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The Monetary Approach to the Balance of Payments with an Empirical Application to the Case of Panama*

The monetary approach to the balance of payments explains the elimination of payments disequilibrium in terms of factors bringing the demand and supply of money into equality. It treats the supply of money as endogenous by assuming a feedback from the balance of payments through changes in international reserves to changes in the monetary liabilities of the central bank and government.

One of the important questions of monetary policy is the extent to which the monetary authority of an open economy can affect the price level or the other arguments of the demand for money, such as the level of real output and the interest rate. If it were the case that these could not be changed, then any increase in monetary liabilities

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of the authority would be met by an equal and offsetting outflow of international reserves (or an equiproportionate rise in the price of home goods and foreign exchange), and one would have to argue that monetary policy had no influence on the real responses of the system.

We argue below that monetary policy will have real effects since it produces changes in relative prices. An example of such a change would be a rise or fall of prices of nontraded or home goods relative to world prices in a regime of either fixed or flexible exchange rates. Thus the effectiveness of monetary policy in an open economy may depend on the existence of a group of commodities whose relative prices can be influenced by domestic conditions of demand and supply. The simple monetarist models do not allow such commodities but focus on a world in which prices are given to each trading country. One of the purposes of this chapter is to widen these assumptions, to allow for nontraded goods, and implicitly to bring monetary policy back into the monetarist model.

A second purpose of the chapter is to clarify the effects of external shocks on the balance of payments. The simple monetarist model may provide an incorrect answer to the question: "What is the impact effect of an increase in particular world prices on the balance of payments of a small country?". The simple model tells us that the balance of payments will temporarily improve as the higher prices produce an increase in the demand for the stock of money. But we shall see that the answer is far more complex. Indeed the effects on the balance of payments depend on whether it is import or export prices that have risen and on a more traditional consideration of elasticities of demand.

This chapter is organized into five sections. Section 1 will discuss the small country model in which the price level and other determinants of the demand for money are exogenous. Section 2 will develop a small country model in which the price level is endogenous. Section 3 will discuss some of the issues involved in empirical testing of the model, and an Appendix treats a more complicated version of the model. Finally, Section 4 discusses some empirical estimates for the case of Panama and Section 5 summarizes the results.

1. SMALL COUNTRY MODEL—EXOGENOUS PRICE LEVEL

One of the first methodological approaches in the area of monetary models of the balance of payments was the specification and testing of the simple, small country model.[1] In such a model the balance of the payments of the country is shown to be positively related to the demand for money and negatively related to the domestic sources of the supply of money, the latter being exogenous to the former.

To see how these results may be obtained, assume that because of fixed effective exchange rates the local price level is fully determined in the world market; that all goods are transportable and markets are perfect so that only one price prevails; and that the country is too small for its quantities purchased and sold to have an effect on world prices, or for its balance of payments deficits and surpluses to have an effect on the world money stock, so that there is no lack of effective demand and aggregate output is supply determined.

Next assume that the country is in equilibrium in the sense that the demand for the money stock, M_d, is continuously equal to the supply of the money stock, M_s. In the simple model, neglecting the commercial banking system, the supply of the money stock is definitionally equal to two sets of liabilities, those of foreign governments, R, and those of the locals, D.[2] The condition of stock equilibrium may then be written:

$$M_d = R + D \tag{9-1}$$

Noting that the three terms are subject to change over time, the theory implies that ΔR may be written as follows:

$$\Delta R = \Delta M_d - \Delta D \tag{9-2}$$

Note that ΔR is the balance of payments.

The empirical implications of Equation (9-2) are that exogenous factors increasing the demand for the money stock (increased prices or output and decreased costs of money holding) will yield a surplus in the balance of payments, while *ceteris paribus* increases in the supply of local monetary liabilities will yield a deficit.[3] In a statistical regression with ΔR the endogenous dependent variable, the theory would lead one to expect a coefficient on ΔD of minus unity, positive coefficients on the (exogenous) changes in the price level and real output.[4]

Empirical tests of the small country model have been carried out by fitting the balance-of-payments function, Equation (9-2), to the right-hand variables (ΔD, and the arguments of ΔM_d) on the assumption that they are all exogenous and the error term results from the M_d equation. The results have been mixed. Some investigators have reported a coefficient on ΔD of minus unity; others obtain a smaller absolute coefficient. Almost all investigators obtain positive coefficients for real income and the price level (which increase M_d), but the coefficients are often different, suggesting that the price level may play a different role from real output in affecting the demand for money. Many of the tests are statistically significant, and the goodness of fit is taken as confirmation of the empirical validity of the model.[5]

This methodology does not permit a definitive test of the proposition that under fixed exchange rates domestic prices are unaffected by monetary policy (most of the tests were carried out for countries with fixed rates). While the data generally do not reject the implications of the small country assumptions, the tests may be insensitive to the possibility that the assumptions are false. What is needed then is a model that is so specified that local prices may be identified as either endogenous or exogenous, depending on the values of certain empirically estimable parameters or on certain statistical relationships that hold in one case and not the other. In Section 4 we make a direct test of the model's underlying hypotheses that local prices move proportionately to world prices and that domestic credit expansion does not affect local inflation.

Before such a model is presented, however, it is useful to look more carefully at the assumptions underlying Equation (9-2). Some of these assumptions may be retained in the later model. Others require considerable exploration and change, particularly if the model is to be applied to a wider variety of country experiences.

1. One problem with Equation (9-2) is definitional: in a developed banking system with a central bank the authority issues high-powered money, H, that is, $H = R + D$, and the relevant measure of D comes only after an examination of the combined financial operations of the central bank and the Treasury; while R consists not simply of gold reserves, *SDR*s and deposits of foreign exchange, but must be corrected for official holdings of the short-term liabilities and assets. There are a number of possible institutional settings in which correct measurement of ΔH, ΔR, and ΔD will not occur by looking only at the balance sheet of the central bank. A few of these are international reserves are held by more than a single government department, or held by the Treasury alone; high-powered money is issued by both Treasury and central bank; the government's short-term liabilities are held by foreign governments and central banks. For these reasons we would submit that the correct way to measure changes in D is through the flows over time in the government–central bank budget constraint. In this definition the sources of government funds consist of tax revenues, t, the net

issuance of debt, i_g, and the issuance of high-powered money, h. (Henceforth flows are denoted by small letters.) The uses of government funds are the net acquisition of international reserves, r, and the purchase of goods and services, y_g. This definition may then be used to express the components of $\Delta H = \Delta D$ as

$$h = r + (y_g - t - i_g) \tag{9-3}$$

The last three terms thus constitute the ΔD that must be measured.

2. A second question relating to Equation (9-2) is the appropriate time period over which it holds. Actual money holdings may differ substantially from desired stocks over long periods of partial adjustment, implying expansions in domestic credit do not immediately "leak out" and over relevant time horizons the sum of coefficients of lagged values of ΔD sum to less than unity. However, there are greater difficulties with the simple model than the appropriate lag structure.

