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THE GOLD-EXCHANGE STANDARD:
SOME EXPLORATORY EMPIRICISM RELATING TO
THE ENDOGENEITY OF COUNTRY MONEY BALANCES

by

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May, 1970
The Price-Specie-Flow Mechanism and the Gold-Exchange Standard:
Some Exploratory Empiricism Relating to
the Endogeneity of Country Money Balances

by

Thomas J. Courchene

Suppose there are 12 millions of paper, which circulate in the kingdom as money...and suppose the real cash of the kingdom to be 18 millions. Here is a state which is found by experience to be able to hold a stock of 30 millions. I say, if it be able to hold it, it must of necessity have acquired it in gold and silver, had we not obstructed the entrance of these metals by this new invention of paper. Whence would it have acquired that sum? From all the kingdom of the world. But why? Because if you remove these 12 millions, money in this state is below its level, compared with our neighbours; and we must immediately draw from all of them, till we be full and saturated, so to speak, and can hold no more.

David Hume

Hume's price-specie-flow mechanism for adjustment under a gold-standard regime is so well accepted that most students become introduced to it in their first course in economics. Countries with an excess supply of gold will experience price level increases relative to other countries: via their balance of payments with the rest of the world this excess gold will flow out. Given tastes, basic endowments, etc. in each country, the allocation among countries of a given quantity of gold is determinate: money (gold) supply in each country is endogenous.

To what extent is this adjustment mechanism operative under the current gold-exchange standard? From the passage quoted above, I think that Hume would have considered it fully operative: an excess supply of domestic paper money will result in an outflow of precious metals (reserves). But economists have not accepted Hume's view of the monetary constraints of a gold-exchange
standard to the point where they are willing to suggest to students that at a given time and with given tastes, endowments, etc., country money supplies are endogenous under the current fixed-rate system. The purpose of this paper is to attempt to investigate the degree to which the "price-specie-flow mechanism" is, in fact, operative under the current fixed-rate regime.

In order to provide a theoretical framework for the empirical section of the paper we devote some time to modelling one version of a fixed-rate system—a dollar standard. The empirical section is divided into two parts. The first focuses on some "global" results and the second on results for individual countries. A discussion of implications of the results completes the paper. We turn now to a model of a dollar standard.

II. A Model Embodying Endogenous Money Supplies

In modelling a world economy which has characteristics consistent with the dictates of Hume's price-specie-flow mechanism we shall assume that U.S. dollars are the only internationally held monetary assets, i.e., we shall be modelling a dollar standard rather than a gold standard. All countries tie their currencies to Country 1, the U.S.A. Let $e^j$ be the number of units of money of Country $j$ obtainable for one unit of Country 1. An increase in $e^j$ implies a depreciation of the currency of $j$. Naturally, $e^1 = 1$. Each of the $m$ countries in the world produces $n$ commodities, bonds and money. Real demands (in value terms) for all goods (commodities, money and bonds) in country $j$ depend on relative prices, real money balances, and real income, i.e.:

$$X^j = \left(\frac{P_2}{P_1}, \ldots, \frac{P_n}{P_1}, r, \frac{M_j}{P^j}, \sum_{i=1}^{n} \frac{X^j_i}{X^1_i}\right)$$

$^1$For an elaboration of this model see [1].
where \( X^j \) = real demand for goods in Country \( j \). \( X^i \), where \( i \) goes from 1 to \( n \), are the demands for the \( n \) commodities: \( X^j_m \) is the demand for real money balances and \( X^j_d \) is the demand for real bonds in Country \( j \).

\[
\frac{P_2}{P_1} \cdots \frac{P_n}{P_1}, r = \text{relative prices of commodities and bonds, i.e., ratios of money prices of commodities 2 to } n \text{ to the money price of commodity 1.}
\]

In equilibrium these relative prices will be equal in all countries so that there is no need to put superscripts (denoting countries) on the various money prices when they are in ratio form.

\[
\frac{M^j + D^j}{p^j} = \text{real money balances, where } M^j \text{ and } D^j \text{ are the amount of the nominal money balances backed by domestic, } M^j, \text{ and international, } D^j, \text{ (U.S. dollar) assets respectively of the central bank. } p^j \text{ is the absolute price level of Country } j. \text{ Both } M^j \text{ and } D^j \text{ are valued in currency units of Country } j.
\]

\[
\sum_{i=1}^{n} X^j_i = \text{real income (endowments) in value terms of Country } j.
\]

The demand functions for Country 1, the United States, are slightly different in that the real balance term consists only of \( \frac{D^1}{p^1} \) since \( M^1 = D^1 \).

