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Foreign Exchange Restrictions, Monetary Policy, and Macroeconomic Stability in the Third World*

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This paper develops a formal mathematical model of balance of payments and monetary equilibrium under a pure foreign exchange rationing regime. Countries with foreign exchange shortages often ration foreign exchange and resist the inevitable IMF "austerity" program ostensibly to maintain living standards. The purpose of this paper is to demonstrate that countries which overvalue their currency and create a need to ration foreign exchange actually reduce living standards. In the extreme case, monetary expansion may serve to depress output and even cause the collapse of the modern economy. This changes the role of monetary policy and requires strict control over the money supply.

I. Introduction

According to a recent press account, Zimbabwe has been experiencing serious difficulties in expanding mineral production, notably gold, due to a shortage of foreign exchange for the importation of spare parts and mining equipment.[1] This situation may seem rather startling and paradoxical to some economists. However, many who have witnessed the use of import and foreign exchange controls first hand will recognize the problem as a common one in developing countries. In 1979, a World Bank Program Loan was used finance the import requirements of Jamaica's export industries. Governments often avoid devaluation from fear that it will increase the domestic cost of living. As a consequence, they are forced to resort to foreign exchange controls.

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1 "Zimbabwe Survey," *African Business*, May 1987, pp. 43-45.

The use of foreign exchange controls for balance of payments purposes is not strictly a Third World phenomenon. On the contrary, such policies antedate the Third World. They common in Europe after the Second World War. Two important articles in the *Quarterly Journal of Economics,* Hinshaw (1951) and Sohmen (1958), vigorously criticized the use of such policies as ineffective and even counterproductive in controlling living costs. The essence of the argument against controls is that overvaluation can not reduce the domestic price of importables if controls reduce the supply of those goods on the domestic market. Each article elicited comments to the QJE, but no strong defense of controls was offered. At best, some authors believed that a case could be made for controls under certain special or limited circumstances. The industrialized nations ultimately abolished foreign exchange controls on current account.

In the developing countries, such controls are common, but the original exchanges in the QJE are almost never cited in the modern economic literature. Often such policy issues have become obscured in North-South debate. McKinnon (1979) complained that devaluation in the presence of quantitative restrictions had not been well worked out in the formal economic literature.

Leith (1980) contains a provocative and novel modern which attempts to show the output losses associated with foreign exchange controls. In Leith's model, as the domestic price level rises, exports and therefore import quotas decline. As the quotas decline, real economic resources are diverted to the competition for licenses, causing a reduction in physical output. Another realistic feature of Leith's model is a direct link of the money supply to the public deficit, which, in turn depends on aggregate output. The model contain many important features of foreign exchange crisises which are immediately recognizable to economists who have witnessed foreign exchange crisises firsthand.

However, some economists may feel that Leith's link between quotas and output loss is rather weak. The diversion of productive resources to pursuit of the economic rents associated with the quotas may strike many as marginal. This article will construct a very similar model with one major difference: output depends upon the availability of imported intermediate goods. Maximum output and absorption depend on optimum trade levels. Foreign exchange controls, as those used by Zimbabwe, may reduce the supply of foreign exchange by reducing the supply of intermediate goods to export industries. They actually can aggravate the very problems that they were intended to solve.

II. The Form of the Model

Most trade models involve the trade of consumable goods: country A exports good X, for which it has an excess supply and comparative advantage, for good Y, for which it has a comparative disadvantage and excess demand. Trade allows for a more efficient distribution of labor among nations. It is assumed that country A could produce both goods in autarky, but can have more of both foods and a superior consumption mix if it specializes in X. In contrast, open economy macromodels, such as Mundell-Fleming models, typically deal with a single, all purpose good which is an imperfect substitute for other goods which are traded on the world market. Output maximization and full resource utilization, rather than resource allocation is the critical issue, since resources can only be allocated to a single industry.

However, these models miss the essential character of specialization of trade of LDCs. In many LDCs, import substitutes cannot be produced domestically. Furthermore, imports are not a substitute for domestically produced goods, but a vital input into the domestic productive process. One does not export simply to import: domestic production requires imports. This article will use the less common approach of a single output good and an intermediate good which is imported under a regime of quantitative restrictions. This approach was also adopted in Chopra and Montiel (1987) as realistic in a developing country context. Chopra and Montiel were primarily interested in the effects of monetary policy and constructed a model in which the government has unrestricted freedom to adjust import quotas as a compliment to monetary policy. Chopra and Montiel show that relaxation of the quotas have unifirmly beneficial results, but do not explain why governments institute the restrictions in the first place. In contrast, in this article, quotas are directly linked to foreign exchange availability. This allows us to model a "foreign exchange crisis" of the type that has occurred, for example, in Jamaica in the late 1970s, Zimbabwe and Zambia in the late 1980s, or that Ghana has periodically suffered since the early 1960s.[2]

The archtype of the economy discussed in this paper is a Black African economy, outside the Franc Zone, which has an overvalued currency, a fixed exchange rate, no capital mobility or ability to raise nonconcessionary loans on world markets, a chronic current account deficit, an import rationing system, and a need for imported inputs in the domestic productive process.

2 See Lieth (1974).

III. The Goods Sector

A model which shows this relationship is developed here in a two good framework. The two goods are designated Q and M. Q is produced and consumed domestically; M is imported and used as an input in the production of Q. One could think of a one crop agricultural economy which produces wheat and imports fertilizer. The production function of Q is:

(1) $Q = Q(M, N, K); \qquad Q_i > Q, \; Q_{ij} < 0, \; Q_{ij} > 0.$

K and N are the capital stock and labor demanded. The capital stock is assumed fixed in the short term. Real wages are fixed and indexed by law, creating a permanent excess supply of labor. The nominal wage rate is a fixed multiple, v, of the price level.

(2) $W = vP \Leftrightarrow W/P = v.$

The use of the imported factor and labor can be derived from the profit function of domestic producers of Q and the first order condition for profit maximization:

(3) $\pi = PQ(M, N, K) = eP_m M - vPN - rPK.$

$$\partial\pi/\partial M = P(\partial Q/\partial M) - eP_m = 0 \Leftrightarrow \partial Q/\partial M = eP_m/P$$

$$\partial\pi/\partial N = P[(\partial Q/\partial N) - v] = 0 \Leftrightarrow \partial Q/\partial N = v.$$

(4) $M = M[(eP_m/P), v, K]; \qquad M_1, M_2 < 0, M_3 > 0$

(5) $N = N[(eP_m/P), v, K]; \qquad N_1, N_2 < 0, N_3 > 0$

where:

P_m = world foreign currency price of M

P = the domestic price of Q

e = exchange rate, expressed in units of domestic currency per unit of foreign currency.

