1/\beta$.

[15] Note, however, that the time required for the equilibrium distribution of the world money stock to assert itself does depend on the degree of capital mobility.

first decides which proportion of its total foreign-exchange reserves to keep in gold; that proportion is denoted by Ψ, $(1 - \Psi)$ denoting the proportion kept in dollars. Of the latter a proportion γ is kept in the Euro-dollar market. The remaining $(1 - \gamma)$ of dollar reserves is split between a proportion λ held with *U.S.* commercial banks and a proportion $(1 - \lambda)$ held with the Fed.

European commercial banks receive European currency deposits from European residents, as before. These are denoted by M'^*. In addition, they receive dollar deposits (Euro-dollar deposits) from three sources: ED from *U.S.* residents; ED^* from the European public; and CED from Europe's central bank. European commercial banks keep European currency reserves of R^* with their central bank, as a given proportion r^* of their European currency deposits M'^*. They keep dollar reserves of DEB with *U.S.* commercial banks, as a given proportion r_d of their total (Euro-) dollar liabilities. (For a discussion of r_d, see Section IV, below.)

American commercial banks, in addition to dollar deposits by residents M', receive dollar deposits from Europe's central bank and from its commercial banks. They keep reserves in a proportion r to their total deposits. The Fed incurs liabilities to both *U.S.* commercial banks and to the European central bank.

Finally, the public desires to keep a given proportionate relationship between its Euro-dollar and other deposits. American residents keep the ratio of their Euro-dollars (ED) to their total deposits ($M' + ED$) equal to ρ. Similarly, European residents keep a proportion Ω of their total deposits ($M'^* + ED^*$) in the form of Euro-dollar deposits (ED^*). The Euro-dollar deposits held by the nonbank residents of each country are counted as being part of the world money stock in the hands of the residents of that country. Thus, the money stock in the hands of the *U.S.* public is redefined as $M = M' + ED$, that in the hands of Europe's public as $M^* = M'^* + ED^*$, and the world money stock as $M_w = M + M^*$. It is assumed that the demand for M is proportionate to the level of economic activity in the United States, the demand for M^* to that in Europe, and hence, that M and M^* must stand in a relationship β to ensure payments equilibrium, as indicated below:[16]

$$(9) \quad M = \beta M_w = \beta(M + M^*) = \beta(M' + ED + M'^* + ED^*)$$

Keeping these assumptions in mind, it is possible to derive a reduced-form expression for the world money stock. The result for the general case where money multipliers are allowed to differ as between banking systems is quite complicated and is relegated to the Appendix. The already rather formidable result for the special case that abstracts from asymmetries due to differences in reserve ratios kept by commercial banks (i.e., set $r = r^* = r_d = 1/m$) is given below:

$$(10) \quad M_w = m[A + G + A^*\{1 - (1 - \Psi) \cdot [(1 - r)(1 - \gamma)\lambda + (1 - r^2)\gamma]\}] \div [\beta[1 - \rho(1 - r)] + (1 - \beta)\{r\Omega + (1 - \Omega)\{1 - (1 - \Psi)[(1 - r)(1 - \gamma)\lambda + (1 - r^2)\gamma]\}\}]$$

An examination of this expression suggests a number of conclusions that will be illustrated with the help of special cases in subsequent sections of this essay.

Most striking is the fact that the basic symmetry of the gold standard is lost in the more general case. This is evident from the fact that in general the effect of a change in A is different from that of a change in A^*, since the latter is postmultiplied by a constant in expression (10). The symmetry can be regained if either $\Psi = 1$, the gold standard case, or both λ and γ are zero, that is,

[16]Counting all Euro-dollar deposits held by the public as part of the world money supply is clearly inappropriate for some purposes. Moreover, the determinants of the "transactions" demand for Euro-dollars and for other deposits may, in fact, be quite different, in contradiction to what is assumed in our model. For instance, the demand for Euro-dollar deposits by European residents may be a function of the volume of trade or of *U.S.* economic activity and similar considerations may apply to the demand for Euro-dollar deposits by the *U.S.* nonbank public.

if Europe's central bank holds reserves neither with the *U.S.* nor with the European commercial banking system. This, as will become clear subsequently, gives us a clue to the basic reason for asymmetries in the system, namely, that what is low-powered money in one part of the system (for instance, deposits with commercial banks) serves as high-powered money in another part of the system (as part of the sources of the foreign-exchange component of the European monetary base).