Perhaps our treatment of nominal money balances warrants some elaboration. It is convenient to equate the money supply for each country with high-powered money. Under this assumption, \( M^j \) and \( D^j \) are, respectively, the domestic and foreign assets held by the central bank (and equal to high-powered money). Alternatively, one can assume that the domestic money supply is a constant multiple of the monetary base and that \( M^j \) and \( D^j \) are the domestic and foreign components, respectively, of the monetary base. In the model, we assume that countries are free to alter \( M^j \) as they please. But the sum of \( M^j + D^j \)
is endogenous.

All goods are assumed to be gross substitutes so that the signs of all the arguments in the demand functions are determinate. For example, an increase in the real money balances in Country $j$ will result in an excess demand for all commodities, an excess demand for bonds and an excess supply of money. An increase in interest rates (fall in bond prices) in $j$ will increase the demand for bonds and decrease the demands for commodities and money, etc.

Let $I^j_1$, $I^j_b$, and $I^j_m$ represent the excess real demands for goods corresponding to the real demands $X^j_1$, $X^j_b$, and $X^j_m$. The balance-of-payments constraint for each country requires that the sum of the excess demands for goods equal the excess supply of international reserves, i.e.,

$$
\sum_{i=1}^{n} I^j_i + I^j_b + I^j_m + I^j_D = 0
$$

where $I^j_D$ is the excess demand for dollars (reserves). In the model that follows we do not employ this version of the balance-of-payments constraint.

Rather, since domestic currencies are, by assumption, not traded internationally, $I^j_m$ must be zero for each of the "outer" countries, i.e., countries 2 to m.

The exchange model of the dollar standard can now be formulated:

(1) \[ I^j_m = X^j_m \frac{P^2}{P_1} \cdots \frac{P^n}{P_1} , \quad r, \quad \frac{w^j_{i+D}^j}{p^j} , \quad \frac{1}{\sum_{i=1}^{n} X^j_i} - \frac{m^j_{i+D}^j}{p^j} = 0; \quad j = 2, m \]

(2) a) \[ I^1_1 + I^2_1 + \ldots + I^m_1 = 0; \quad i = 1, n \]

b) \[ I^1_b + I^2_b + \ldots + I^m_b = 0 \]

c) \[ I^1_D + I^2_D + \ldots + I^m_D = 0 \]

(3) \[ \sum_{j=1}^{m} e^j D^j_j = \frac{D}{P^j} \]

(4) \[ p^j = e^j p^1; \quad j = 2, m \]

The arguments in the excess demand functions of $I_1$, $I_b$ and $I_D$ have been deleted for simplicity.
Equations (2) are the \( n+2 \) (but, via Walras' Law only \( n+1 \) independent) global clearing equations for commodities bonds and dollars. For the United States, the balance-of-payments constraint is
\[
\sum_{i=1}^{n} I_i^1 + I_b^1 + I_D^1 = 0
\]
and the reader can satisfy himself that this equation is implicit in equations (1) and (2). Intuitively, one can consider the \( m+n \) equations of (1) and (2) as determining the \( m \) real balances \( \frac{M^j_{i+D^j}}{p^j} \) for \( j=2, m \) and \( \frac{I^1_D}{p^1} \) and the \( n \) relative prices \( \frac{P_2^j}{p_1^1}, \ldots, \frac{P_n^j}{p_1^1}, r \). The total stock of dollars in the world, \( D \), is fixed by the Federal Reserve System implying that if \( m-1 \) of the \( D^j \) are known, so is the last one. Rather than use this relationship to eliminate from the endogenous variables one of the values for \( D^j \), we use (3) to determine the absolute price level of the U.S.A., \( P^1 \). The real stocks of \( D^j/p^j \) are converted (via the fixed exchange rates, \( e^j \)) into prices of Country 1 and the price level of Country 1 adjusts so that the equation is satisfied. Given \( P^1 \), the absolute price levels in the other countries are determined via equations (4).\(^2\) The exogenous variables are the endowments, \( \sum_{i=1}^{n} x_i^j \), the exchange rates, \( e^j \), the level of dollars, \( P \), and the domestic components of the money supplies of the outer countries, \( M^j \), where \( j = 2, n \). The two \( m+n \) independent equations determine uniquely the two \( m+n \) endogenous variables, \( P^j, D^j, P_2/P_1, \ldots, P_n/P_1 \) and \( r \).

Consider now from a position of equilibrium, an increase in the money supply in Country \( j \) via an increase in the \( M^j \) term (i.e., an increase in money engineered by an increase in the domestic assets of \( j \)'s central bank). An excess supply of money results with a corresponding excess demand for both commodities and bonds.\(^4\) Equilibrium

\(^2\)This procedure is adapted from Mosak [4, p. 54].

\(^3\)This assumes that the price-index weights are identical in all countries.