Since M and N are complementary factors, any increase in the use of M, results in an increase in labor demand (More complicated versions of this model in which this assumption was dropped, in favor of a fixed nominal wage, yield similar results). Since K and v are parametric, the supply of Q can be considered as a function of (eP_m/P) in the short term and equation 1 may be rewritten:

(1a) $Q[(eP_m/P)\ \bar{v}, \bar{K}] = Q(eP_m/P); \quad Q' < 0.$

The output function and the input demand functions thus determine the level of national production. Q has four basic uses: it is consumed by households, it is used as capital, it is consumed by the public sector, and it is exported.

On the world market, Q is a close substitute for products made elsewhere (as in a Mundell-Fleming model for example) and variable in limitless supply. The price of substitute in the world market, is represented by a composite foreign exchange price, P_w. The market will tolerate small deviations of the hard currency price of Q, P/e, from P_w. However, if P/e exceeds P_w by more than a small premium the country can lose its entire export market. Symmetrically, if P/e drops too far below P_w, total national output of Q could be exported. "Small deviations" is not well defined, of course. As an example, shirt manufacturers on the Caribbean island of St. Lucia, might charge $16, when Hong Kong or Italian manufacturers charge $15, for identical quality shirts. However, if the St. Lucians sell the same quality shirt for $20, they lose almost their entire export market. But if the price is cut to $12, they exhaust the entire productive capacity of the island for the export of shirt alone.

The demand for Q on world markets is given by:

(6) $X = X(eP_w/P); \quad X' > 0$

$X'(eP_w/P)$, in accordance with the previous argument, reaches a minimum for some value of $eP_w/P = k \approx 1$. Thus $X''(eP_w/P) > 0$ for $eP_wP/P > k$ and $X''(eP_w/P) < 0$ for $eP_w/P < k$. A further important assumption, which follows from the previous argument, is that the absolute value of the export elasticity of Q, with respect to eP_w/P is greater than one, even at its minimum level.

We are also interested in calculating the hard currency export revenues from Q, designated E:

(7) $E(e/P,\ P_w) = (P/e)\, X\, (eP_w/P).$

(8) $\partial E/\partial P = E_p(e/P,\ P_w) = X/e - X'(P_w/P) < 0.$

The sign of the last term depends on the assumption that the absolute value of the elasticity of export demand is greater than one. Later, we will use the facts that:

(9) $E_{pp} = X''(e/P)(P_w/P)^2 < 0$ iff $(eP_w/P) < k$.

(9a) $E_{pp} = X''(e/P)(P_w/P)^2 > 0$ iff $(eP_w/P) > k$.

(10) $$\partial E/\partial e = E_e = -(P/e^2)X + (P/e)X'(P_w/P) = -(P/e)\,[X/e - X'(P_w/P)] = -(P/e)E_p > 0.$$

IV. The External Sector

In this model, the only elements of the balance of payments which are endogenous are export and import volume. Interest payments on the government's foreign debt, i, is the only other element of current account and is determined by the volume of foreign holdings of government bonds and the foreign interest rate. The Central Bank has no useable foreign exchange holdings with which to help finance a balance of payments deficit and does not attempt to build its reserves since this would reduce already low levels of current expenditure. The current account deficit, –(CAS), must exactly equal available financing, F, which is exogenously determined. F and i together determine the balance of trade deficit, –(BOT).

(11) $(CAS) = E - P_m M - i = -F < 0.$

(12) $-(BOT) = P_m M - E = -i + F.$

At this point we can distinguish between two foreign exchange regimes, a flexible exchange rate or a fixed and overvalued exchange rate with consequent foreign exchange rationing. In the former, (F–i), determines the BOT. The sum of three exogenous variables F and –i in equilibrium is equal in absolute value but opposite in sign to $(E(P, e, P_w) - P_m M(eP_m/P))$. As (F–i) increases, the ratio e/P declines, *ceteris paribus*, adjusting the balance of trade deficit to its equilibrium level and making the equilibrium value of the ratio e/P a function of (F–i).

(13) $BOT = E(e/P,\ P_w) - P_m M(eP_m/P) = -i + F.$

(14) $e/P = f(F-i);\quad f' < 0.$

In the fixed exchange rate case, $e = \bar{e}$ for some $\bar{e}$, such that $(\bar{e}P_w/P) < k$, excess demand for foreign exchange is suppressed by rationing foreign exchange purchases or import licences. The Central Bank allocates to the private sector whatever remains from export earnings and financing inflows minus required interest payments.

$$(15) \quad \hat{M} = [E(\bar{e}/P,\ P_w) + F - i]/P_m$$

The (^) over the M or Q, is used when specific reference is being made to import levels which are fixed by quota, or the output levels which result from such a rationed import system. It is assumed that the import rationing system results in no additional output loss due to resource misallocation as a result of bureaucratic corruption or incompetence. This assumption tends to reduce the output loss resulting from the imports restrictions and causes the results of this model to hold a *fortiori*.

One way, in which efficient allocation of the rationed import could be achieved, is by the existence of an competitive secondary market in $\hat{M}$. If imports are not rationed, the domestic market for M constitutes a small portion of the world market so that the supply curve, at the given domestic price, $\overline{eP}_m$, is flat (Figure 1a). When imports are rationed, the supply in the secondary market is fixed by foreign exchange availability to $\hat{M}$, so that we hae a vertical supply curve (Figure 1b). The demand for M is now determined by the modified profit function and the modified first order condition:

$$(3a) \quad \pi = PQ(M,\ N,\ K) - PP^m M - vPN - rPK.$$

$$\partial\pi/\partial M = P(\partial Q/\partial M) - PP^m = 0 \Leftrightarrow \partial Q/\partial M = P^m.$$

Figure 1a

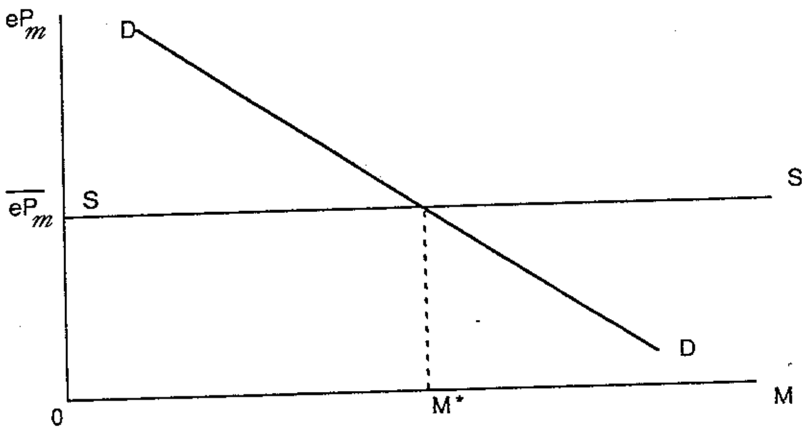
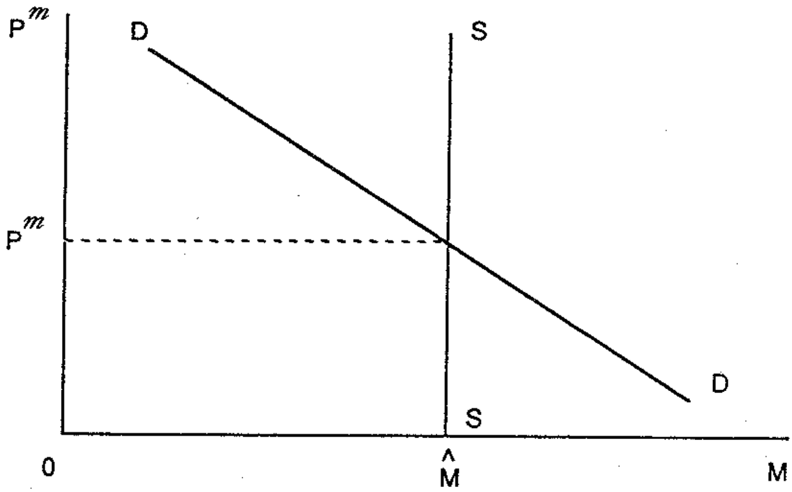