Second, whatever their differential impact on the effects of open-market operations according to national origin, various patterns of asset preferences will impinge on the size of the multiplier effects of an open-market operation of given national origin. Differentiating, for instance, dM_w/dA with respect to various behavior parameters, one can trace out some of the effects of a change in the structure of asset preferences. An increase in Euro-dollar deposits reinforces the effect of *U.S.* open-market policy whether it originates in a switch by *U.S.* residents from dollars to Euro-dollars, in a switch by the European public, or in an increase in the European central bank's deposits. A switch by Europe's central bank from deposits with the Fed to deposits with *U.S.* commercial banks has similar effects as has a decrease in its gold holdings.

III. The Dollar Standard

To understand the origin of the asymmetries noted above, consider a pure dollar standard. That is, assume that the European central bank holds no gold and that there is no Euro-dollar market. This implies that $\Psi = r_d = \rho = \Omega = \gamma = 0$. Also assume for simplicity, as will be done in the remainder of the text, that all reserve ratios of commercial banks are equal. Under these simplifying assumptions, equation (10) becomes:

$$(11)\quad M_w = m \cdot \frac{A + A^*[1 - \lambda(1 - r)]}{\beta + (1 - \beta)[1 - \lambda(1 - r)]}$$

It is immediately apparent that λ, the proportion of dollar reserves held with the *U.S.* commercial banking system, has an important role to play. The higher λ the larger the world money supply multiplier applicable to an increase in A. With $\lambda = 0$, formula (11) becomes:

$$(12)\quad M_w = m \cdot \frac{A + A^*}{\beta + (1 - \beta)} = m(A + A^*)$$

This is exactly the same formula as the gold standard one when r is set equal to r^* and the gold stock is neglected. In other words, a dollar standard where the European central bank holds its reserves with the Fed operates, at least in some respects, exactly like the gold standard. The reason is simply that an open-market operation that leads to inflows or outflows of foreign-exchange reserves has the same impact on the reserves available to commercial banks in the two systems: an outflow of gold from the United States lowers the reserves of American commercial banks by lowering the sources of the money base; an outflow of dollars reduces *U.S.* commercial bank reserves by the increase in the European central bank's reserves (dD^*), given A.

With $\lambda = 1$, that is, when Europe's central bank holds all its reserves with *U.S.* commercial banks, formula (11) becomes:

$$(13)\quad M_w = \frac{mA + A^*}{\beta + r(1 - \beta)}$$

An important asymmetry is introduced since an open-market operation in the United States changes the world money stock by m times more than an equal-size open-market operation in Europe. Moreover, the absolute size of dM_w/dA is increased and that of dM_w/dA^* is decreased in comparison with the case where $\lambda = 0$. These asymmetries are explained by the fact that reserve holdings by the European central bank, D_2^*, are a source of the high-powered base of the European money supply while they compete with lower-powered money in the liabilities of the *U.S.* commercial banking system. The reserve outflow created by expansionary monetary policy in the United States diminishes the *U.S.* money stock by less than it increases

TABLE 2

	$\lambda = 0$	$\lambda = 1$
$\frac{dM_w}{dA}$	m	$\frac{m^2}{m\beta + (1 - \beta)}$
$\frac{dM_w}{dA^*}$	m	$\frac{m}{m\beta + (1 - \beta)}$
$\frac{dM}{dA}$	$m\beta$	$\frac{m^2\beta}{m\beta + (1 - \beta)}$
$\frac{dM}{dA^*}$	$m\beta$	$\frac{m\beta}{m\beta + (1 - \beta)}$
$\frac{dM^*}{dA}$	$m(1 - \beta)$	$\frac{m^2(1 - \beta)}{m\beta + (1 - \beta)}$
$\frac{dM^*}{dA^*}$	$m(1 - \beta)$	$\frac{m(1 - \beta)}{m\beta + (1 - \beta)}$
$\frac{dIR^*}{dA}$	$(1 - \beta)$	$\frac{m(1 - \beta)}{m\beta + (1 - \beta)}$
$\frac{dIR^*}{dA^*}$	$-\beta$	$\frac{-m\beta}{m\beta + (1 - \beta)}$

the European one, the redistribution of foreign-exchange reserves thus increasing the world money stock by $(m - 1)$ times the reserve flow.