3. Perhaps the strongest assumption underlying Equation (9-2) is that the determinants of the demand for money are exogenous, and therefore, unaffected by the supply of money. To see how extreme this assumption is, consider what it implies for the price level. While foreign prices may be independent of the money supply can the same be true of prices of nontraded goods? To make a case for such a proposition, one would have to argue that the price of nontraded goods is strictly proportional to export and import prices. However, to satisfy equilibrium conditions these prices also must bear a determinate relation to each other, which depends on the production transformation function and the state of demand, a relation that would be proportional only under very specific assumptions. Thus the assumption of independence of money demand and supply is broken once nontraded goods are allowed into the picture. In the next sections we explore the implications of such a more complicated model.

Once we do assume that all prices are fixed in the world market, then it is easy to see why the level of output and employment are independent of monetary policy. Why should anyone close down a factory or lay off workers if he can see all his output at a fixed price in the world market? One would have to assume institutionally fixed wages to have unemployment in such an economy; and even then the output level would be exogenous in the sense that producers can sell what they wish, abroad if not at home, and cannot be influenced by domestic manipulation in aggregate demand.

While the assumption of exogenous output is therefore logically consistent with the small country hypothesis, it seems unsatisfactory as a maintained hypothesis. Even small countries seem to have experienced periods of Keynesian unemployment and less than desired output by producers. Moreoever, imports appear to have a positive statistical association with short-run variations in real output in a manner contrary to that implied by Equation (9-2). Thus a more theoretical structure is needed to understand why the overall balance of payments appears explainable in a model that does not attempt to explain variations in output. This problem also will be explored below.

2. A SMALL COUNTRY WITH ENDOGENOUS PRICE LEVEL

To keep the presentation simple, we will assume that the government issues money, there are no banks, and no market in securities. Later in the chapter these institutions will be introduced, but the logic of the model may be seen by abstracting from them.

It is assumed that the household earns income from the production of an export good, x, and a home good, y. Income is disbursed on the home good, y_h, an imported good, v, on the flow accumulation of cash balances, m, and on the payment of taxes, t.[6] All the symbols are in nominal money units. Thus we have

$$x + y \equiv y_h + v + m + t \tag{9-4}$$

It is assumed that government finances its expenditure through taxation, t, and the issuance of money, m^s. These funds are spent on the net purchase of international financial assets, r, and on the purchase of the home good.[7] We have

$$t + m^s \equiv r + y_g \quad \text{or} \tag{9-5}$$
$$m^s \equiv r + y_g - t = r + d$$

The excess demand for home goods may then be written:

$$E(y) \equiv y_h + y_g - y = x - v - m - t + y_g$$

When the definitions of the balance of payments ($r = x - v$) and of the government budget constraint are introduced, we have

$$E(y) \equiv m^s - m$$

Looking behind the definitions to the economic determinants of m^s and m, we shall demonstrate that excess demand for home goods is a function of P_y and the money stock M_s. We shall then assume that the home good market is cleared by the movement of that price.[8]

This model stands in contrast with the simple one-country model presented earlier, where the only endogenous variable is r, determined by a structural equation (9-2). As we saw earlier, that relation implied a positive relation between r and prices. But in the present model, P_y is endogenous, related to d, and is not fixed; thus (9-2) is not sufficient to determine r. An additional relation in which the home goods market clears is necessary. It will be seen that the second relation, which also implies a relation between r and P_y, can be interpreted as the "conventional wisdom" on the balance of payments and underlies the usual "micro" approach to balance-of-payments analysis.

To put it another way, in the short run with the money stock fixed a determinate price of y brings $E(y)$ to zero in a stable fashion. In addition, in the short run the flow of reserves, r, simultaneously adjusts the flow rate of increase in the money supply toward flow money demand. Thus to repeat, in the short run the model has two endogenous variables, r and P_y.

In the long run, M_s constitutes a third endogenous variable. In the long run, with the money stock determined by government budget activities and reserve increments, the money stock, r, and P_y all attain stable equilibrium values.

2.1. The Determinants of m^s: As shown in the government budget constraint (9-5), the growth of the money supply consists of two terms—r, the net growth of international financial assets, and a composite term $y_g - t$, which, in the simplified institutional setting assumed here, is the growth of domestic liabilities of the government, d. We shall assume that d is exogenous, but that r depends on the factors influencing exports and imports. Two factors stand out—P_y and M_s. It is assumed the prices of exports and imports are exogenous. When P_y rises, there will be two effects—a substitution of consumer spending away from y and toward imports and a substitution of production away from exports and toward y. Both effects will lead to an excess supply of y.[9] The two effects, also by assumption, lead to a reduction in the excess of exports over imports.

The balance of payments also depends on M_s, the money stock. Holding everything else constant, a higher level of M_s would lead to an increase of household expenditures and thus an increase of imports and a decline in the balance of payments position. To summarize, the determinants of m^s may be written:

$$m^s \equiv r\,(P_y, M_s) + d, \quad \text{where } r_1, r_2 < 0 \tag{9-6}$$

The $r\,(\cdot)$ function, which constitutes the traditional wisdom about the balance of payments, implies a negatively sloped relation between r and P_y for a given money stock, as shown in Figure 9-1. The function shifts downward for larger values of M_s.

2.2. The Determinants of m: We shall assume that the desired flow rate of hoarding responds to the stock disequilibrium. If households wish to hold more money than they have at present, then they will hoard, and conversely, if they wish to hold less. Thus it is immediately evident that the flow rate of hoarding is negatively related to M, the stock of money. But what determines the desired level of money stock; and will households move immediately to the desired level, or will they adjust fractionally and with a lag? We shall adopt the approach that households use money as a shock absorber to even out the flow of real consumption in the face of short-run variations in prices.[10] This role of money may be seen by rewriting the consumer budget constraint:

$$m \equiv x + y - y_h - v - t$$

An increase in the price of exports would raise the household's income. So would a rise in the price of the domestic goods since $y > y_h$. Assume that the household expects such increased income to be temporary and holds real consumption constant. This assumption implies that households engage in short-run hoarding or saving of money in the face of the expectation that real income will fall to

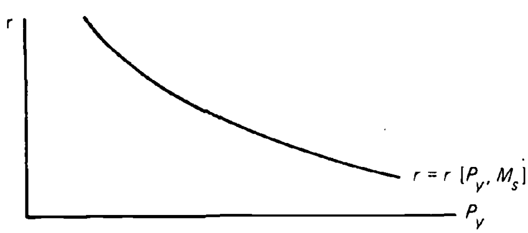

FIGURE 9-1. Graphical Relation Between Prices and the Balance of Payments—Monetarist View

its original level at a later date. Thus the holding of money as a shock absorber will be positively related to the price of y and price of exports. Import prices may also affect hoarding, though the direction of the relation is ambiguous.[11] It is also reasonable to assume that the demand for money as a shock absorber is negatively related to the amount of money so held.

Households also store wealth in the form of money. This part of the demand dominates in the long run but presumably changes more slowly and will not be discussed in detail in the theoretical model. However, in any econometric estimation involving changes over time one would expect long-run demands for wealth to play a role.

We shall then write m in terms of its determinants:

$$m = f(P_y, M_s) \qquad f_1 > 0, f_2 < 0 \tag{9-7}$$

Combining (9-6) and (9-7), the market clearing of the price of domestic goods can be written as a single equation:

$$\dot{P}_y = g(E[Y]) = g(m^s - m) = g(r[P_y, M_s] + d - f[P_y, M_s]) \tag{9-8}$$

For a given level of the money stock and of d, Equation (9-8) implies a stable market clearing process since $r_1 < 0$ and $f_1 > 0$.