\(^4\)This is the gross substitutes assumption: an excess supply of money will cause a deficit in both the current and capital accounts. This need not be the case of course. But it is adequate for our purposes since in the empirical section we are only interested in the overall balance of payments. The assumption of gross substitutes does aid in the stability analysis of this model, however.
can be restored in Country j only when real balances are brought to their original levels. If the country in question is a ministate and, therefore, has no impact on the world price level\(^\text{5}\) all this excess demand for money will be eliminated by outflows of dollar reserves, i.e., the money supply will fall back because the \(D^j\) component of total money \((M^j+D^j)\) will decrease. If Country j sterilizes this reserve outflow by increasing further the \(M^j\) component it will simply keep on losing reserves. If Country j is large enough to have some impact on prices, then world prices will rise somewhat as reserves flow out of Country j so that the loss of dollar reserves from j (decrease in \(D^j\)) will be somewhat smaller than the increase in \(M^j\). This type of relationship is, of course, precisely that to which Hume alludes in the passage quoted in the introduction.

From an equilibrium position consider an increase in \(\bar{D}\) via open market operations by the Federal Reserve in New York. Excess demands in the U.S. for commodities and bonds increase and the excess demand for money will fall. Dollars flow out to finance these commodity and/or bond inflows. Those countries garnering the largest increases in reserves will be those with the largest excess demands for money. The U.S. deficit is endogenous: it depends on the monetary policies (the policies toward \(M^j\)) of the outer countries. If the central banks of the outer countries respond to the open market purchase in the U.S. by increasing their own domestic assets, i.e., by increasing \(M^j\) component of the money supply, the U.S. will lose fewer dollars and, hence, will run a smaller deficit.

\(^{5}\text{In this model the world price level is simply the purchasing power of the U.S. dollar since the price-index weights are assumed to be identical for all countries.}\)
If the excess supply of real money balances of the outer countries exactly offsets the excess supply for money in the U.S., no dollars will flow out. Rather, absolute price levels will rise throughout the world to satisfy the excess money supplies, i.e., the quantity-theory-type result occurs: a doubled money supply in all countries via the $M^j$ term will double world prices. For further analysis of the dollar standard and other international standards consult [1].

This leads to two hypotheses:

Hypothesis I

An increase in the excess demand for real balances in Country $j$ will result in an inflow of reserves to Country $j$, other things being held constant (i.e., excess demands for money balances in the other countries).

Hypothesis II

Country $j$ will lose reserves if there is an increase in the excess demand for real balances in the rest of the world, all else held constant.

Under a "pure" dollar standard, the sum of all the balance-of-payments deficits for the $m$ countries will be zero. Reserves for the "outer" countries can increase only by the amount of the U.S. deficit. But in the present international monetary system an exogenous change in
gold also increases the level of world reserves. This allows the sum of the balance-of-payments surpluses for all countries to be positive. It is theoretically possible, therefore, for all countries to have excess supplies of money and yet for all countries to increase their reserves. This leads to Hypothesis III:

**Hypothesis III**

An increase in world reserves will increase the reserves of Country j, ceteris paribus.

These three hypotheses provide the framework under which the empirical section of the paper proceeds. However, we shall depart from the theoretical underpinnings of the model in one important aspect. We shall treat reserves of all countries in gross terms. This implies that the outflow of U.S. short-term liabilities to official holders will not be treated as a balance-of-payments deficit for the U.S.A. In other words we are treating the U.S. outflow of official short-term liabilities in exactly the same manner as the outflow of South African gold—neither outflow decreases the reserves of the country in question. This means that our empirical work will not shed light on whether or not the U.S. balance-of-payments deficit (on an Official Settlements basis) is endogenous. Indeed, we shall even go further and, for some equations, exclude the U.S.A. from the analysis. The implications of these assumptions impinge primarily on Hypothesis III, which will now refer to world gross reserves.
III. Empirical Evidence on the Price-Specie-Flow Mechanism

A. Some "Global" Results

An adequate test of the three hypotheses developed in the previous section would entail an enormous amount of work. For example, deriving appropriate excess demand equations for real money balances on a country-by-country basis would require at the very least a three-equation, simultaneously estimated model for each country. Although considerable effort did go into the empirical work reported below, our approach is at best a naive one. This said, we now turn to a description of the methodology we followed leaving until later the more detailed comments on the inadequacies of the approach.

Only 15 countries comprise our "world". They are the 14 industrialized countries listed in the IMF publication International Financial Statistics plus Australia. Our time span is the ten year period 1958-1968. Because most of the 15 countries' currencies were not convertible prior to 1958 (indeed some became convertible only in the early 1960's) we chose this date to begin the analysis. The data are annual observations obtained from IFS tapes. The list and definitions of the variables appear in an appendix to the paper.