The importance of the pattern of reserve holdings by Europe's central bank is illustrated in Table 2, which gives the effect of changes in A and A^* on various variables under the two extreme cases where $\lambda = 0$ and $\lambda = 1$. The $\lambda = 0$ column of this table contains the same elements as the second column of Table 1. This confirms the identity of this version of the dollar standard with the gold standard. The second column of Table 2 is equal to the first column multiplied by $m/(m\beta + (1 - \beta)) > 1$ for the derivatives with respect to A, and by $1/(m\beta + (1 - \beta)) < 1$ for the derivatives with respect to A^*, with the exception of dIR^*/dA^*, this last derivative being multiplied by $m/(m\beta + (1 - \beta))$. This confirms the conclusions reached above that the holding of Europe's foreign-exchange reserves with $U.S.$ commercial banks makes American monetary policy more effective (in the somewhat limited terms of "bang per buck" to be discussed further at the end of this section) and European monetary policy less effective. The counterpart to the loss of effectiveness of European open-market operations in terms of money supply changes is their increased impact on Europe's international reserves. This is a factually relevant conclusion as in practice European central banks have tended to keep few reserves with the Fed and a large proportion of their dollar reserves in $U.S.$ government securities, a custom that has similar effects analytically to keeping them with $U.S.$ commercial banks.

As a matter of fact, the practice of keeping European foreign-exchange reserves with the $U.S.$ commercial banking system is equivalent to sterilization of $(1 - r)$ of any reserve flow by the Fed. A European reserve gain deposited with $U.S.$ commercial banks diminishes the reserves available to those banks for backing of $U.S.$ resident held dollar balances by rD_2^* given A; had the reserves been deposited with the Fed, the fall in $U.S.$ commercial bank reserves would have been equal to the European gain of foreign-exchange reserves.[17] In other words, the effect on the world money supply of a European reserve gain of one dollar deposited with $U.S.$ commercial banks is the same as that of a one dollar reserve gain deposited with the Fed, $(1 - r)$ of which is neutralized. When Europe's central bank holds its reserves in $U.S.$ Treasury Bills, a European payments surplus exerts no contractionary effect on the $U.S.$ money supply. The money initially lost by the United States is put back into circulation when Europe buys $U.S.$ Treasury Bills. Europe, in effect, performs open-market operations in the United States and neutralizes, as it were, on the Fed's behalf.[18]

[17] It is easily shown that when the Fed neutralizes the D^* but not the D_2^* component of reserve flows, the world money supply formula becomes

$$M_w = m \cdot \frac{\bar{B} + \lambda r A^*}{\beta + (1 - \beta)\lambda r}$$

[18] This result holds, strictly, only in the case of perfect capital mobility (perfect substitutability of $U.S.$ and European bonds). Consider an open-market purchase of European bonds by the European central

One may question the relevance of a discussion of the effectiveness of monetary policy in terms of the partial derivative of the world money stock with respect to open-market operations on the grounds (a) that monetary authorities are interested in the national and not the world money stock, and (b) that reduced effectiveness can be compensated by a higher dose of open-market operations. In the model, however, any change in effectiveness with respect to M_w immediately translates into a similar change with respect to M and M^* given β. Second, though bang per buck of open-market operation may not be a matter of great concern in the closed economy, it is a relevant concern for the policymaker in a fixed exchange rate open economy with a finite stock of international reserves (or of domestic assets). For, other things equal, the less "effective" an open-market operation in terms of domestic and world money stocks, the greater will be the loss of international reserves associated with expansionary purchases of bonds.

The final and related point to be made in this section concerns one additional difference between the gold and dollar standards: whereas the given world stock of gold puts a limit on the extent of *U.S.* monetary expansion compatible with maintenance of the system, no such limit exists, in theory, in the case of the dollar standard.