Figure 1b



The term P^m refers to the relative price in the secondary market denominated in units of Q, and PP^m is the nominal domestic price of imports. Thus, PP^m in the original import and labor demand functions. The individual firm is not constrained by the import quota, but may have all that it wishes at the market clearing domestic price, $P^m > \overline{eP}_m$.

(4a) $M = M(P^m, v) = \hat{M}$; $M_1, M_2 < 0$.

(5a) $N = N(P^m, v)$; $N_1, N_2 < 0$.

However, since P^m is a monotonically decreasing function of $\hat{M}$, the short term output function for Q remains essentially unchanged. Domestic supply and demand for M, has just been determined and equilibrated by a different mechanism. (1a) becomes:

(1b) $\hat{Q}(P^m(\hat{M}) | \bar{v}, \bar{K}) = \hat{Q}(\hat{M})$; $\hat{Q}' > 0$.

Under this regime, the balance of trade is fixed, but not the level of trade. If $\bar{e}$ is fixed too low, import rationing becomes necessary since export volume drops. Trade levels will be lower than under a flexible exchange rate.

V. National Income

The total real national income, generated from the production of Q, is equal to the domestic value added $Q-(eP_m/P)M$. Net foreign interest payments must be subtracted from this to give total national income:

(16) $Y = Q-(e/P)(i + P_m M)$

This definition holds if imports are rationed. Its decomposition is changed, since the counterpart items to domestic value added includes import license premia as well as returns to domestic value added. Nominal income is defined in the two cases as:

(17) $PY = PQ-e(i + P_m M).$

(17a) $P\hat{Y} = P\hat{Q}-\bar{e}(i + P_m \hat{M}).$

VI. The Money Market

Initially it is assumed that the government maintains full control over the money supply by meeting any domestic financing requirements by borrowing all that it needs from the domestic banking system. This assumption will be relaxed later. The total end of period money supply, m^s, is the supply of high powered money, multipled by the money market multiplier q. It is also assumed, for simplicity, that the velocity of money is unity. The demand for money is given by total nominal expenditure, which is assumed to be equal to nominal expenditure by domestic residents which is the sum of domestic income plus external borrowing in domestic currency, eF, and nominal purchases by foreigners, PX:

(19) $$\text{Nominal Expenditure} = PY + eF + PX = PY + eF + eE$$
$$= PQ + e(E-P_m M-i + F)$$
$$= PQ + e(BOP) = PQ$$

The balance of payments, (BOP), is always identicallv equal to zero since by assumption there are no reserve flows. For the import rationing case:

(19a) $$\text{Nominal Expenditure} = P\hat{Y} + \bar{e}F + PX = PY + \bar{e}F + \bar{e}E$$
$$= P\hat{Q} + \bar{e}(E-P_m \hat{M}-i + F)$$
$$= P\hat{Q} + \bar{e}(BOP) = P\hat{Q}$$

Monetary equilibrium is given by the quantity equality:

(20) $qH = PQ.$

We are not ready to build two distinct dynamic models, one in which the exchange rate is flexible and a second in which the exchange rate is fixed and the foreign exchange ration for imports varies. In both models, systemic equilibrium is achieved when the markets for money and foreign exchange are in equilibrium. Since neither market is affected by domestic interest rates, it is assumed here that the interest rate is free to adjust in order to maintain savings investment equilibrium. A set of asset demand functions consistent with this model is given in Appendix 2.

In the first model, the level of imports is fixed by import demand as in equation (4). An excess demand for foreign currency (EDFX) results in an increase in e. (Note that there is no provision for hoarding or dishoarding of foreign exchange in this model, since it is assumed that foreign exchange controls forbid the purchase of foreign assets. Thus in both versions of this model, foreign exchange is not a portfolio asset. The reason for making this somewhat unrealistic assumption is to evaluate this type of exchange rate regime as an ideal policy in the absence of any illegal activities which might undercut it.) In the second version of the model, the level of imports is fixed by equation (20) and an excess supply of foreign currency (ESFX) results in an increase in $\hat{M}$. In both versions, an excess supply of money (ESM), calculated by substituting the appropriate form of equation (1) into equation (20), drives up the price level. The two forms of the model can thus be represented as dynamic systems composed of two simultaneous equations each. The flexible exchange rate version is:

(21) $\dot{P} = k_1[ESM] = k_1[qH-PQ(eP_m/P)].$

(22) $\dot{e} = k_2[EDFX] = k_2[P_mM(eP_m/P) + i-E(e/P,\ P_w)-F].$

$$k_1',\ k_2' > 0$$

where H, q, P_w, P_m, i, v, k, and F are exogenous and Q, M, N, and X are dependent on P and e. Total differentiation of the system yields the following matrix of coefficients on the changes on the endogenous variables:

(23) $$\begin{bmatrix} -[Q + PQ'(-eP_m/P^2)] & -\ PQ'(P_m/P) \\ -[E_p + M'e(P_m/P)^2] & -[E_e-M'P_m{}^2/P] \end{bmatrix}$$

The determinant of the matrix of coefficients on the endogenous variables is:[3]