The procedure for estimating excess demands for real money balances is as follows. For each country real money balances were regressed on real income and interest rates over the period 1948-1962 (for some countries data permitted estimation only from 1953-1962.) This equation was then assumed,

---

6 Initially we intended to include South Africa and New Zealand as well but data inadequacies prevented this.

7 The definition of money - demand deposits plus currency or demand deposits plus currency plus "quasi" (IFS terminology) money - for each country was decided on the basis of goodness of fit of the money demand equation. All
quite arbitrarily, to be an estimate of the demand for money for the country in question. Using data for real GNP and interest rates for 1958-1968, the regression coefficients were employed to extrapolate estimates of the demand for real money balances for each country over this period. From this estimate was subtracted the actual level (i.e., supply) of real balances in each period and the difference termed the "excess demand for real money balances." These excess demands were then converted to their U.S. dollar equivalents and summed (without regard for country differences in velocity or in degree of openness of the economy) to obtain a "world" excess demand for money for each of the years 1958 to 1968. Likewise country real balances were converted to U.S. dollar equivalents and summed to obtain a "world" money supply. From these data two sets of independent variables were generated; a) \( \text{EXD}_j \) and \( \text{EXD}_w \), where the former is the excess demand for real balances in Country \( j \) and the latter the excess demand for the world, both expressed in U.S. dollars; and b) \( \text{(D/S)}_j \) and \( \text{(D/S)}_w \) where the former is the ratio of demand for real balances to the supply of real balances for Country \( j \) and the latter is the world counterpart. The dependent variables are \( \Delta R_j \) and \( R_{jt} / R_{jt-1} \) corresponding to the linear and ratio form of the excess demand variables where \( R \) is the level of gross reserves for each of the countries. (Consult the Appendix for the definition of \( R \).) Correspondingly, the change in "world" reserves income coefficients were positive and significant and for only two countries did interest rates not acquire a negative coefficient. These individual country regression results are available upon request. To estimate the equations over the 1958-1968 period directly would have constrained the net excess demand for real balances to be zero over the period for each country--an unacceptable restriction, in our view.

Incidentally, for the demand-for-money buffs, the real income elasticity of real money balances (using an extended money definition for all countries) at the "world" level is 1.08 and not significantly different from unity.
is represented by either $\Delta R_w$ or $R_{wt}/R_{wt-1}$ depending on whether or not the linear or ratio version of the model is being tested. Although we force the coefficients for country excess demands, world excess demands, the change in world reserves to be the same for all countries, we do allow each country its own intercept term in the equations. These intercepts should capture some of the various individual country characteristics as they relate to reserve changes, thus allowing the remaining variables to reflect more adequately the effects they were intended to.

Table I contains the results from the "global" regressions. Bracketed figures beneath the coefficients of the first three variables (country excess demand, world excess demand and the change in world reserves) are t-values. No t-values are shown for intercept terms. Asterisks attached to the intercept coefficients indicate statistical significance. The overall constant, when included in the equation, is presented as the second figure in the last column. Equations (1) through (3) include the U.S.A. in the sample, while the remaining seven equations exclude the U.S.A.

The results in Table I lend substantial support for Hypothesis I: Ceteris paribus, the greater the excess demand for real balances in Country $j$ the greater will be the reserve inflows into Country $j$. Focusing on the first seven equations, every coefficient for the country excess demand variable is positive and significant at the 5% level. And this holds true whether or not the equations include the U.S.A., whether or not the variable enters in a lagged or unlagged manner and whether or not the equation is estimated in linear or ratio form. The evidence is less decisive when it comes to the world excess demand variables. In the first seven equations, none of these variables acquires a significant coefficient. However, all of the coefficients are negative which is consistent with Hypothesis II: An increase in world
### Table I

"Global" Results

<table>
<thead>
<tr>
<th>Eqn.</th>
<th>Country Intercepts</th>
<th>Change in World Reserves Variable</th>
<th>World Demand Variable</th>
<th>World Excess Demand Variable</th>
<th>Country Excess Demand Variable</th>
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**Notes:**

1. Equations 1 through 3 include the U.S.A.
2. The second figure in the last column records the intercept where it is included (in equations 3, 6, and 10).
3. Bracketed numbers beneath coefficients are t-values. For the country intercepts, asterisks denote significance at the 5% level.
excess demand will lead to an outflow of reserves from Country j, all else held constant.

When world reserves are increasing, all countries will tend to experience reserve inflows, ceteris paribus. This is Hypothesis III and it too receives considerable support in Table 1 even though only one of the coefficients in the first seven equations is statistically significant. For comparable equations, excluding the U.S. data results in a larger t-value for both $\Delta R_{wt}$ and $R_{wt}/R_{wt-1}$, i.e., compare equations (1) and (4) and equations (2) and (7). This is to be expected since world gross reserves have grown while U.S. gross reserves have fallen over the 1958-68 period.