IV. The Euro-Dollar Market

In the preceding section, no allowance was made for the existence of the Euro-dollar market. The latter impinges on the general model's results in four ways: European residents want to hold a proportion Ω of their money balances as dollar deposits with European commercial banks; *U.S.* residents, likewise, want to keep a proportion ρ of their money holdings with European commercial banks; the European central bank keeps γ of its dollar reserves in the Euro-dollar market; and European commercial banks keep dollar reserves with *U.S.* commercial banks as a fraction r_d of their total dollar deposits.

This last assumption is admittedly *ad hoc*, but so is any assumption of fixed reserve ratios even when minimum ratios are set by law. The assumption can be justified in broad terms on both theoretical and factual grounds. In the first place, European banks do keep demand and time deposits in New York and their volume has been increasing together with the volume of Euro-dollar business though it is impossible to apportion the increase in deposits into reserves against Euro-dollar deposits, regular working balances, etc. Second, some observers and participants in the Euro-dollar market have argued that maturities of assets and liabilities were closely matched, currency by currency, in the Euro-currency market and that little, if any, of the assets would be held in lower-yielding instruments in New York. Though this may be true of interbank deposits within Europe it will not hold for liabilities to and assets on nonbank institutions or the United States, the only net positions appearing in the consolidated balance sheets of this paper, intra-European interbank deposits having been netted out in the balance sheet consolidation process. Holding of reserves in New York against liabilities to nonbanks seems a sensible and prudent practice. Finally, and this is a related point, traditional banking analysis suggests that an individual bank will choose to hold a positive level of reserves even in an unregulated system. Voluntary reserve holdings are a simple consequence of maximization of expected returns in the face of rising costs of illiquidity and a stochastic supply of deposits to the bank; the holding of excess reserves is

bank. That bank will have to sell dollar bonds to acquire back its own currency now in excess supply on the foreign-exchange market. In the end, the total amount of bonds outstanding will be the same, the authorities having swapped *U.S.* bonds against European bonds with the public. If the two types of bonds are not perfect substitutes, however, portfolio equilibrium in terms of stocks would imply a fall in the interest rate on European securities and a rise in the rate on dollar assets. As a result, β would tend to fall and the world and European money supply to rise.

indirect evidence for this thesis. As Euro-dollar deposits and withdrawals are typically settled by the transfer of claims on New York banks, the latter constitute the natural reserve instrument for Euro-banks. Though in fact r_d may be less stable than other reserve ratios, it will be assumed to be given here; consequences of its variation can, however, be easily traced in the model.

To analyze the impact of the Euro-dollar market on the world money supply process, it will be convenient to examine three special cases. The Euro-dollar market is grafted in turn on a gold standard, a dollar standard with $\lambda = 0$, and a dollar standard with $\lambda = 1$. We assume for simplicity that $r_d = r = r^*$.[19]

Grafting the Euro-dollar market onto the gold standard implies setting $\Psi = 1$ (the European central bank keeps only gold reserves) in formula (10) above to yield:

$$(14)\quad M_w = m[A + G + A^*] \div [\beta[1 - \rho \cdot (1 - r)] + (1 - \beta)[1 - \Omega(1 - r)]]$$

Expression (14) indicates that the system is still symmetrical with respect to equal changes in the various components of the base (A, A^*, and G). The reason is that reserve flows set in motion increases in the supply of money in the hands of residents of the surplus country that are exactly offset by decreases in the deficit country. The world money supply multiplier, however, is larger than what it would be without a Euro-dollar market. The reason is simply that European commercial banks keep reserves against their Euro-dollar deposits with *U.S. commercial* banks and not with a central bank. Again, what is high-powered money in Europe (*DEB*) is low-powered money from the point of view of the *U.S.* banking system.