Over time the money supply will also change, as a consequence of the government budget and balance of payments flows, and a second equation is added:

$$\dot{M}_s = m^s = r(P_y, M_s) + d \tag{9-9}$$

For a given level of d, the money stock and price level reach equilibrium through a stable process at which $m^s = 0$; $m = 0$, $r = -d$.[12]

2.3. Equilibrium with Fixed and Variable Money Supply. The approach to short-run equilibrium may be depicted graphically by imposing on Figure 9-1 the representation of the flow money market equilibrium condition $m^s = m$. Writing this as $r = -d + f(P_y, M_s)$ we may plot the relation as an upward sloping function in the r, P_y plane. This is shown in Figure 9-2, together with the negatively sloped "micro" relation $r = r(P_y, M_s)$.

As mentioned earlier, the upward sloping relation is an implication of the simple, small country approach discussed at the beginning of the chapter. If P_y were exogenous, as claimed in that model, then there would be no need for the graph. The flow of reserves would be determinate, as only one r satisfies the flow equilibrium relation,

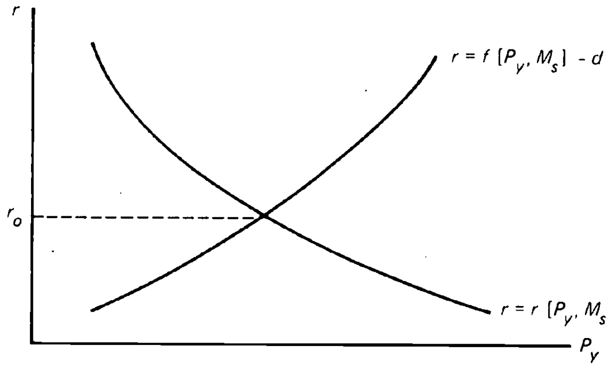

FIGURE 9-2. Joint Determination of the Balance of Payments and Home Goods Prices

$r = f(P_y, M_s) - d$, for the given values of P_y and M^s. However, in the present model P_y is endogenous, and the short-run, flow equilibrium pair, P_y, r, are found at the point on the $r(P_y, M_s)$ function that implies equilibrium in both the home goods and money markets.

The approach to equilibrium with a variable money supply may also be described in Figure 9-2. Suppose for the sake of example that the intersection, r_0, is a positive balance of payments, and $d = 0$. Then the money stock will increase. The negatively sloped r ( ) function will shift back to the left, and the positively sloped $m = m^s$ function will shift down to the right. The net effect is to eliminate the balance-of-payments surplus and change the money supply at full long-run equilibrium when stock as well as flow demands equal supplies.

We can now see the short-run and long-run effects of changing d. Begin at full equilibrium with $d = 0$. Then raise d to some positive number. In the short run, holding M^s constant this yields an increase of P_y equal to $-1/(r_1 - f_1)$ and a reduction of r equal to $-r_1/(r_1 - f_1)$. This increase of d will yield money supply growth because $\Delta r/\Delta d + 1 > 0$.

In the new full equilibrium, when the money supply stops growing the flow value of r equals the negative of d while P_y has risen (from the original $d = 0$ equilibrium) by $-f_2/r_2(r_1 - f_1) - r_1(r_2 - f_2)$. Whether P_y rises more in the long run than the short run depends on the difference $r_2 - f_2$.

Note that this long run does not imply homogeneity of degree zero; that is, the equilibrium real money stock is not necessarily invariant to changes in the flow rate of domestic credit creation, d.

Unlike the result of the simple model, all domestic credit creation does not leak out through corresponding losses in reserves. The reason is that the creation of domestic credit raises the demand for home goods and household's perception of their long-run incomes since $y > y_h$. Households, by assumption, are unaffected by the falling relation of reserves to domestic credit in the equilibrium money stock that this credit creation implies.

In a more realistic world, where international reserves are limited, households might use the change in the composition of the money stock in forming their expectations about the future course of relative prices and react accordingly. In other words, the composition of the money stock would enter the behavioral functions. However, in such a world governments also would act to stem the reserve loss by either reducing credit expansion or varying the effective exchange rate. Of course, the latter policy might include variations in tariffs and other limitations on international commerce and finance as well as straightforward variations in the exchange rate. The discussion of these reactions by households and governments goes far beyond the scope of this chapter and will be treated in the authors' future work.

2.4. **The Shock Absorber Hypothesis.** The shock absorber hypothesis is derived from the permanent income theory of consumption. It underlies the preceding discussion of the hypothesis that cash hoarding and dishoarding are used to maintain a constant level of utility in the face of expected but temporary variations in real income. Deeper examination of this hypothesis reveals more clearly the nature of the $r(P_y, M_s)$ and $f(P_y, M_s)$ functions discussed earlier and permits a closer identification of the exogenous elements of the government budget constraint. Look again at the household budget constraint and rewrite it in terms of prices and quantities.

$$m \equiv x \cdot P_x + y \cdot P_y - y_h \cdot P_y - v \cdot P_v - t$$

where x, y, y_h, and v all now represent quantities rather than nominal values. Now assume that t, P_x, and P_v are fixed and derive $f_1 = \delta m/\delta P_y$.

$$\delta m/\delta P_y = \left[P_x \cdot \frac{\delta x}{\delta P_y} + P_y \frac{\delta y}{\delta P_y}\right] - \left[P_y \cdot \frac{\delta y_h}{\delta P_y} + P_v \frac{\delta v}{\delta P_y}\right] + y - y_h \qquad (9\text{-}10)$$

Assuming competitive equilibrium in the production of x and y, the first bracketed term is zero. Assuming consumer utility maximization and a fixed level of utility, the second bracketed term is zero. Thus the effect on hoarding of a change in P_y is

$$\delta m/\delta P_y = y - y_h > 0 \qquad (9\text{-}10')$$

Now look at the balance-of-payments relation implied by the shock absorber demand for hoarding. Rewrite the budget constraint and derive $r_1 \equiv \delta r/\delta P_y$.

$$r \equiv x \cdot P_x - v \cdot P_v \equiv m - yP_y + y_h P_y + t \qquad (9\text{-}11)$$

$$\delta r/\delta P_y \equiv \delta m/\delta P_y - y + y_h - P_y \frac{\delta y}{\delta P_y} + P_y \frac{\delta y_h}{\delta P_y}$$

Substituting from above, we see

$$\delta r/\delta P_y = - P_y \frac{\delta y}{\delta P_y} + P_y \frac{\delta y_h}{\delta P_y} < 0 \qquad (9\text{-}11')$$

Note that $\delta y_h/\delta P_y$ is negative for a constant level of utility. Thus the negative slope $\delta r/\delta P_y$ depends only on substitution effects in the production and consumption of y.[13]