The last two equations combine Hypotheses I and II. Specifically, rather than allowing $(D/S)_j$ and $(D/S)_w$ to enter separately, we form the ratio $(D/S)_j/(D/S)_w$ for equation (8) and (because of a computational error) its reciprocal for equation (9). A country will gain reserves if its excess demand increases relative to world excess and vice versa: $(D/S)_j/(D/S)_w$ should have a positive coefficient and its reciprocal a negative coefficient. This is clearly confirmed by the results of equation (8) (unlagged) and (9) (lagged). In addition, the world reserve coefficients $R_{wt}/R_{wt-1}$ achieve their highest degree of significance in these two equations. Subject to the defects of our methodology, we interpret these results as confirming our hypotheses and substantiating the assertion that the price-specie-flow mechanism (or more correctly, the price-dollar-flow mechanism) is operative under the current fixed-rate regime.

It is difficult to assign meaning to the size of the coefficients appearing in Table I. Nor should we desire to be very precise about the implications of the coefficient values because of the simpliste approach we followed. However for the ratio version of the model, the coefficients
values do appear to be reasonable. The world reserve variable, $R_{wt}/R_{wt-1}$, attains a coefficient value greater than unity in the equations in which U.S. data are excluded. This is to be expected because over this period the U.S. was a net supplier of gross and net reserves (i.e., its official short-term liabilities to foreigners rose and its holdings of gold and foreign exchange declined.) In equation (2), which includes the U.S., the coefficient of $R_{wt}/R_{wt-1}$ is not statistically different from unity. A coefficient value for $(D/S)_j$ greater in absolute value than that for $(D/S)_w$ (as does occur in all equations) seems eminently reasonable: an increase in the excess demand for real balances in Country j will increase the reserves of j more than will be the case if the excess demand of world real balances falls by the same amount. Finally, from equation (7) a given percent increase in $(D/S)_j$ increases $R_{t}/R_{t-1}$ by a factor of 1.401. One interpretation of this would be that reserve inflows and outflows are sterilized to some degree. Under a "rules-of-the-game" gold (dollar) standard one would expect a coefficient of unity.

In terms of goodness of fit, our model explains at best about one-quarter of the variance in country reserve levels. Our purpose is not to maximize the coefficient of determination nor to suggest that the price-specie-flow mechanism is the sole determinant of reserve change. Rather, we are interested in demonstrating that under the present fixed-rate regime (in which country money supplies are able to be set exogenously) reserve flows between countries are, to some degree, endogenously determined.

Table I confirms this.

We turn now to some individual country equations.
B. Some Country Results

Interesting as are the global results it is important to investigate to what degree individual countries' reserve behavior can be explained in terms of our basic hypotheses. These results appear in Table II. Unfortunately, we only have ten observations on each variable so that our results are at best indicative of whether or not further research is likely to be worthwhile. The methodology underlying the Table is straightforward. For each country (excluding Canada) reserve changes were regressed against the variables we employed in the Table I equations. For nine countries (U.S.A. to Australia in Table II) these results were reasonable enough to report. For the other countries we present some results from an alternative model which is also consistent with the general theoretical framework of the study. These are the last seven equations of the Table. Ceteris paribus, an increase in Country j's proportion of world money (M*) will result in a loss of reserves for j and conversely for the income proportion variable (Y*). Therefore, a negative coefficient for M* and a positive coefficient for Y* is consistent with the price-specie-flow mechanism. In a few cases the dependent variable includes changes in the net foreign asset position of commercial banks. An excess demand for money will draw in foreign money. But this inflow need not be reflected in reserves if private individuals and institutions are willing to hold the foreign currency or assets. We shall leave to the reader the bulk of the task of sorting through the various equations in Table II and focus only on some aspects of the Table.