Consider now the second special case mentioned above by setting $\Psi = 0$ and $\lambda = 0$. The resulting reduced-form equation for M_w is

$$(15)\quad M_w = m \cdot [A + A^*\{1 - (1 - r^2)\gamma\}] \div [\beta[1 - \rho(1 - r)] + (1 - \beta) \cdot \{r\Omega + (1 - \Omega)[1 - (1 - r^2)\gamma]\}]$$

Central bank holdings of dollars in the Euro-dollar market, in a proportion γ to their dollar holdings with the Fed, introduce a new dimension into the system. Asymmetries arise and dM_w/dA increases while the derivative of M_w with respect to A^* decreases. The explanation again arises from the fact that a loss of foreign-exchange reserves by the United States creates a smaller decrease in commercial bank reserves there than an equal gain of foreign-exchange reserves expands commercial bank reserves in Europe. As the European central bank's foreign-exchange reserves expand, part of the gain is deposited in European commercial banks, which in turn redeposit a fraction r_d of this increase in their dollar liabilities (*CED*) with *U.S.* commercial banks.

A further multiplicative element is added when the European *central* bank keeps a fraction λ of its foreign exchange reserves with *U.S.* commercial banks. For the case where $\lambda = 1$, the reduced-form equation for M_w becomes:

$$(16)\quad M_w = m \cdot [A + A^*\{1 - [(1 - r) \cdot (1 - \gamma) + (1 - r^2)\gamma]\}] \div [\beta[1 - \rho \cdot (1 - r)] + (1 - \beta)\{r\Omega + (1 - \Omega) \cdot \{1 - [(1 - r)(1 - \gamma) + (1 - r^2)\gamma]\}\}]$$

Positive official dollar holdings with *U.S.* commercial banks D_2^* adds a multiplier effect that is similar to that described for the special case $\lambda = 1$ in the section discussing the dollar standard.[20]

In conclusion, a switch from traditional national currency holdings to Euro-dollar deposits, be it by the European public, the *U.S.* public, or the European central bank, tends to expand the world money supply,

[19] The assumption that r_d is equal to the other two reserve ratios is purely a matter of convenience. If it is, as is perhaps likely, lower than either r or r^*, the analysis can be carried out without important qualitative changes with the help of the general reduced form for the world money stock given in the Appendix.

[20] When the Fed neutralizes all reserve flows, the world money supply becomes $M_w = m\bar{B}/\beta(1 - \rho)$.

TABLE 3

	$\frac{dM_w}{dA}$	$\frac{dM_w}{dA^*}$	$\frac{dIR^*}{dA}$	$\frac{dIR^*}{dA^*}$
Pure gold or dollar standard				
1. $\lambda = \rho = \Omega = \gamma = 0$	4(8)	4(0)	.5(1)	−.5(−1)
Pure dollar standard				
2. $\lambda = .5, \Psi = \Omega = \rho = \gamma = 0$	4.9(7.1)	3.1(.89)	.62(.89)	−.62(−.89)
3. except $\lambda = .8$	5.7(6.7)	2.3(1.3)	.71(.83)	−.71(−.83)
4. except $\lambda = 1$	6.4(6.4)	1.6(1.6)	.8(.8)	−.8(−.8)
Euro-dollars and gold standard				
5. $\Psi = 1, \gamma = 0$	4.8	4.8	.45	−.55
Euro-dollars and dollar standard				
6. $\lambda = 0, \Psi = 0$	5.3	4.3	.49	−.60
7. except $\lambda = 1$	7.5	1.6	.70	−.85
General case				
8. See note (a)	5.9(10)	3.5(0)	.55(.94)	−.67(−1)

Notes: (a) Unless otherwise indicated assumed values of behavior parameters are as follows: $\beta = .5$, $r = .25$, $\Psi = .4$, $\lambda = .8$, $\Omega = .25$, $\gamma = .2$, $\rho = .2$.

(b) Numbers in parentheses indicate results for the case of neutralization. In rows 1 and 8 all reserve flows are neutralized, in rows 2, 3, and 4, only European dollar reserves held at the Fed are neutralized. The derivatives in the neutralization case are to be interpreted as being taken with respect to $\bar{B}$.