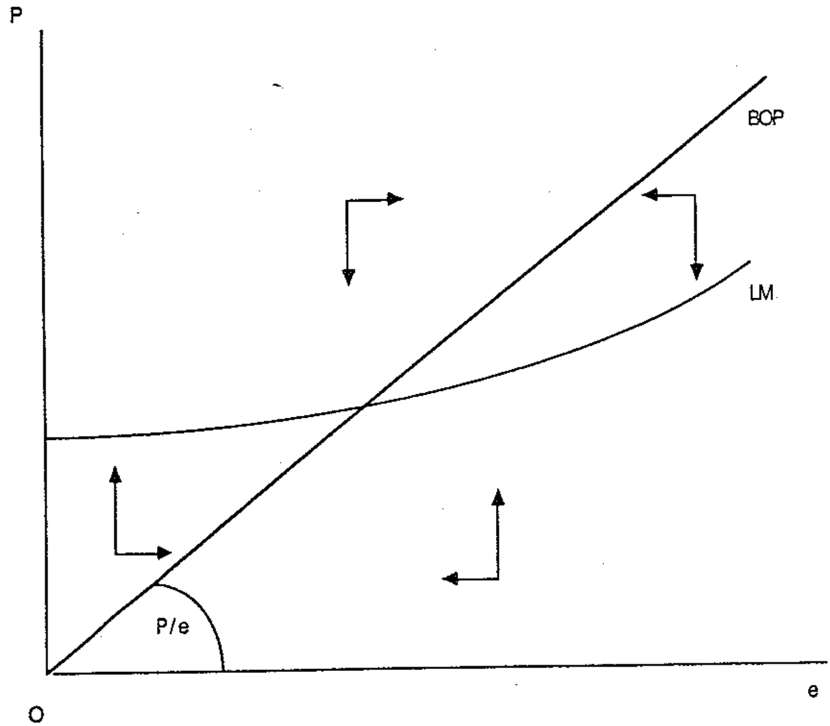
(24) $(-P/e)\ [E_p + M'e(P_m/P)^2]Q > 0.$

The term in brakets is the derivative of current account with respect to the price level and is always negative. The whole term is positive, which fulfills a necessary condition for dynamic stability, that the determinant of the two by two matrix must be positive.

Any increase in the price level simply brings about a proportional change in the exchange rate, leaving all real values unchanged. The phase diagram for P and e is shown in Figure 2. The slope of the BOP and LM lnes in the flexible exchange rate model are:

(25) Slope BOP $= P/e > 0$

Figure 2



3 To prove that the determinant of the matrix described in 24 is indeed equal to the term in 30, we must remember that E_e equals $-(P/e)^{*}E_p$, from equation 10. The rest is then straightforward.

(26) $$\text{Slope LM} = (P/e)[PQ'(P_m/P)]/[-(P/e)Q + PQ'(P_m/P)] > 0$$

The slope of the BOP line is a straight line and is determined by equation (14). Dynamic stability is represented on the phase diagram when the slope of the BOP curve is greater than the slope of the LM curve. This is equivalent to the determinant stability condition in equation (24) (A digression on the properties of flexible exchange rate and optimal trade levels is included in Appendix 1).

Now let us compare the fixed exchange rate version of the model:

(27) $$\dot{P} = c_1[ESM] = c_1[qH - P\hat{Q}(M\hat{M})]$$

(28) $$\dot{\hat{M}} = c_2[ESFX] = c_2[E(\bar{e}/P,\ P_w) + F - P_m\hat{M} - i]$$

$$c_1',\ c_2' > 0$$

where H, q, P_w, i, $\bar{e}/P$, v, K, and F are exogenous and $\hat{Q}$, N, and X are dependent on P and $\hat{M}$. The matrix of coefficients on the changes in endogenous variables is:

(29) $$\begin{bmatrix} -\hat{Q} & -P\hat{Q} \\ E_p & -P_m \end{bmatrix}$$

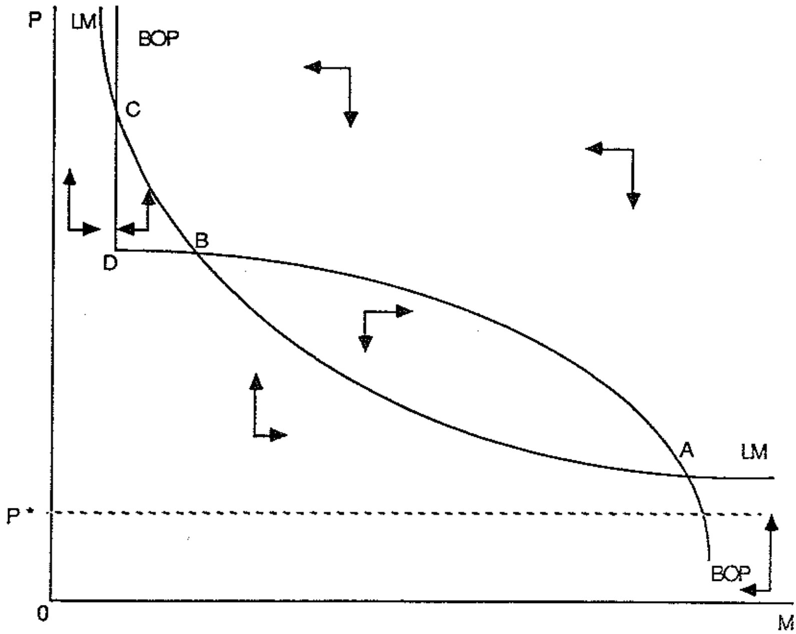
The determinant of this matrix is:

(30) $$P_m[\hat{Q} + P\hat{Q}'\cdot E_p/P_m] = P_m[\hat{Q} + P\cdot\partial\hat{Q}/\partial P] \lesseqgtr 0$$

This must be positive if the system is stable. The term in brackets is the derivative of the change in nominal income with respect to the price level. Since $\hat{Q}$ is positive and the second part of the term is negative, this cannot be signed and the system may be unstable. Whether the necessary determinantal condition for stability is fulfilled, will depend upon whether the elasticity of supply with respect to price is less than minus one. In the extreme case, an excess supply of money raises prices, decreases nominal income, and thus exacerbates the excess supply of money.

This can be examined in the phase diagrams in Figure 3. The excess demand for foreign exchange, in the absence of import rationing, is a function of the ratio (e/P), (as per equation (14). For any given $\bar{e}$, there is a unique P^*, at which the foreign exchange market will be in equilibrium. Below P^*, import rationing would not be necessary and the Cen-

Figure 3



tral Bank would need to buy reserves to maintain the exchange rate. Above P*, import rationing is required. Thus the phase diagram in Figure 3, represents the economy only when $P > P^*$. The slopes of the BOP and LM curves are:

(31) Slope $BOP = P_m / E_p < 0.$

(32) Slope $LM = -(P\hat{Q}')/\hat{Q} < 0.$

Stability implies that the slope of the LM curve is greater than the slope of the BOP curve, which is the equivalent of the determinantal test.

As we move towards the NW, in Figure 3, the slope of the LM line becomes more negative compared to the BOP line, due to the increasing marginal productivity of $\hat{M}$ as import levels decline and the greater price sensitivity of export revenues ($E_{pp} < 0$). The equilibria in this area are thus more likely to be unstable than equilibria occurring at lower levels of P. Eventually we reach the point D, at which all price sensitive exports cease and the slope of the BOP line goes to $-\infty$, which insures stability. If we look at the three possible equilibria and their equivalent prices, only the upper and lower equilibria are stable. If the price level should be displaced above B prices will rise and imports (and output) will collapse to their minimum possible level, C. If they are displaced below B, then prices will fall and imports rise to equilibrium A.