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9 For part of the 1958-1968 period Canada was on a flexible exchange rate leaving an insufficient number of relevant observations to make estimation worthwhile.
<table>
<thead>
<tr>
<th>Country</th>
<th>Dependent Variable</th>
<th>Intercept</th>
<th>Country Excess Demand Variable</th>
<th>World Excess Demand Variable</th>
<th>World Reserve Variable</th>
<th>( R )</th>
<th>D.W.</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.A.</td>
<td>( R_t/R_{t-1} )</td>
<td>2.092 (2.39)</td>
<td>-1.115 (1.29)</td>
<td>8.725 (1.52)</td>
<td>0.48</td>
<td>1.14</td>
<td></td>
</tr>
<tr>
<td>U.K.</td>
<td>( R_t/R_{t-1} )</td>
<td>4.271 (1.82)</td>
<td>-12.22 (1.62)</td>
<td>0.20</td>
<td>2.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>( R_t/R_{t-1} )</td>
<td>0.5828 (0.17)</td>
<td>3.131 (3.64)</td>
<td>0.81</td>
<td>2.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>( \Delta R_t )</td>
<td>-550.1 (0.85)</td>
<td>833.2 EXD_t (1.07)</td>
<td>0.4743 ( \Delta R_{w_t} ) (1.56)</td>
<td>0.41</td>
<td>2.03</td>
<td></td>
</tr>
<tr>
<td>Germany**</td>
<td>( R_t/R_{t-1} )</td>
<td>-1.785 (0.77)</td>
<td>1.599 (1.21)</td>
<td>+4.460 ( R_{w_t} / R_{w_{t-1}} ) (2.27)</td>
<td>0.36</td>
<td>1.98</td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>( \Delta R_t )</td>
<td>678.4 EXD_t (2.08)</td>
<td>-129.3 EXD_t (_{t-1}) (2.67)</td>
<td>-0.09213 ( \Delta R_{w_t} ) (0.62)</td>
<td>0.25</td>
<td>2.51</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( \Delta R_t )</td>
<td>593.6 EXD_t (2.10)</td>
<td>-114.3 EXD_t (_{t-1}) (2.74)</td>
<td>-0.09213 ( \Delta R_{w_t} ) (0.62)</td>
<td>0.34</td>
<td>2.20</td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td>( \Delta R_t )</td>
<td>-422.9 EXD_t (1.33)</td>
<td>-7.948 EXD_t (1.09)</td>
<td>0.1170 ( \Delta R_{w_t} ) (5.44)</td>
<td>0.73</td>
<td>2.62</td>
<td></td>
</tr>
<tr>
<td>Norway</td>
<td>( \Delta R_t )</td>
<td>992.8 EXD_t (3.63)</td>
<td>-3.835 EXD_t (6.55)</td>
<td>+0.007686 ( \Delta R_{w_t} ) (1.42)</td>
<td>0.82</td>
<td>2.35</td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>( \Delta R_t )</td>
<td>904.46 EXD_t (_{t-1}) (0.81)</td>
<td>-17.72 EXD_t (_{t-1}) (1.55)</td>
<td>+0.04679 ( \Delta R_{w_t} ) (0.46)</td>
<td>0.34</td>
<td>1.53</td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td>( \Delta R_t )</td>
<td>1178.0 EXD_t (2.21)</td>
<td>-15.38 EXD_t (_{t-1}) (1.19)</td>
<td>0.0657 ( \Delta R_{w_t} ) (1.31)</td>
<td>0.37</td>
<td>2.08</td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>( R_t/R_{t-1} )</td>
<td>-1.953 (1.33)</td>
<td>-2.507 M* (2.72)</td>
<td>+3.326 Y* (3.75)</td>
<td>+2.240 ( R_{t}/R_{w_{t-1}} ) (1.54)</td>
<td>0.78</td>
<td>0.68</td>
</tr>
<tr>
<td>Country</td>
<td>Dependent Variable</td>
<td>Intercept</td>
<td>Country Excess Demand Variable</td>
<td>World Excess Demand Variable</td>
<td>World Reserve Variable</td>
<td>R</td>
<td>D.W.</td>
</tr>
<tr>
<td>-----------</td>
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</tr>
<tr>
<td>Switzerland</td>
<td>( \frac{R_t}{R_{t-1}} )</td>
<td>-1.276 (1.44)</td>
<td>-0.8037 M* ( t )</td>
<td>2.365 Y* ( t )</td>
<td>0.7479 ( RW_t / RW_{t-1} )</td>
<td>0.16</td>
<td>1.60</td>
</tr>
<tr>
<td>Austria</td>
<td>( \frac{R_t}{R_{t-1}} )</td>
<td>-2.214 (1.27)</td>
<td>-1.121 M* ( t-1 )</td>
<td>2.160 Y* ( t )</td>
<td>2.247 ( RW_t / RW_{t-1} )</td>
<td>0.38</td>
<td>1.98</td>
</tr>
<tr>
<td>Sweden</td>
<td>( \frac{R_t}{R_{t-1}} )</td>
<td>-13.65 (1.75)</td>
<td>-2.078 M* ( t-1 )</td>
<td>9.687 Y* ( t-1 )</td>
<td>6.98 ( RW_t / RW_{t-1} )</td>
<td>0.83</td>
<td>2.82</td>
</tr>
<tr>
<td>Belgium</td>
<td>( \frac{R_t}{R_{t-1}} )</td>
<td>-2.324 (2.06)</td>
<td>-1.370 M* ( t )</td>
<td>+2.904 Y* ( t )</td>
<td>1.80 ( RW_t / RW_{t-1} )</td>
<td>0.27</td>
<td>2.00</td>
</tr>
<tr>
<td>Denmark</td>
<td>( \frac{R_t}{R_{t-1}} )</td>
<td>-9.754 (1.50)</td>
<td>-0.575 M* ( t-1 )</td>
<td>+0.6968 Y* ( t-1 )</td>
<td>+9.825 ( RW_t / RW_{t-1} )</td>
<td>0.64</td>
<td>2.67</td>
</tr>
<tr>
<td>Japan**</td>
<td>( \frac{R_t}{R_{t-1}} )</td>
<td>-8.652 (3.03)</td>
<td>-0.6134 M* ( t-1 )</td>
<td>6.134 Y* ( t )</td>
<td>3.967 ( RW_t / RW_{t-1} )</td>
<td>0.15</td>
<td>1.60</td>
</tr>
</tbody>
</table>