(c) $\frac{dIR^*}{dA} = r(1-\Omega)(1-\beta)\frac{dM_w}{dA}$, $\frac{dIR^*}{dA^*} = r(1-\Omega)(1-\beta)\frac{dM_w}{dA^*} - 1$

other things equal, and creates or reinforces asymmetries that increase the effectiveness of *U.S.* monetary policy and decrease that of European monetary policy.[21] Note, finally, that to derive a Euro-dollar multiplier formula would violate the spirit of the general method of analysis used in this paper, for such a formula must assume exogenous flows of dollar reserves to the Euro-dollar market. In the present analysis, these flows are endogenous, and the effect of autonomous changes in monetary policy or asset preferences on the Euro-dollar market can be studied instead.

[21] The hedging statement "tends" in the text has been inserted to take into account an ambiguity in some of the partial derivatives of expression (10) with respect to a number of parameters. However, imposing the restriction that European reserves be positive (i.e., that $A > \beta/(1-\beta)A^*$), enables one to establish that $\partial M_w/\partial\Psi, \partial M_w/\partial r, \partial M_w/\partial\gamma < 0$, and that $\partial M_w/\partial\lambda > 0$. In addition, $\partial M_w/\partial\rho > 0$. Finally, $\partial M_w/\partial\Omega$ will tend to be positive, the smaller γ and λ. More precisely, positivity of $\partial M_w/\partial\Omega$ requires that $1 - [(1-\lambda)\cdot\gamma + \gamma] > r\gamma$, that is, that the ratio of European central bank reserves held with the Fed (or in gold) must be greater than that held in Euro-banks times r. The intuitive explanation is as follows: Suppose Europe only holds Euro-dollars (*CED*) as international reserves. A switch by European residents towards Euro-dollar deposits increases European commercial banks' demand for dollar deposits in New York, but these can only be made available through a decrease in the deposits available to private *U.S.* holders, that is, through a decrease in the *U.S.* money stock M, if the *U.S.* monetary base is given as it will be if the switch does not result in a reduction of the Fed's liabilities to foreign official holders or in an increase in its gold stock.

V. A Numerical Example

The relevance of the institutional arrangements outlined above to the long-run impact of national monetary policy and to the functioning of the international monetary system can be highlighted with the help of the numerical examples shown in Table 3.

It is assumed throughout the table that the United States and the rest of the fixed exchange rate world are of roughly equal economic size (i.e., that $\beta = .5$) and that reserve ratios are the same in the two countries and in the Euro-dollar market and equal to .25 (i.e., $m = 4$). Row 1 in Table 3 illustrates the simplest gold or pure dollar standard where Europe's central bank holds all its reserves with the Fed. A \$1 open-market operation by either Europe or the United States increases the world money stock by four times as much and each national money stock by half that amount (since $\beta = .5$); a gain in reserves of .5 brings about the required increase of 2 in the surplus country's money stock, given the national money multiplier of 4. The results for the case where the United States sterilizes all reserve flows under the gold or simplest dollar standard case are given in parenthesis in row 1. As stated in previous sections, neutralization by the United States reduces the effectiveness of Europe's monetary policy with respect to its effect on money supplies to zero, but makes European open-market operations an extremely efficient means of controlling its stock of reserves. Since $\beta = .5$, the effectiveness of *U.S.* monetary policy is doubled (remembering that $dM_w/d\bar{B} = m/\beta$); an increase of \$1 in the *U.S.* monetary base means that the *U.S.* money stock has to increase by m dollars in equilibrium. This is only possible if Europe's money stock increases by $(1 - \beta)/\beta$ times this amount, or, in our example by \$4. This will have occurred when Europe has gained \$1 of reserves and total domestic assets held by the Fed have increased by \$2.

Consider now row 8 of Table 3. The results there are based on the assumptions that 40 percent of Europe's reserves are held in the form of gold ($\Psi = .4$); that 20 percent of the remainder is held in the Euro-dollar market ($\gamma = .2$); that, of European reserves held in the United States, 80 percent are deposited with *U.S.* commercial banks and 20 percent with the Fed ($\lambda = .8$); and that the European and American public keep 25 and 20 percent, respectively, of their total money holdings in the Euro-dollar market ($\Omega = .25$ and $\rho = .2$). These are not entirely unrealistic assumptions as to the magnitudes involved in the mid-1960's, though they perhaps overestimate the role of the Euro-dollar market (at least in terms of average if not in terms of marginal ratios) and underestimate that of the dollar standard and neutralization.[22] The result, as compared with row 1, is an increase in the "effectiveness" of *U.S.* monetary policy from 4 to 5.9 and a decrease in that of European monetary policy from 4 to 3.5.