However, maximum imports and output will take place at P*, so that a contractionary monetary policy, which shifts LM to the left, will further increase output. It is also possible that the LM curve lies everywhere above the BOP equilibrium line to the right of equilibrium point C: (equilibria A and B do not exist); thus as soon as the price level rises above P*, the economy collapses to point C.

The reduced form multipliers, for changes in P and $\hat{M}$ resulting from changes in the stock of base money are:

(33) $\partial P/\partial H = q/[\hat{Q} + P\cdot\partial\hat{Q}/\partial P] > 0.$

(34) $\partial\hat{M}/\partial H = q\cdot E_p/[P_m(\hat{Q} + P\cdot\partial\hat{Q}/\partial P)] < 0$

for stable equilibria A and C (determinant of the term in 30 is negative for these cases). For C this term is zero, since $E_p = 0$.

(35) $\partial\hat{M}/\partial F = \hat{Q}/[P_m(\hat{Q} + P\cdot\partial\hat{Q}/\partial P)] > 0$

(36) $\partial P/\partial F = -(P\hat{Q}')/[P_m(\hat{Q} + P\cdot\partial\hat{Q}/\partial P)] < 0.$

If the system is stable, output must decline as the price level rises. When the price level rises, exports decline, imports decline, and thus output must decline. The quickest way to boost output in the stable case is to devalue the currency (increase $\bar{e}$), since output is a function of $\hat{M}$.

(37) $\partial\hat{M}/\partial\bar{e} = [(E_e/P_m)\cdot\hat{Q}]/[\hat{Q} + P\cdot\partial\hat{Q}/\partial P]$

$= [\partial\hat{M}/\partial E\cdot E_e\cdot\hat{Q}]/[\hat{Q} + P\cdot\partial\hat{Q}/\partial P] > 0.$

VII. The Model with an Endogenous Money Supply

Now, we shall expand the model one step more by using an alternative assumption about residual government financing. In the model thus far, we have assumed that the residual financing item for the government deficit is domestic borrowing. But it may be very difficult and expensive for the government to raise money on private capital markets even by resorting to coercion. If the government cannot satisfy its domestic borrowing needs by selling bonds to the private sector, due to absolute unavailability of funds or for fea or choking the private sector, fiscal policy may determine monetary policy. This links monetary to fiscal policy, not as an alternative method of regulating aggregate demand, but as an ultimate means of deficit financing. Of course, this is not unique to underdeveloped economies. But in Third World country, the absence of well developed capital markets, very large budget deficits, and small levels of domestic savings, make the problem far more crucial. The change in high powered money is calculated as a residual financing item:

(38) $$\Delta H = PG + r^{p}{}_{1}B^{p} - T(P\hat{Q} - \bar{e}P_{m}\hat{M} + r^{p}{}_{1}B^{p}) - \bar{e}(F-i) - \Delta B^{p}.$$

where: G = the government purchase of Q,

$r^{p}{}_{1}B^{p}$ = fixed rate interest payments on beginning of period domestic debt,

$T = T(PQ - eP_{m}M + r^{p}{}_{1}B^{p})$ = nominal tax revenue, $0 < T' < 1$

ΔB^{p} = domestic sales of government bonds to the banking system.

ΔH = the flow supply of base money.

Taxes are a function of total private sector income which is the sum of value added in the production of Q plus net government interest payments to domestic residents.

The money supply is now endogenous. We can now rebuild the model by substituting this value for ΔH first into equation (20) and then into equation (27) (and designating the beginning of period base money supply H_1), to get a new excess supply of money equation and using this with excess supply of foreign exchange equation, equation (28).

(39) $$\dot{P} = c_1[ES\dot{M}]$$
$$= c_1[q\{H_1 + (PG + r^{p}{}_{1}B^{p} - T(P\hat{Q}(\hat{M}) - eP_{m}\hat{M} + r^{p}{}_{1}B^{p}) - \bar{e}(F-i) - \Delta B^{p}\} - P\hat{Q}(\hat{M})].$$

We now have a new matrix on endogenous variables:

(40) $$\begin{bmatrix} qG-(1+qT')\hat{Q} & -(1+qT')\hat{Q}' \\ E_p & -P_m \end{bmatrix}$$

The determinant of the whole system is:

$$(41) \qquad P_m[(1+qT')(\hat{Q}+\hat{Q}'E_p/P_m)-qG]=P_m[(1+qT')(\hat{Q}+P\cdot\partial\hat{Q}/\partial P)-qG]\lesseqgtr 0.$$

This term must be positive to fulfill the necessary determinant condition for dynamic stability. When the money supply was exogenous, $(\hat{Q}+P\cdot\partial\hat{Q}/\partial P)>0$, was sufficient to fulfill the condition. Here, that is no longer sufficient to fulfill the condition. Even if that term is positive, it must be larger than $qG/(1+qT')$. So the system tends to be even more unstable than the fixed exchange rate model with an exogenous money supply.

The source of the additional instability is the effect of an increase in the price level on the government deficit. An increase in the price level may either increase or decrease the deficit, via such mechanisms as bracket creep, raising the nominal value of government expenditures and erosion of the real tax base due to output decline.

The determinantal equilibrium condition is the equivalent of the stability condition that the derivative of the excess supply of money function, with respect to P, be negative. This includes both the direct effects, captured by the a_{11} term of the matrix (40), and the indirect effects which come as a result of the change in $\hat{M}$ as the price level affects foreign exchange availability. The indirect effects are calculated by multiplying element a_{12} by the $\partial\hat{M}/\partial P=E_p/P_m=\partial\hat{M}/\partial E^{*}E_p<0$. This term is calculated using the BOP equilibrium condition and the implicit function theorem.

$$(42) \qquad \partial[ESM]/\partial P=qG-(1+qT')\hat{Q}-(E_p/P_m)\,(1+qT')(P\hat{Q}')=-(1+qT')(\hat{Q}+P\cdot\partial\hat{Q}/\partial P)-qG]\lesseqgtr 0.$$

If this term is negative, the value of (40) must be positive.

Fiscal policy can now be modeled as a determinant of monetary policy. The reduced form multipliers for government expenditure are:

$$(43) \qquad \partial\hat{M}/\partial G=qP\cdot E_p/[P_m\{(1+qT')(\hat{Q}+P\cdot\partial\hat{Q}/\partial P)-qG\}]=[qP\cdot\partial\hat{M}/\partial P]/[(1+QT')(\hat{Q}+P\cdot\partial\hat{Q}/\partial P)-qG]<0.$$

$$(44) \qquad \partial\hat{Q}/\partial G=[qP\hat{Q}'\cdot\partial\hat{M}/\partial P]/[(1+qT')(\hat{Q}+P\cdot\partial\hat{Q}/\partial P)-qG])<0.$$

if stability is assumed. Thus, in this model, what would in a Keynesian model be an expansionary fiscal policy, is a contractionary policy.