**Notes:**

**Dependent variable includes changes in net foreign assets of commercial banks as well as reserve changes.**

Y* is the percentage change from one year to the next in the ratio of GNP of country j to world GNP.

M* is the percentage change from one year to the next in the ratio of real balances of country j to world real balances. For the Austria, Denmark and Switzerland equations money supplies for all countries included "quasi" money. For the other four equations the narrow definition of money was employed.
In general we feel that there is a surprisingly (and, given our bias, a very encouraging) degree of conformity to the dictates of the model on the part of individual country reserve behavior. For some countries (e.g., Norway) over 60% of the variance in reserve changes from 1958 to 1968 can be explained by the model. Even changes in the reserves for the U.S. can be partially explained in terms of this adjustment mechanism although no positive relationship appeared between U.S. reserve changes and world reserve changes (i.e., the world reserve variable was deleted from the equation.) It may be of some interest to note that the \((D/S)_j\) coefficient is highest for England (i.e., 4.271.) Likewise, the coefficient for \((D/S)_w\) is also highest for the U.K. What we interpret these findings to mean is that the U.K., more than any other nation, has been abandoning the "rules of the game": changes in relative excess demands for money have indeed resulted in reserve flows but these reserve flows have been far greater than would be necessary under "appropriate" conformity to the underlying monetary dictates of the fixed-rate standard. Note that Germany has been accounting for approximately 50% of the increase in world reserves (the fourth equation in Table II.)

Turning now to the results for the alternative model, we note that a substantial proportion of reserve variation for Germany, Belgium and Japan can be explained in terms of proportional changes (relative to world levels) in real money and real income. An increase in \(Y^*\) (defined beneath Table II) increases the excess demand for money and draws in reserves while an increase in \(M^*\) increases the excess supply of money and depletes reserves. That \(M^*\) acquires negative coefficients is impressive because the direct link between reserve inflows and money supplies is a positive relationship. ¹⁰ Finally it

¹⁰ It is appropriate to point out that our empirical work has departed considerably from the dictates of the formal model outlined above in that we do not distinguish between changes in money supplies arising from \(M^*\) and
should be noted that the equations reported in Table II were the "best" that could be found in support of the basic framework underlying the paper. For some of the countries results contrary to the hypotheses can be obtained. For example, for both France and the U.S.A. the $M^*$ variable acquires a positive and significant coefficient. 11

IV. Conclusion

As stated in the introduction to the empirical section, there are a great many defects inherent in our approach. The method for deriving the excess demand equations leaves a great deal to be desired. No account was taken of the degree of openness of the various countries nor of the differing velocities of money in deriving the "world" excess demand results. To some degree, allowing countries to acquire their own intercept takes account of some of these defects but a more direct attempt to meet these problems would be preferable. For the individual countries the constraint of only ten observations limits the conclusions one would like to draw from the Table II results. The failure to follow through the dictates of the model in distinguishing between foreign and domestic assets of central banks as well as the exclusion of the Euro-dollar market from the analysis also detract from the study. But on the positive side of the ledger the empirical results are encouraging to say the least, and surely augur well for future and more enterprising research of the monetary interrelationships among the world's economies.

those arising from $D^J$ (to use the terminology of the model.) Time did not allow this distinction to be carried out at the empirical level. Failure to make this distinction probably seriously biases our work to generate results counter to our hypotheses. This is especially true for the individual country results embodying the $M^*$ specification since, as suggested in the text, the direct relationship between reserve inflows and money supplies is a positive one. Isolating this direct link by utilizing $M^J$ and $D^J$ should improve the results considerably--improve in the sense of lending more support to the hypotheses of the paper.

11 One of the problems with the reserve series for France is that the percentage increase from 1958 to 1959 is, given our estimate of the "use of
We can be more assertive, however. This paper represents the second attempt to investigate empirically the mechanism of adjustment under fixed rates. Utilizing a quite different model, Arthur Laffer [3] finds a significant positive relationship between rate of country growth and rate of change in reserves. This result is consistent with our framework since, ceteris paribus, the larger the increase in income the larger the excess demand for money and the greater the tendency for reserves to flow in. Neither paper should be interpreted as an attempt to extol the virtues of the fixed-rate system. Rather what they do suggest is that a) there is in theory a process of adjustment that characterizes a fixed-rate regime and b) this adjustment mechanism is indeed operative under the gold-exchange standard.