It may also be seen that m and r depend negatively on the actual amounts of cash held. Assume that the consumption levels y_h and v depend on cash holdings. Then

$$\delta m/\delta M_s = - P_y \cdot \delta y_h/\delta M_s - P_v \cdot \delta v/\delta M_s \qquad (9\text{-}12)$$

and

$$\delta r/\delta M_s = - P_v \cdot \delta v/\delta M_s \qquad (9\text{-}13)$$

We may now see more clearly the $r(P_y, M_s)$ and $f(P_y, M_s)$ functions underlying the equilibrium depicted in Figure 9-2. The $f(\ )$ function depicts the behavior described in (9-10) and (9-12); the $r(\ )$ function depicts that described in (9-11) and (9-13). The condition of equilibrium that implies $m^s = m$ may again be written as the upward sloping function.

$$r = m - d = f(P_y, M_s) - d \qquad (9\text{-}14)$$

While the downward sloping r function may be written

$$r(P_y, M_s) = m - yP_y + y_g P_y + y_h P_y + t = f(P_y, M_s) \qquad (9\text{-}15)$$
$$- E(y) - d$$

Exogenous shifts in the two functions may be seen by rewriting them with the d term made explicit:

$$r = (xP_x + yP_y - y_h P_y - vP_v - t) - (y_g P_y - t) \qquad (9\text{-}14')$$

$$r = (xP_x + yP_y - y_h P_y - vP_v - t) - (yP_y - y_h P_y - y_g P_y) \qquad (9\text{-}15')$$
$$- (y_g P_y - t)$$

It may be seen that a shift of d that occurred through a rise of government demand for y, holding t constant would shift (9-14′) but not (9-15′). On the other hand, a change in d that occurred because of an exogenous change in the level of tax collections would have *no* effect on either function because it would change the demand for hoarding by an equivalent amount. This rather extreme result is due to the shock absorber assumption that the household views changes in the determinants of its cash flow as temporary, maintaining a consumption level that yields a constant level of utility. There is no question that if a change in t were expected to be permanent, there would be a smaller effect on m because the household would change its long-run consumption level.

2.5. An Expanded Model. It is possible to increase the range of the model by introducing the commercial banking system and a central bank. The government-central bank will issue high-powered money to be used exclusively as a reserve by the commercial banks. There will be a securities market in the liabilities of government, business, and households, all assumed to pay the same interest rate, n. Securities will be purchased by foreigners, by households, and by banks. Security sales by businesses will be used to purchase the domestic good for capital construction.

The new assumptions lead to a new set of budget constraints, an additional market, and an additional dependent variable, the interest rate n. Whereas the simpler model was solved by finding an equilibrium price level and money stock, this expanded system also has an equilibrium interest rate. That is, we assume there are no small countries in the world capital market; additional borrowings require payment of higher interest rates.

Budget Constraints

a. Government-Central Bank
Sources of funds are $h + t + i_g$, respectively, the issuance of high-powered money, tax receipts, and net sales of debt. Uses of funds are $r + y_g$ as before, the net acquisition of international reserves and the nominal purchase of goods and services. This implies that $h = r + (y_g - t - i_g)$. We shall now denote the parenthesized term as d.

b. Commerical Banks
Sources of funds are m^s, the net issuance of new deposit liabilities. Uses of funds are $h + i_B$, respectively, the acquisition of high-powered money and the acquisition of securities.

c. Households
As before, sources of funds are $x + y$, the income generated from production of exports and home goods. Uses of funds are $y_h + v + m + t + s$, the same as before, but with the addition of s, the net purchase of securities.

The Securities Market

It will be assumed that the interest rate equilibrates the flow demand and supply of securities. The demand for securities consists of foreign demand b_k, plus the sum of household and bank demand, $s + i_B$. The supply consists of the sum of security issuance by government and businesses, $i_g + y_B$. When the securities market is thus in equilibrium, the balance on capital account is the net foreign purchase of securities.

$$b_k = i_g + y_B - i_B - s \tag{9-16}$$

Additional Behavior Assumptions

The cash hoarding demand m will now depend on P_y, M_s, n, and W, nonmonetary wealth, consisting of the net sum of securities owned by households. It will be assumed that cash hoarding will depend positively on W and negatively on n. It will also be assumed that the level of business investment depends negatively on n and that foreign purchases of securities depend positively on n.

Solution for P_y, M_s, and n

The new budget constraints again lead to the definition of excess demand for y equal to $m^s - m$.[14]

$$y_h + y_g + y_B - y \equiv m^s - m \tag{9-17}$$

Assuming that P_y brings the excess demand for y to zero, we may write:

$$m^s = f(P_y, M, n, W)$$

Furthermore, assume that the growth of the money supply bears a fixed ratio, ϕ, to the growth of high-powered money:

$$m^s \equiv \phi(r + d)$$

Then equilibrium in the market for home goods implies the relation

$$\phi(r + d) = f(P_y, M_s, n, W) \tag{9-18}$$

For fixed levels of d, n, M, and W, this may again be represented as a positive relation between r and P_y.

When we do not impose the condition $m^s = m$, the definition in (9-17) again implies a negatively sloped relation between r and P_y. This may be seen by rewriting (9-17)

$$\phi(r + d) = m + y_h + y_g + y_B - y \tag{9-19}$$

thus

$$r = r[P_y, M, n] \tag{9-19'}$$

The arguments given earlier indicate that in (9-19) $\delta r/\delta P_y < 0$ since $\delta r/\delta P_y$ depends on the substitution responses of the households and firms to the change in P_y. It may also be seen that in (9-19') r depends on n because both m and y_B will decline if n increases.[15]

The system is closed by noting that equilibrium in the securities market determines a relation between m and h; and therefore, there is a second relation between n and r. This may be seen by rewriting (9-16), noting that b_k and y_B depend on n, s depends on W, and i_B depends on h.

Thus we have

$$b_k(n) = i_g + y_B(n) - s(W) - i_B$$

Substituting the identity

$$i_B \equiv m^s - h = h(\phi - 1)$$

we have

$$b_k(n) = i_g + y_B(n) - s(W) + h(1 - \phi)$$
$$= i_g + y_B(n) - s(W) + r(1 - \phi) + d(1 - \phi)$$

So we may write

$$r = b(n, W) \tag{9-20}$$

To recapitulate, with a fixed level of the money stock M_s, and wealth W, Equations (9-18), (9-19), and (9-20) determine equilibrium levels of P_y, n, and r. When we allow the money supply to change as a result of the solution for r, a long-run equilibrium will be reached at which an equilibrium money stock is found. This solution implies $r + d = 0$. Thus in the long run, we have a solution for P_y, n, and M_s.

2.6. Floating Exchange Rates. Up to now the model has been applied to a fixed exchange environment in which the government purchased all the foreign exchange presented to it. It is possible to weaken this assumption so that one may simultaneously determine the price of home goods, the money supply, and the exchange rate. A free exchange rate system is usually conceived to be an environment in which the government fixes the money supply independently of the state of the balance of payments and allows the exchange market to set the price of foreign exchange. If the government allowed the money supply to be influenced directly by the state of the balance of payments, there could be no variation in the price of foreign exchange.