To gain some feeling of the respective importance of the dollar standard, neutralization, and the Euro-dollar market in influencing various measures of the impact of monetary policy, consider briefly rows 2 through 7 of Table 3. Comparing rows 1 and 5, it immediately appears that, even on our perhaps exaggerated assumptions about the actual importance of the Euro-dollar market, the increase in the world money supply multiplier entailed by the market, though significant, is not huge. Furthermore, as long as the European central bank does not hold reserves in the Euro-dollar market, symmetry with respect to the effect of open-market operations on the world money stock, though not on foreign-exchange reserves, prevails. The asymmetry with respect to reserve changes arises from the fact that an increase in the world money stock brought about by an increase in A or A^* increases the demand for dollars by European residents, and hence absorbs part of the initial excess supply of *dollars* dA, but not of European currency dA^*. In contrast to the case where $\gamma = 0$, holdings of Euro-dollar deposits by the European central bank ($\gamma = .2$) introduce asymmetries in the impact of monetary policy, raising the effectiveness of *U.S.* policy and lowering that of European monetary policy, as indicated by a comparison of rows 5 and 6.

Clearly, however, the strongest asymmetries arise from the practice of holding foreign-exchange reserves with *U.S.* commercial banks (compare cases where λ takes on increasingly higher values) and from

[22]The results in Genberg and the author suggest that the behavior of the world money stock in the period 1957–71 is not inconsistent with the hypothesis of complete neutralization by the United States (and a zero long-run multiplier for European open-market operations). The world money stock in that paper does not include Euro-dollar deposits.

neutralization by the United States, as perusal of Table 3 immediately indicates.[23]

VI. Conclusions

The method of analysis outlined in this paper seems appropriate to the investigation of a number of issues. It does emphasize that, under strictly fixed exchange rates, international monetary theory can make use of the concepts developed for closed-economy monetary theory, adding to it distributional considerations effected through the payments adjustment mechanism. It also shows that the specific institutional pattern ruling interbank and intercountry relations has an important impact on the effectiveness of monetary policy at both a global and national level.

The method of analysis, however, suffers from the same shortcomings as does closed-economy money multiplier analysis when applied to problems with which it is not equipped to deal. This suggests a number of extensions. First, models of the world money supply could be integrated with an explicit general equilibrium analysis of the determinants of output and interest rate fluctuations. This would be particularly appropriate for an analysis of the short run before all variables have fully adjusted. Second, and again in a short-run context, the dynamics of the money supply process could be analyzed by formulating stock adjustment functions.[24]

Finally, empirical investigation of the world money supply process is needed to assess the importance of the asymmetries and multiplier effects emphasized above as well as to gain a better understanding of the importance of the institutional changes that have occurred in the world's fixed exchange rate system from its gold standard heyday to its recent and partial demise. The method of analysis proposed in this paper is designed to provide a tentative framework for such an investigation.[25]

Appendix

1) Recall the *balance sheet structure* of the general model of Section II:

United States

Fed		Commercial Banks	
Assets	Liabilities	Assets	Liabilities
A	R	R	M'
αG	D^*	L_I	D_2^*
			DEB

Europe

Central Bank		Commercial Banks	
Assets	Liabilities	Assets	Liabilities
A^*	R^*	R^*	M'^*
$(1-\alpha)G$		L_I^*	ED^*
D^*		DEB	ED
D_2^*			CED
CED			

2) *Definition of behavior parameters:*

U.S. reserve ratio against commercial banks domestic currency liabilities:

$$r = \frac{1}{m} = \frac{R}{M' + D_2^* + DEB}$$

European reserve ratio against commercial banks domestic currency liabilities:

$$r^* = \frac{1}{m^*} = \frac{R^*}{M'^*}$$

European commercial banks dollar reserve ratio against Euro-dollar liabilities:

[23] Comparing rows 1, 2, 3, and 4, note that asymmetries introduced by neutralization diminish as λ rises. This is due to the fact that holding dollar reserves with *U.S.* commercial banks is equivalent to neutralization on behalf of the United States and, hence, the less the total increase in A needed to sustain a given increase in $\bar{B}$. When $\lambda = 1$, the required neutralization by the United States is zero as indicated by the equality of the original results with those in parentheses in row 4.