VIII. Conclusions

The conclusions which can be drawn from the model developed in this paper should be applicable to a broad range of Third World countries. However, two special features of the model are worthy of note. An important feature of the model developed in this article, is the absence of resource to commercial credit markets. Governments have often borrowed from private credit markets to protect overvalued currencies. In this model it is assumed that such sources of finance are completely exhausted. Some countries, particularly in Latin America, have combined foreign exchange controls and overvalued currencies with significant external borrowing for short periods of time. During such periods, their economies may behave differently. However, as the Debt Crisis has demonstrated, this can be a very short-term policy.

The single output, imported input model avoids the index problems associated with the consumption of multiple commodities in trade models. The disadvantage of such a framework is that import substitution effects in production and consumption cannot be studied. However, the works of Dervis, de Melo, and Robinson, using computable general equilibrium models, yield similar results in a multicommodity framework with rich output and substitution effects.

1) In an economy with a foreign exchange rationing system, the money supply does pin up the price level, as in more conventional marco-models. But the importance of the money supply and price level is the effect it has on the effective exchange rate. Keeping the price level low keeps the exchange rate in line with the currency's real purchasing power. This is not terribly different from the Central Bank's role under a fixed rate regime when reserve movements must be controlled. However, in this type of model, it is import levels which the Central Bank is indirectly controlling. Using the Central Bank to compensate for the original error of overvaluing the exchange rate is clearly a second best solution to exchange rate decontrol, but far better than the usual Third World combination of a fixed rate and rapid money growth.

2) Countries which overvalue their exchange rates usually have extremely large fiscal deficits by international standards. These deficits are often monetized because the same countries have the weakest and least developed financial institutions and methods for mobilizing savings to finance the government deficit. This aggravates the original problem.

3) This combination of rapid money growth and a negative output response to price level increases means that once the government expands the money supply, the excess supply of money may be absorbed very slow-

ly by an increase in nominal income or not at all, in the extreme case where nominal income declines in response to a price increase. In the latter case the economy is unstable and may collapse if the money supply is not tightly controlled. Thus, it is a ultimately monetary mechanism which makes this type of economy unstable.

Above all, the results of this model show that for many economies in the world, strong IMF programs do not result in an overall reduction of living standards, although some individuals which benefit directly from public expenditure may be adversely affected. The country's foreign exchange shortage is the real cause of lower output and consumption. The more forcefully the government moves to eliminate the overvalued exchange rate, the sooner living standards will recover (although one might complain that there could be a lag). But in the medium term, there should be no trade off between balance of payments adjustment and living standards.

Lastly, this paper dealt exclusively with a pure foreign exchange rationing regime. However mixed regimes are also possible. Exchange rate literature usually concentrates on two pure types of exchange regimes: free convertibility of currencies under either fixed or flexible exchange rates. A mixed regime is also recognized, the crawling peg. Exchange controls and mulitple exchange rates have not received serious attention in macromodelling: they are usually swept under the heading of complicating assumptions and avoided in formal economic analysis. Exchange controls do not constitute a special case of a fixed exchange rate regime. The method for balancing foreign exchange markets is fundamentally different: foreign exchange controls substitute for reserve changes. We should give these regimes separate identities, such as a reserve adjustment regime vs. a rationing regime. This is not merely a semantic difference. As this paper has tried to demonstrate, exchange rate controls may fundamentally after the process of economic stabilization and should not be subsumed as complicating variations on existing themes. Exchange controls may yield theoretically surprising results.

If we add the foreign exchange rationing regime as the third pure type of exchange regime, we now have three additional mixed regimes, beside the crawling peg: combination rationing and reserve adjustment, rationing and flexible rate, and the combination of all three, rationing, reserve adjustment, plus flexible rate regime. While Brazil is often credited with inventing the crawling peg, the country has maintained a broad and varying range of exchange controls since the end of the Second World War. Brazil actually invented the triple mixed regime.

Appendix 1
The Optimality Properties of the Flexible Exchange Rate

Given the nature of this economy, it is logical to ask how the optimal trade level is determined and what types of economic policies will attain that level. Higher trade levels increase production by increasing the amount of the available imported input, but require that a portion of production be exported rather than consumed. The economy operates under a second restriction that the marginal product of labor must be greater than or equal to the minimum real wage, v. To determine the export level which allows the highest level of output minus exports, we begin with the following propositions. Equilibrium in the foreign exchange market implies:

(a.1) $M = (P_x X + F - i)/P$

P_x is the hard currency price of domestic output on world markets, which is equivalent to the term P/e used elsewhere. The assumption that F, and i are fixed is retained. The demand for exports is:

(a.2) $X = f(P_x); \quad f' < 0.$

P_x is a function of the export level. This function is simply the inverse of the export demand function:

(a.3) $P_x = g(X) = f^{-1}(X) \Leftrightarrow \partial P_x / \partial X = 1/f'.$

We also note that the elasticity of export demand is:

(a.4) $\varepsilon = -(\partial X/\partial P_x)\ (P_x/X) > 0 \Leftrightarrow 1/\varepsilon = -(\partial P_x/\partial X)\ (X/P_x).$

This allows imports to be expressed as a function of the export level:

(a.5) $M = M(X),$

$$\partial M/\partial X = [P_x + X\ (\partial P_x/\partial X)]/P_m = (P_x/P_m)(1 - 1/\varepsilon).$$

Short term output levels can be expressed as a function of export levels and the quantity of labor used. This is because output, which is actually a function of import levels, is in turn, a function of export levels.

(a.6) $Q = Q(M(X), N); \quad Q_M, Q_N > 0,\ Q_{NN}, Q_{MM} < 0,\ Q_{MN} > 0,$

$$Q_x = Q_m\ (P_x/P_m)(1-1/\varepsilon)>0$$

The economy's optimization problem can then be represented by the maximization of the following Lagrangian:

(a.7) $L(X, N) = Q(M(X), N) - X + \lambda[v - Q_N(M(X), N)]$.

The necessary first order conditions are:

(a.8) $\partial L/\partial X = Q_M\ (P_x/P_m)(1-1/\varepsilon) - 1 - \lambda[Q_{NM}\ (P_x/P_m)(1-1/\varepsilon)] \leqslant 0$,
and $(\partial L/\partial X)\ X = 0$.

(a.9) $\partial L/\partial N = Q_N - \lambda Q_{NN} \leqslant 0$, and $(\partial L/\partial N)\ N = 0$.

(a.10) $\partial L/\partial \lambda = v - Q_N(M(X), N) \leqslant 0$, and $(\partial L/\partial \lambda)\ \lambda = 0$.

In the case where $\lambda = 0$, $\varepsilon = -\infty$, and $X>0$, (a.8) implies that:

(a.11) $Q_m = P_m/P_x$,

the marginal productivity of the imported factor would be equal to the barter terms of trade, which would be the natural result of the free exchange of goods under a flexible exchange rate, since $P_x = P/e$. Policy makers can influence the level of trade. Increasing the effective exchange rate by whatever means, will increase the volume of trade and decreasing the effective exchange rate will reduce trade.