Turning more directly toward the findings of the present paper we are able to assert that the volatile behavior of individual countries' reserves can, to a considerable degree, be explained in terms of Hume's price-specie-flow mechanism. Even though individual countries have the freedom to set the level of their own money supplies, there are forces at work in the system to ensure that these real balances (nominal balances for ministates) do not get too far out of line. Excess domestic credit expansion (excess in the sense that credit expansion is beyond the level that real incomes and interest rates would suggest) will result in reserve losses. 12 But this is just another way

Fund Credit" for France in 1958, approximately 240%. This observation dominates the entire data series. In addition, France achieved de jure convertibility only in 1961.

12 While we have deleted entirely any direct reference to the Euro-dollar market in our analysis, it seems very evident (to us, at least) that the role of the Euro-dollar market is to make it far more difficult for countries to have independent monetary policies. In this sense the Euro-dollar market facilitates the fixed-rate adjustment mechanism. This does not imply that it is an unmixed blessing: the Euro-dollar market facilitates the transferral of the U.S. inflation to the rest of the system. But it is important to realize that this is precisely what one should expect under a fixed rate regime dominated by a super power.
of stating that real money balances are *endogenous* under a fixed-rate regime. It is important to emphasize that this endogeneity does not imply that all countries will have identical percentage changes in their respective money supplies. For example, no one suggests that the growth rates of the money supplies in the twelve Federal Reserve districts are identical even though the money supply in each district is indeed endogenous. Rather, given the basic economic and institutional structure, including the level of real income and interest rates, there exists an equilibrium level of real balances for each country. Domestic monetary expansion beyond this level will result in foreign exchange losses thus tending to bring the money supply back to its equilibrium level. An alternative way of interpreting this endogeneity (and one which is also consistent with the implications of the model formulated above) is that the real balance effect is the mechanism linking individual countries' economic systems to the global economy.

In the empirical section we have not been explicit about the channels through which an excess supply of real balances, for example, will result in reserve outflows. If the gross substitutes assumption is valid empirically then both the current and capital accounts will be in deficit: an excess supply of money generates an excess demand for bonds and goods so that both bond and commodity prices tend to rise and tend to generate deficits on the capital and current accounts respectively. If gross substitutes is an inappropriate assumption then all one can say is that the sum of the current and capital accounts will be in deficit.\(^{13}\) Given an excess supply of money, tinkering with the capital account to ensure a surplus there will only force

\(^{13}\text{Although not phrased in our terms, Laffer's results appear to suggest that an excess supply of money will result in capital account outflows and perhaps in current account inflows, i.e., reserves changes are more correlated with capital account movements. See [3].}\)
the excess supply of money to be taken out on the current account. To the extent that our results can be interpreted at their face value, there are basic economic forces underlying the fixed-rate regime and these forces will out. Appropriately enough, Hume recognized the folly of trying to obstruct these basic economic laws. If there exists an excess demand for money, reserves will flow in "by a hundred canals of which we have no notion or suspicion" [2, p. 42].
LITERATURE CITED


DATA APPENDIX

\[ R_j \]
- Reserves of Country j, defined to include gold plus foreign exchange plus "reserve position in the Fund" minus the "use of Fund credit."

\[ R_w \]
- World reserves. Calculated as the sum of the \( R_j \).

\[ \text{EXD}_j \]
- Excess demand for real money balances in Country j, expressed in U.S. dollars.

\[ \text{EXD}_w \]
- Sum of the \( \text{EXD}_j \).

\[ (D/S)_j \]
- Demand for real balances divided by the supply of real balances for Country j.

\[ (D/S)_w \]
- Calculated as the supply of real balances at the world level, \( S_w \), plus \( \text{EXD}_w \) all divided by \( S_w \), i.e., \[ \frac{S_w + \text{EXD}_w}{S_w} \]

\[ M^* \]
- Rate of change in the proportion of Country j's percent of world money, i.e., \( (M_j/M_w) (M_j/M_w)_{t-1} \) where all M's are in real terms and expressed in terms of U.S. dollars. \( M^* \) was calculated for both the narrow and extended definitions of money.

\[ Y^\star \]
- Calculated as \( (Y_i/Y_w) (Y_i/Y_w)_{t-1} \) where all Y's are in real terms and expressed in U.S. dollars.

All data are from the IFS tapes. Reserves are in nominal terms—all other variables are in real terms. With hindsight it may have been appropriate to deflate reserves. But the deflation would have to be done after \( \Delta R \) is calculated in order that the direction of reserve flow not be inverted by correcting for prices.