One can see the impossibility of simultaneous determination of the price of home goods, money supply, and exchange rate by writing the following market-clearing system. Note that p is the price of foreign exchange. (For the sake of simplicity, the discussion of this section ignores the capital market and returns to the model of Section 1.

$$\dot{P}_y = (r(P_y, p, M_s) + d - f[P_y, p, M_s]) \tag{9-21}$$

$$\dot{M}_s = r(P_y, p, M_s) + d \tag{9-22}$$

$$\dot{p} = -\theta(r[P_y, p, M_s]) \tag{9-23}$$

The determinant of this system would be zero. However, it is possible to model the three variables if one imagines government intervention in the exchange market that leans against movements in the exchange rate, but does not attempt to fix the rate. If, for example, the government purchased foreign exchange when the price fell and sold foreign exchange when the price rose, then an additional functional relation would be added to the model. It would link changes in the money supply to changes in the exchange rate. Moreover, the exchange rate would now bring the net sum of all international financial transactions to zero. Those transactions that the government chose not to clear through its own foreign exchange stabilizing operation would be brought to equality with those transactions carried out for stabilization purposes. An important result of this section is that the government demand for foreign exchange must be price elastic. That is, the government must increase the domestic currency value of foreign exchange purchases when the price of foreign exchange falls. An inelastic demand for foreign exchange would destabilize the model.

The assumed type of reaction function is not unrealistic. Most governments intervene in the exchange market even when there is no stated par value for foreign exchange. The problem with modeling such an assumption, however, is that the target level of p that triggers off such intervention will itself change from one period to another. In the conceptual model, this issue will be ignored, and the target level will be assumed a constant. The problem would surface, however, if an econometric specification were considered.

Government intervention in the exchange market requires a redefinition of variables. In particular, r will now denote the net excess supply of foreign exchange, consisting of the sum of two elements, r^o, the private supply, and r^1, the government demand.[16] Note that both r^o and r^1 are measured in the domestic currency. The term r^1 denotes government purchase (or sale) of foreign exchange. It will be assumed that

$$r^1 = j(p) \qquad j' < 0$$

Government buys foreign exchange when its price falls, and sells foreign exchange when its price rises. The government budget constraint is then $m^s = r^1 + d$.

The new model is now written as follows:[17]

$$\dot{P}_y = r^o(P_y, p, M_s) + d - f(P_y, M_s) \qquad (9\text{-}21')$$

$$\dot{p} = -\theta(r^o(P_y, p, M_s) - j[p]) \quad (9\text{-}22')$$

$$\dot{M}_s = j(p) + d \quad (9\text{-}23')$$

It is assumed that P_y and p quickly reach equilibrium for a fixed level of the money supply. The determinant of the system in P_y and p is positive if $j' < 0$, as assumed. The value of this determinant is $j'(r_1^o - f_1) + f_1 r_2^o$. Also note that a higher level of the money stock implies a higher price of foreign exchange. Over time the money stock will change if $j + d \neq 0$, and the money stock will reach a stable equilibrium if $\delta M_s / \delta M_s \equiv j'(\delta p / \delta M) < 0$. This is assured if $j' < 0$. It is clear then how important the assumption of exchange rate intervention ($j' < 0$) is to determine this hybrid system. Note that both the exchange rate and money supply are determinate and that the exchange rate brings r^o (the portion of the excess demand for foreign exchange that the government does not accommodate) into equality with $-r^1$.

3. SOME ASPECTS OF ECONOMETRIC ESTIMATION: A MODEL INVOLVING HOME GOODS, NO SECURITIES, NO BANKS, FIXED EXCHANGE RATES

We shall derive reduced form estimating equations for the preceding models on the assumption that the data satisfy short-run but not necessarily long-run equilibrium. Thus it is assumed that $m = m^s$ (the demand for hoarding equals the flow of new cash), but that the money stock continues to change as a result of new shocks to its exogenous component d. The statistical implications of this hypothesis will be contrasted with rival hypotheses about the determinants of the money supply.

The model may be written as a set of linear equations and put into the reduced form. It is also possible to include M as an endogenous variable, changing over time in response to the identity $m^s \equiv r + d$. In that case the final reduced forms involve distributed lags of exogenous variables—the government deficit, d, and the export and import prices, P_x and P_v.

The hoarding function $f(P_y, M_s)$ can be written

$$m = a_o + a_1 P_y - a_2 M + a_3 P_x - a_4 P_v \quad (9\text{-}24)$$

The equality of m^s and m may then be written:

$$r = -d + a_o + a_1P_y - a_2M + a_3P_x - a_4P_v \quad (9\text{-}25)$$

[18]

The balance of payments equation $r = r(P_y, M_s)$ will be written:

$$r = u_o - u_1P_y - u_2M + u_3P_x + u_4P_v \quad (9\text{-}26)$$

The coefficients of P_x and P_v reflect the assumptions that a rise of P_x will increase m and r, a fall of P_v will increase m, and has an ambiguous effect on r.

Equations (9-25) and (9-26) can be solved for r by eliminating P_y.

$$r = B_o - B_1d - B_2M + B_3P_x - B_4P_v \quad (9\text{-}27)$$

where the Bs are functions of the as and us. Unfortunately, this system is not identified, that is, if Equation (9-27) is estimated we cannot obtain the original values of the as and us. However, if we assume that P_v does not affect the demand for money, as discussed earlier, the system is just identified.

If it seems desirable to incorporate M as an endogenous variable, we note that $M_T = M_o + \sum_0^T (r_T + d_T)$. When this definition is substituted in (9-27) a difference equation may be formed:

$$\begin{aligned} r_T = {} & v_1r_{T-1} - v_2d_T + v_3d_{T-1} + v_4P_{xT} - v_4P_{xT-1} \\ & - v_5P_{vT} + v_5P_{vT-1} \end{aligned} \quad (9\text{-}28)$$

This difference equation may be expressed as r_T equal to a sum of weighted lagged terms in d_T, P_{xT}, and P_{vT} where the weights decline to zero. That is,

$$r_T = \sum_0^T \delta_T d_T + \sum_0^T \epsilon_T P_{xT} + \sum_0^T \theta_T P_{vT} \quad (9\text{-}29)$$

where the coefficients of the lagged exogenous variables represent weights that decline to zero. A least squares estimation procedure may be used by truncating the length of the lags. Once an estimate of r_T is obtained, it can be used to estimate M_T, and P_y may be estimated in the second stage from either (9-25) or (9-26). The discussion of the shock absorber hypothesis suggests that d might be replaced by y_g in (9-25).

4. SOME EMPIRICAL RESULTS: THE CASE OF PANAMA

Panama represents an interesting test case for the monetary model of the balance of payments. In addition to being physically small, which should tend to reduce the relative size of the home goods sector, it is one of the few countries in which foreign and domestic currency circulate side by side. The rate of exchange has been maintained at par with the dollar and is unlikely to change although there may have been some variations in the effective rate of exchange.[19] Thus it seems that the simple monetary theory should be quite appropriate in the case of Panama.

The simple monetary model yields two directly testable hypotheses—that local prices move in proportion to international prices and that domestic credit expansion has no effect on the rate of change of prices. To test the first hypothesis the growth rate of local prices, as measured by the consumer price index, was regressed on the growth rate of import prices, yielding the following equation:[20]

$$\begin{aligned}&\text{Growth rate of consumer prices}\\ &= 0.19 + \underset{(0.10)}{0.47}\ \text{Growth rate of import prices}\end{aligned}$$

$$R^2 = 0.97\ SEE = 1.33\ DW = 1.55\ \text{(no serial correlation)}$$

That is a 10 percent growth in import prices causes a growth in consumer prices of between 2.7 and 6.7 percent, but *not a 10 percent* growth as the simple model predicts. Regressions of the logarithms of consumer prices on import prices or import and export prices yield elasticities significantly less than one.[21] This result would reject the applicability of the simple model.