If $N>0$ and $\lambda \neq 0$, then (a.9) and the patrials of the production function imply that λ is negative. In this model, not all of the available labor is utilized since the real wages rate is inflexible downwards. Increasing the level of trade and the amount of the complementary imported factor of production increases the marginal productivity of labor. This will cause firms to increase their labor utilization. An artificially high level of trade is thus a type of second best solution to the wage rigidity problem. This would indicate that policy makers should seek an effective exchange rate above the rate which would be determined in the free market.

If $\infty > |\varepsilon| > 1$, an increase in export levels will cause a deterioration of the terms of trade (the first inequality is just a restatement of the assumption made earlier). If $|\varepsilon|$ is relatively small, then the classic argument that a large country could benefit via the terms of trade effect by restricting trade may be valid. But if $|\varepsilon|$ is very large, as would be case for most LDC's, then only a tiny reduction of trade below unrestricted levels would be optimal. In this situation policy makers should seek to reduce the effective rate below free market levels.

There are thus opposing factors which would cause optimal trade levels to differ from the free trade level determined under a flexible exchange rate. Which would dominate is not certain. However, for a small economy, it would be hard to justify very reduced levels of trade, which might result from a grossly overvalued currency. Certainly a major overvaluation would not be useful.

Appendix 2
The Asset Market in This Model

This model is based on the assumption of a domestic sector which is isolated from the world by currency controls so that domestic residents must devide their portfolios among three assets: money, government bonds, and loans to firms. There is a fractional reserve banking system which accepts deposits and buys government bonds and loans. The interest rate on deposits is fixed, which prevents the interest rate from affecting the demand for money, but the loan rate is free to vary. The ratio of money to base money is q, the money market multiplier. Therefore, the net private sector flow demand for assets, total private savings, must be divided among three assets, base money, government bonds and loans. Asset market equilibrium requires that flow savings be equal to the real flow supply of these assets.

The change in demand for base money is simply the change in nominal output divided by the money market multiplier:

(b.1) $\Delta H^{d} = \Delta(P \cdot Q)/q$

The banks are required to buy whatever quantities of bonds the government chooses to force upon them. Thus as long as the banks have some free reserves:

(b.2) $\Delta(B^{p})^{d} = \Delta(B^{p})^{s}$

The savings constraint forces demand for the third asset, loans, to equal total private savings plus foreign borrowing minus the demand for the first two assets. Firms supply loans to the banking system to finance their demand for physical capital. The interest rate adjusts to equilibrate the supply and demand for loans.

(b.3) $s[Q-(eP_mM-r^p{}_1B^p)/P-T(PQ-eP_mM+r^p{}_1B^p)]+eF/P$
$-\Delta H^d/P-\Delta(B^p)^d/P=I(r)$

On the left of the equality, the first term is a savings function ($0\leqslant s'\leqslant 1$) and the last three terms are net government savings plus foreign borrowing. The term on the right is a standard investment function, where r is the market determined loan rate and $I'<0$.

Appendix 3
Putting the Model in Price-Output Space

It is extremely important to understand exogenous money supply version of the model, as described in equations (27) and (28), in price-import space, which demonstrates the essential logic behind the model, the relationship between price and trade levels. However, the model in P-Q space yields its results in more intuitive fashion and can be more easily manipulated.

The first step is expressing the import level as a function of the price level, $\hat{M}(P)$. We derive this function by applying the implicit function theorem to the excess supply of foreign exchange function, (equation(28)) to get:

(c.1) $\partial\hat{M}/\partial P=E_p/P_m=\partial\hat{M}/\partial E^*E_p<0.$

This implies that the derivative of the current account balance, in foreign currency, with respect to P, is also negative. The supply of Q can be written as a function of P:

(c.2) $Q^s=\hat{Q}(\hat{M}(P))=Q^s(P).$

The derivative of this function is:

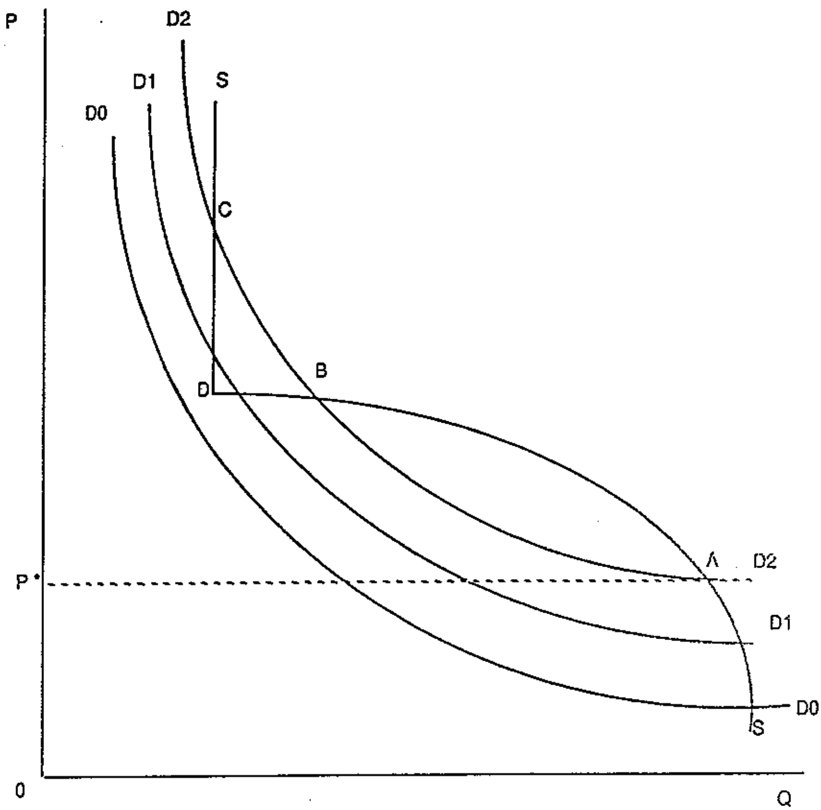
(c.3) $\partial\hat{Q}/\partial P=\hat{Q}'^*\partial\hat{M}/\partial P=\hat{Q}'^*\partial\hat{M}/\partial E^*E_p=\hat{Q}'^*E_p/P_m<0.$

The demand function for Q is derived by solving the monetary equilibrium condition (equation (20)) for Q^d, holding the balance of payments equal to zero.

(c.4) $Q^d=qH/P,$

(c.5) $\partial Q^d/\partial P=-qH/P^2<0.$

Figure C.1



The elasticity of demand with respect to price is thus –1 and the demand curve is the familiar rectangular hyperbola of the quantity equation for money demand.

We can now reinterpret the determinantal stability condition, (30):

(c.6) $\hat{Q} + P * \partial \hat{Q} / \partial P > 0.$

(c.7) $P / \hat{Q} * \partial \hat{Q} / \partial P > -1.$

This is the price elasticity of supply, which must be greater than minus one, the value of the price elasticity of demand.