[24] It may be worthwhile to note that the money supply formulae developed throughout the text incorporate elements of money demand functions since β is in equilibrium equal to the ratio of the first country's demand for money to the sum of the demands for money in the world.

[25] For a first attempt at econometric modelling along the lines suggested in the text, see Genberg and the author.

$$r_d = \frac{1}{m_d} = \frac{DEB}{ED^* + ED + CED}$$

Proportion of European residents' money holdings held as Euro-dollars:

$$\Omega = \frac{ED^*}{M^*} = \frac{ED^*}{M'^* + ED^*}$$

Proportion of *U.S.* residents' money holdings held as Euro-dollars:

$$\rho = \frac{ED}{M} = \frac{ED}{M' + ED}$$

Equilibrium proportion of world money stock held by residents of country 1:

$$\beta = \frac{M}{M_w} = \frac{M' + ED}{M_w}$$

Proportion of Europe's foreign-exchange reserves held in gold:

$$\Psi = \frac{(1 - \alpha)G}{R^* - A^*}$$

Proportion of Europe's dollar reserves held in Euro-dollar market:

$$\gamma = \frac{CED}{D^* + D_2^* + CED}$$

Proportion of Europe's reserves in the United States held with *U.S.* commercial banks:

$$\lambda = \frac{D_2^*}{D^* + D_2^*}$$

Proportion of *U.S.* gold holdings in the (given) world gold stock (G), an *endogenous* variable:

$$\alpha G$$

3) *Definition of money stocks:*

1. $M = M' + ED$
2. $M^* = M'^* + ED^*$
3. $M_w = M + M^* = M' + M'^* + ED + ED^*$

4) *Derivation of general reduced form for the world money stock:*

The behavior parameters and definitions of the money stock are used to derive a world money supply formula. The most important relations used in the process are given below:

1. $G = \alpha G + (1 - \alpha)G$
2. $R = r\{M' + D_2^* + DEB\} = \frac{1}{m} \cdot \{M' + D_2^* + DEB\}$
3. $R^* - A^* = \frac{1}{\Psi}(1 - \alpha)G = \frac{1}{1 - \psi} \cdot \{D^* + D_2^* + CED\}$
4. $R^* = r^* M'^* = \frac{1}{m^*} M'^*$
5. $DEB = r_d[ED^* + ED + CED] = \frac{1}{m_d} \cdot [ED^* + ED + CED]$
6. $ED^* = \Omega M^* = \Omega(M'^* + ED^*)$
7. $ED = \rho M = \rho(M' + ED)$
8. $M = \beta M_w$
9. $M^* = (1 - \beta)M_w$

Through a tedious process of substitution the following general reduced term for M_w is obtained:[26]

$$M_w = [A + G + A^*\{1 - (1 - \Psi)[(1 - r) \cdot (1 - \gamma)\lambda + \gamma(1 - rr_d)]\}] \div [\beta\{r[1 - \rho(1 - r_d)]\} + (1 - \beta) \cdot \{rr_d\Omega + r^*(1 - \Omega)\{1 - (1 - \Psi) \cdot [(1 - r)(1 - \gamma)\lambda + (1 - rr_d)\gamma]\}\}]$$

[26]To illustrate the process of substitution, take the derivation of equation (8) in the text, the reduced-form expression for M_w relevant to the simple gold standard case discussed in Section I. From equation (7) recall that:

$$M_w = M + M^* = mA + m^*A^* + m^*G + (m - m^*)\alpha G$$

Note also that the gold reserves of the first country can be expressed as:

$$\alpha G = rM - A = r\beta M_w - A$$

Substitute the second expression into the first and simplify to obtain:

$$M_w = m^*(A + A^* + G) + (m - m^*)r\beta M_w$$

Solve for M_w and divide numerator and denominator by m^* to obtain expression (8) in the text.

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