To test the second hypothesis, domestic prices were regressed on domestic credit creation, changes in reserves, real growth, and import prices. The influence of domestic credit was found to be significantly positive although quite small. Import prices had an insignificant effect on the growth of domestic prices when domestic credit was included. Thus this direct test also rejects the applicability of a simple model.

The effect of reserve growth on prices was generally insignificant. Since there is a high inverse correlation (-0.81) between reserves and import prices one might imagine that to some extent reserves act as a buffer to import price changes and at the same time buffer the effect of import prices on the domestic price index.[22]

As a preliminary test of the model of the balance of payments described in Section 2 we linearize equations (9-6) and (9-8), shown in Figure 9-2, and add an error term.[23]

$$r = a_o \underset{(+)}{+ a_1 P_y} \underset{(+)}{+ a_2 P_x} \underset{(-)}{+ a_3 M} \underset{(-)}{+ \alpha_4 d} + u_I$$

$$r = b_o \underset{(-)}{+ b_1 P_y} \underset{(+)}{+ b_2 P_x} \underset{(-)}{+ b_3 M} + b_4 P_v + u_{II}$$

where the expected signs of the coefficients are shown in parentheses. These structural equations are just identified[24] but were estimated with two stage least squares to facilitate hypothesis testing.

The estimated structural equations, using the estimated values of r and P_y, respectively, are:

$$P_y = 91 + \underset{(0.02)}{0.06\, d} + \underset{(0.03)}{0.04\, \hat{r}} + \underset{(0.01)}{0.06\, M_{t-1}} + \underset{(0.02)}{0.04\, P_x}$$

$$R^2 = 0.99 \; SEE = 0.68 \; DW = 1.03$$

$$r = 2199 - \underset{(7.0)}{29.9\, \hat{P}_y} + \underset{(0.44)}{1.51\, M_{t-1}} + \underset{(0.50)}{1.69\, P_x} + \underset{(1.51)}{4.9\, P_v}$$

$$R^2 = 0.91 \; SEE = 10.7 \; DW = 2.6$$

All variables are significant at the 95 percent level and of the correct sign except r, which is significantly positive at only the 90 percent level in the first equation, and M which is significantly positive in the second. As the hypothesis suggests, the coefficients of d and r are essentially the same (actually 0.056 and 0.042).[25] Imports appear to be highly elastic, that is, a rise in import prices reduces both import quantity and expenditure on imports substantially. Exports appear to be in elastic supply.

5. CONCLUSION

This paper develops an extended version of the monetary model of the balance of payments in which home goods provide some monetary independence in a fixed exchange rate economy. That is, an expansion of domestic credit does not fully leak out through an exactly equal loss of international reserves, but is partially absorbed by an increased demand for money, brought about by an increased relative and absolute price of domestic goods. The increased price of domestic goods occurs because government (flow) monetary creation (in excess of monetary demand at stable prices) represents an excess of purchasing power, relative to production, that must fall partially on home goods. Within this home goods model the extent of the reserve loss and local price change can be shown to be interdependent and to depend partially upon the traditional elasticities. The analysis can be extended to analyze the effect of exogenous changes in foreign prices and to include trade in securities as well as goods. In the latter case a local interest rate as well as a local price level is determined.

This analysis should not be interpreted to mean that "excess" domestic credit creation will leave international reserves intact. In fact, as we show, the quasi-equilibrium is one in which the flow loss of reserves equals the constant flow expansion of domestic credit although the total loss in reserves will be less than the expansion of credit. Clearly such a flow loss would be untenable in the long run and any country suffering such a loss would be forced to initiate some sort of corrective action.

In the last section of the paper we perform some econometric tests using data from Panama, which allow us to distinguish between the extended and simple monetary model. Panama was selected owing to the openness of its economy and the fact that U.S. currency circulates freely.

We show that even in an economy as open as Panama foreign and local prices do not move proportionately, as the simple model would predict, and that domestic credit does influence the local price level, contrary to the simple model. These results suggest that the extended model, involving the simultaneous determination of reserve loss, and the price level, is more appropriate. This model was then estimated using two-stage least squares and yielded satisfactory results, while the straightforward estimate of the reserve loss as a function of domestic credit expansion, assuming domestic prices exogenous as implied by the simple model, performs poorly.

NOTES

1. For example, see Johnson (1961) and Mundell (1968) for representations of such a model. Collery discusses how Hume's price specie flow model differs from the modern monetary theory of the balance of payments, elements of which are found in Johnson (1973) and Mundell (1971). A recent summary of the monetary model can be found in Whitman.

2. If we include a commercial banking system, then the money stock consists of net domestic and foreign assets of the consolidated banking system.

Under fractional reserve banking, domestic assets would be related to member bank reserves, which would in turn depend upon loans and foreign assets of the central bank. See note 3.

3. It is assumed implicitly or explicitly that demand for local money is independent of the ratio $R : D$ and, if asset markets are also considered, the interest rate is independent of the same ratio.

4. Assuming fractional bank reserves of $RR\%$, that currency is a liability of the central bank and a constant fraction, c, of bank reserves, and that either foreign exchange reserves of commercial banks are zero or count as bank reserves, we have

$$\begin{aligned} M_d &= \textit{Demand Deposits} + \textit{Currency} \\ &= MBR/RR \qquad + cMBR \\ &= \frac{(D+R)}{1+c}\left(\frac{1}{RR}+c\right) = (D+R)\,\frac{1+c\,RR}{(1+c)\;RR} \end{aligned}$$

$$\Delta R = -\Delta D + \Delta M^d\,\frac{(1+c)\,RR}{1+c\,RR}$$

and the hypothesized coefficient of ΔD remains unity, with ΔR = the change in the banking system's holdings of reserves.

5. In an unpublished paper written in April 1974, Hans Genberg noted twenty-five studies of the empirical aspects of the monetary approach to balance of payments.

6. The general nature of the results does not change if exportables are consumed or importables produced. See Jones for a discussion of the real interactions of production and consumption where all three goods may be produced and consumed.

7. For the results of the model it is only necessary that the government buys some of the nontraded good although the above representation may be a reasonable approximation of behavior.

8. Thus there is no lack of demand because of the possibility of fixed prices in the home goods sector. For a similar model in which lack of demand and unemployment may result from a fixed wage price vector see Grossman, Hanson, and Lucas.

9. Rudiger Dornbusch analyzes a micromodel of devaluation in which the excess demand for the home good is offset by fiscal policy. This chapter assumes instead that excess demand for the home good is corrected in the short run by changes in its price and in the balance of trade (P_y and r); and in the long run it is corrected by changes in its price and in the money stock (P_y and M).

10. See Michael Darby's paper for a statement of this theory applied to the demand for consumer durables. Except for the results on the price of imports, all the results of this chapter can be obtained using the usual demand for money function.

11. A change in import prices that was known to be permanent would seem to have no affect on long-run money holdings since it does not cause a change in

the division of expenditures between present and future. A permanent rise (fall) in import prices would lower (raise) the real value (in terms of utility) of present consumption and saving-wealth-future consumption in exactly the same proportion. Therefore, there would be no incentive to vary hoarding. See Kemp for a discussion of this point.

A change in import prices that is not known to be permanent could affect hoarding either positively or negatively. When import prices fall temporarily, there is a tendency to spread the potentially higher level of consumption over the future by using cash balances as a shock absorber. On the other hand, if imports are durables, which may be an important case in developing countries, then there will be some tendency to take advantage of abnormally low prices by substituting holdings of goods for cash. See also note 13. Notice that both the income and speculative effects work in the same direction for home goods, as $y > y_h$.

12. It is assumed that P_y reaches an equilibrium for a given level of M_s and then is displaced by changes in the level of M_s. The stability of this process thus depends on sign $dM_s/dM_s = r_1(P_y/M_s) + r_2 = (r_1f_2 - r_2f_1)/(r_1 - f_1)$. Under the sign assumptions in the text this derivative is negative.

13. These relations may also be used to identify the effect of an exogenous increase in P_v, the price of imports. Using the same arguments as above we see that $\delta m/\delta P_v \equiv f_3 = -v$; while $\delta r/\delta P_v \equiv r_3 = -v - P_v(\delta v/\delta P_v)$. Thus, both of the curves shift in Figure 9-2 as a consequence of the increase in the price of imports. The upward sloping $f[\ ] - d$ function shifts downward while the downward sloping $r[\ ]$ function may shift in either direction, depending on the (utility constant) price elasticity of demand for imports. The impact on P_y is unambiguously positive since $\delta P_y/\delta p_v = (f_3 - r_3)/(r_1 - f_1) > 0$. The impact on r the balance of payments function is ambiguous since $\delta r/\delta P_v = (r_1f_3 - r_3f_1)/(r_1 - f_1)$. Note, however, that even if expenditures on imports are unchanged ($r_3 = 0$), the balance-of-payments effect will be negative since the higher P_y draws resources out of export production.

14. A series of substitutions lead to this result:

$$E(y) \equiv y_h + y_g + y_B - y \equiv x - v - m - s - t + y_B + y_g.$$

Substitute $b_k = i_g + y_B - s - i_B$

$$E(y) \equiv x - v - m - t + y_g + b_k - i_g + i_B.$$

Substitute $m^s \equiv h + i_B$

$$E(y) = x - v - m - t + y_g + b_k - i_g + m^s - h.$$

Note the definition of the balance of payments

$$r \equiv x - v + b_k$$

and substitute the government budget constraint.

15. As in the case discussed in Section 3, the two functions (9-18) and (9-19) shift asymmetrically with a change in d. This may be seen by rewriting (9-18) and (9-19) explicitly

$$\phi r = m - \phi d = x + y - y_h - v - t - s - \phi(y_g - t - i_g) \tag{9-18$'$}$$

$$\phi r = m - y + y_h + y_B + y_g - \phi(y_g - t - i_g) \tag{9-19$'$}$$

A number of variations of d are possible. If t and i_g are constant and y_g varies, then

$$\delta r / \delta d = -1$$

$$\delta r / \delta d = (1 - \phi)/\phi < 0$$

If y_g and i_g are constant, and t varies,

$$\delta r / \delta d = (1 - \phi)/\phi$$

$$\delta r / \delta d = -1$$

If y_g and t are constant, and i_g varies,

$$\delta r / \delta d = -1$$

$$\delta r / \delta d = -1$$

Those differences can play a role in identifying the econometric counterparts of (9-18) and (9-19).

16. The net private supply of foreign exchange $r^o = r^o(P_y, p, M_s)$ is derived from the function $r = r(P_y, M_s)$ described earlier in equation (9-6). It is assumed that $r_1^o < 0$, $r_2^o > 0$, and $r_3^o < 0$.

17. The function f would depend on the exchange rate if the demand for hoarding rises when foreign prices rise. In fact, under the shock absorber hypothesis m is independent of p since a change in traded goods prices changes the money value of exports and imports equiproportionately. Starting the analysis at a current account equal to zero, the change in p leaves m unchanged.

18. Notice that Equation (9-25) precludes a long-run demand function for money that is homogeneous of degree zero. While we have previously hypothesized homogeneity, it would be useful to test the hypothesis. Unfortunately, this would require a flow money demand equation that is nonlinear in P_y, yielding inconsistent estimators in the reduced forms. This problem might be solved through an iterative estimating procedure, but at present we have decided to use the linear forms.

19. Tariffs for purposes of import substitution have risen. The physical growth of the Free Zone of Colon vis-à-vis the rest of the country also tends to act as an effective devaluation.

20. All data have been taken from IMF International Financial Statistics (IFS). Monetary data for June were taken directly from the monetary survey for the following years: 1953-1954, IFS, December 1955, 1955-1956, IFS, December 1957, 1957-1962 IFS Summary, 1963-1964, 1967, 1965-1966, 1968, 1967-1968, 1970, 1969-1971, IFS, January 1973, 1972-1973, IFS, July 1975. Reserves = Foreign Assets (net) - Foreign Deposits, Domestic Credit = Money - Reserves. Money includes quasi-money but excludes currency. Most of the currency consists of U.S. bills, and there are no estimates of the amount circulating. The assumption used here is that the relationship between currency and quasi-money is stable.

Consumer prices were used to represent home goods prices as they contain a larger element of service prices than wholesale prices. The GNP deflator was not used, owing to the problem of a variable base. Import prices shown in the IFS are U.S. export prices; import unit values, shown in various issues of *Ingreso Nacional*, yield similar results. Presuming that the effective exchange rate, including transport costs, that is applicable to imports has risen more rapidly than U.S. export prices, the responsiveness of local consumer prices to import prices in Panama would be even lower than shown here.

21. Log consumer prices = 1.88 + 0.59 log import prices
(0.03)

$$R^2 = 0.98 \; SEE = 0.02 \; DW = 0.72$$

Log consumer prices = 1.43 + 0.58 import prices + 0.11 log export prices
(0.02) (0.03)

$$R^2 = 0.99 \; SEE = 0.01 \; DW = 1.09$$

Part of the slight difference in coefficients is attributable to the use of logarithms rather than percentage growth rates.

22. The revelant regressions are:

Growth rate of domestic prices = -0.92

+ 0.13 Growth rate of money due to domestic credit
(0.04)

+ -0.01 Growth rate of money due to reserve changes
(0.04)

+ 0.09 Growth rate of import prices
(0.12)

- 7.8 Growth rate of income
(9.4)

$$R^2 = 0.90 \; SEE = 0.99 \; DW = 1.75$$

$$\text{Growth rate of domestic prices} = -0.61$$
$$+ \underset{(0.01)}{0.03} \text{ Change Domestic Credit } - \underset{(0.01)}{0.03} \text{ Change in reserves}$$
$$- \underset{(0.08)}{0.11} \text{ Growth rate of import prices}$$
$$+ \underset{(5.7)}{11.5} \text{ Growth rate of income}$$
$$R^2 = 0.96 \; SEE = 0.59 \; DW = 1.49$$

$$\text{Growth rate of domestic prices} = 0.02$$
$$+ \underset{(0.01)}{0.04} \text{ Change Domestic Credit}$$
$$- \underset{(0.10)}{0.11} \text{ Growth rate of import prices}$$
$$R^2 = 0.94 \; SEE = 0.70 \; DW = 1.85$$

23. Recall the linearization implies that the flow money demand function cannot be homogeneous of degree zero.

There is also a question of the appropriate point at which to measure prices and money for flows over a period. In this preliminary work the money stock is measured at the end of June, and prices at the year end. It could be argued that the appropriate measure of prices over the period and money stock would be centered at the middle of the period, that is, December from the year June to June. However, this presents certain problems due to seasonality and because the mid-period money stock is not completely independent of the flows. These problems will be investigated in later work.

24. Recall this depends upon our assumption that import prices do not enter the money demand function. However, we have just seen that import prices do not significantly influence domestic prices when domestic credit is included.

25. In the direct regression of r on d, allowing for nonlinearities in the demand for money, the coefficient of d was not significantly different from zero as opposed to the coefficient of one predicted by the monetary theory.

$$r = -7.6 + \underset{(0.22)}{0.01}\, d + \underset{(0.58)}{0.96}\, (\text{growth of income} \times M)$$
$$- \underset{(1.26)}{3.83}\, (\text{growth of price} \times M)$$
$$R^2 = 0.94 \; SEE = 8.1 \; DW = 2.34$$

26. Equations (9-30) and (9-32) are derived in the text as (9-18) and (9-20). Equation (9-31) goes back to Equation (9-6).

27. Foreign purchases of domestic securities may also depend on the exchange rate for two reasons. First, because of speculative anticipations of future changes in the exchange rate, and second, because foreign demand perhaps should be measured in the foreign unit of currency and then converted to domestic currency at the going exchange rate.

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Appendix 9 Some Additional Aspects of Econometric Estimation in More Complicated Models

Add securities, banks, and the rate of interest to the model of Section 3, but keep the exchange rate fixed. The reduced form of this system may be derived by looking back at Equations (9-18) to (9-20) and changing the specifications slightly. We shall split the balance of payments r into its components b_c, the balance on current account, and b_k, the balance on capital account. The actual solutions will not be presented because of their length, but the solution will be described heuristically. There are now five equations in this system:[26]

Equilibrium in the market for home goods

$$\phi(r + d) = f(P_y, M, n, P_x, P_v, W) \qquad (9\text{-}30)$$

The balance on current account

$$b_c = r(P_y, M, P_x, P_v) \qquad (9\text{-}31)$$

The balance on capital account

$$b_k = i_g + y_B(n) - s(W) + r(1 - \phi) + d(1 - \phi) \qquad (9\text{-}32)$$

where

$$b_k = b_k(n) \qquad (9\text{-}33)$$

$$r \equiv b_c + b_k \qquad (9\text{-}34)$$

The endogenous variables in this system are r, b_c, b_k, P_y, and n. The procedure followed is to note that we may transform (9-31) into

$$b_c = f(P_y, n, E) \qquad (9\text{-}31')$$

by substitution from (9-33) and (9-34). The term E denotes the exogenous variables. In addition, (9-32) may be transformed into

$$b_c = h(n, E) \qquad (9\text{-}32')$$

by substitution from (9-33) and (9-34). We may then solve (9-32′) for n as a function of b_c; solve (9-33) for P_y as a function of b_c, and substitute into (9-30′), deriving a reduced form for b_c as a function of the exogenous variables.

$$b_c = j(E) \qquad (9\text{-}35)$$

This reduced form may be estimated. The estimates b_c will be employed to derive a second-stage estimate of r as a function of b_c and the other exogenous variables. The vehicle for this procedure is Equation (9-32), which may be written as follows:

$$r(1 - \phi) = b_k(n(b_c, E)) - y_B(n(b_c, E)) - i_g - s(W) - d(1 - \phi) \qquad (9\text{-}36)$$

All of the right-hand side variables are now exogenous, and we may estimate (9-36). It should, therefore, be possible to find the effects of exogenous variables on the current account as well as on the capital account.

Ad Hoc Assumptions about Central Bank Behavior

At the beginning of the paper, it was suggested that h may not be an endogenous variable. The Central Bank may fix the level of the increase in high-powered money h, or it may vary h in response to variations into the interest rate.

If the Central Bank fixes the level of h independently of the other variables in the system, then h will be independent of r, the predicted level of the balance of payments. This hypothesis may be tested once r is estimated.

If h is a function of the interest rate, then equation (9-32) could be estimated directly with n as a function of W and the other exogenous variables in that equation. Then $\hat{h}$ could be estimated from $\hat{n}$, and $\hat{M}$ could be estimated from $\hat{h}$. These estimates could be compared with h and M derived from the earlier procedures. An additional test would be available from alternative estimates of (9-30). If h is a function of n, then P_y can be estimated as a function of present and past values of n and values of P_x, P_v, and W. These estimates of P_y could be compared with those derived above for, if h is independent of r, then P_y should be independent of r.

Add Floating Exchange Rates

Assume that government transactions in foreign exchange are a function of the exchange rate, as described earlier in Section 2.5. Again we shall write government purchases of foreign exchange as $r^1 = j(p, \overline{p}), j_1 < 0$. We shall also assume that the government has a target value of the exchange rate in mind. This target value is not a rate that they wish to achieve, but a benchmark that serves to define the further range of government exchange operations. When this benchmark changes, as it is likely to do from time to time, the whole function will shift. The exchange rate brings the total volume of exchange market transactions into equilibrium, that is, $j = b_c + b_k$. Thus floating exchange rates may be introduced into the preceding model by expanding the system to six equations. As before we have equilibrium in the market for home goods:

$$\phi(r^1 + d) = f(P_y, n, E) \tag{9-37}$$

As before we assume that the exchange rate does not affect the demand for cash hoarding. E denotes the exogenous variables.

The balance on current account:

$$b_c = r(P_y, p, E) \tag{9-38}$$

The exchange rate does affect the current account.

The balance on capital account:

$$b_k = i_g + y_B(n) - s(W) + r^1(1 - \phi) + d(1 - \phi) \tag{9-39}$$

Foreign purchases of domestic securities:[27]

$$b_k = b_k(n) \tag{9-40}$$

The government's decision function for purchasing foreign exchange:

$$r^1 = j(p, \overline{p}) \tag{9-41}$$

Finally the exchange market equilibrium condition

$$r^1 = b_c + b_k \tag{9-42}$$

Conceptually, this system can be reduced to four equations and then solved for b_c as a function of the exogenous variables. By substituting from (9-42) and (9-40), equation (9-37) may be written as

$$b_c = f(P_y, n, E) \tag{9-37$'$}$$

By substituting from (9-40) and (9-42), Equation (9-39) may be written as

$$b_c = g(n, E) \tag{9-39$'$}$$

By substituting (9-38), (9-39), and (9-41) into (9-42) we have

$$p = p(P_y, n, E, \overline{p}) \tag{9-42$'$}$$

This system of four equations may then be solved for b_c as a function of the exogenous variables. The econometric procedures would then follow those described for the fixed exchange rate case. Note that the measurement of $\overline{p}$ is not possible so that it may be necessary to use dummies for specific periods when it is known from other information that $\overline{p}$ has changed.