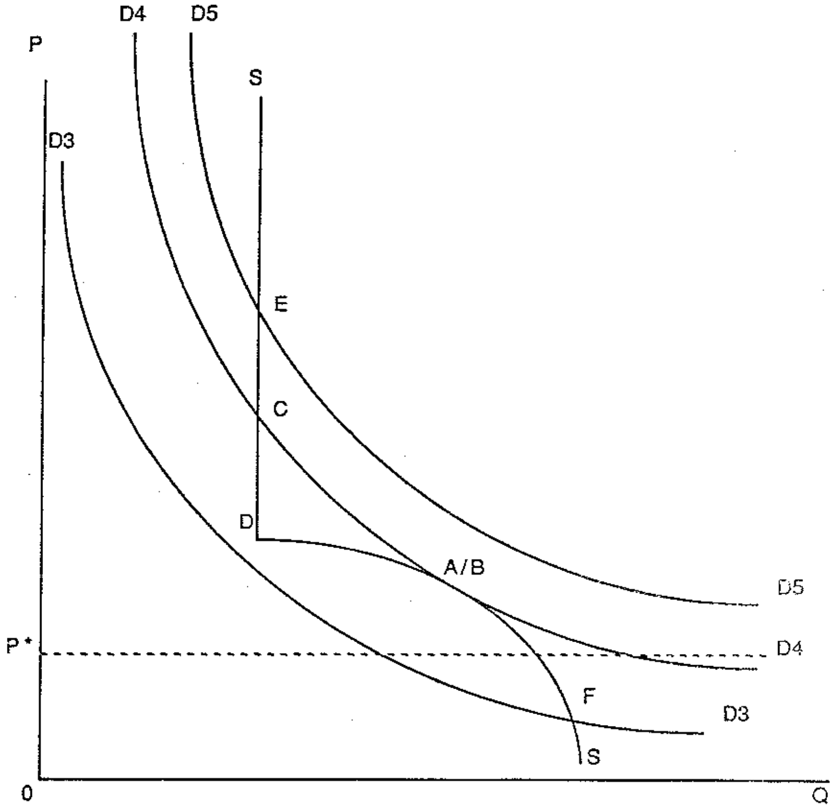
(c.8) $P / \hat{Q} * \partial \hat{Q} / \partial P > P / Q^{d} * \partial Q^{d} / \partial P.$

If we wish to put things in a Marshallian context, with price on the horizontal axis:

(c.9) $(P/\hat{Q}^{*}\partial\hat{Q}/\partial P)^{-1} < (P/Q^{d*}\partial Q^{d}/\partial P)^{-1}$.

This means that for a stable equilibrium, the supply curve must cut the demand curve from above, as in equilibria A and C in Figure C.1. B is an unstable equilibrium. Notice the key feature of this model, the ***backward bending*** aggregate supply curve, between points A and D.[1] Above D, the supply curve is vertical, all price sensitive export activity has ceased. The backward bending supply curve is similar to the one found in

Figure C.2



[1]The slope of the supply curve is, $P_m/(\hat{Q}'^{*}E_p)$, the inverse of the term in equation 49. It becomes flatter as P increases because the absolute value of both $\hat{Q}'$ and E_p increase as P increases and $\hat{M}$ decreases.

Leith (1980), although the motivation is somewhat different.

This apparatus, now allows us to discuss how a nation could heap such an obvious misfortune on itself and begin to ration foreign exchange. We begin by assuming that the country involved begins with a price level below P* and is on a demand curve such as D^0D^0 or D^1D^1, where even if there exist equilibria at price levels greater than P*, there is no dynamic which brings us there. An expansion of the money supply pushes the demand curve right to D^2D^2. The price level reaches the lowest level for which import rationing is necessary at point A.

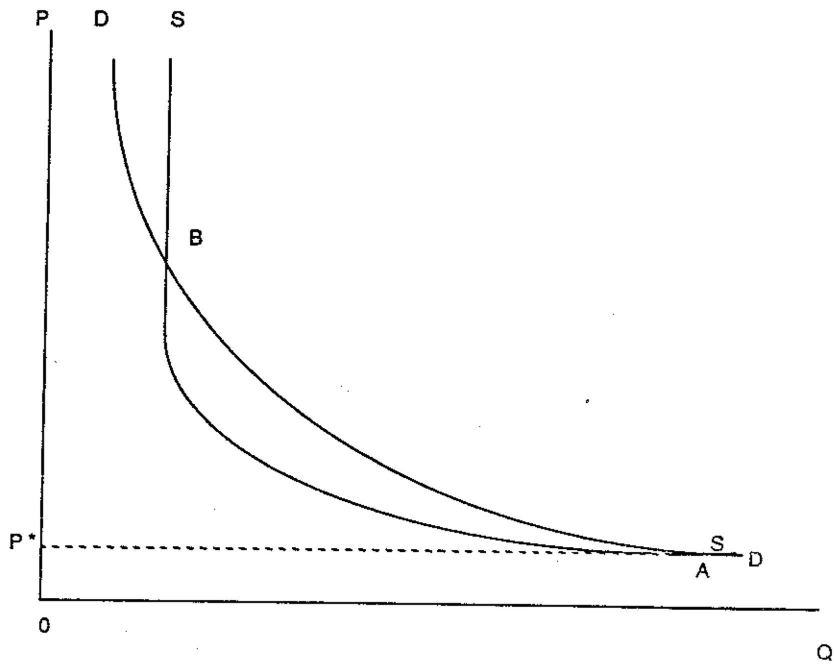
Now this story becmes relevant. In Figure C.2, the money supply has expanded further and pushed the demand curve to D^4D^4 and equilibria points A and B have now moved together to an equilibrium which is stable from below and unstable from above. Any further displacement of the price level upwards, by moving the demand curve to D^5D^5 or even due to a temporary shock, will cause hyperinflation and output decline until the economy arrives at a new equilibrium point such as C or E. Now further expansion of the money supply can do no more damage to ouput, just inflate the price level (unless creditors loss their nerve, shifting the supply curve backwards).

Another situation is displayed in Figure C.3, where the lower equilibrium point A, is unstable and as soon as the import rationing system becomes necessary, the process of hyperinflation and collapse will begin.

Can this damage be reversed, at least in theory? Certainly contracting the money supply will reduce the price level and economy will follow the supply curve down to the dogleg at D in Figure C.2 and then prices should collapse to a point such as F in Figure C.2 or, in Figure C.3, to a price below P*. If the economy is at a stable equilibrium such as F, further reduction of the money supply should cut prices and increase output. However, if prices are slow to decline in the face of excess supply, a short term increase in unemployment will result. Also, in a slightly more realistic model, with specialized export industries, export supply may respond very slowly after more favorable conditions are reestablished.

Many Third World countries faced with demands for deflationary reforms complain that such measures will result in a reduction of living standards. Such arguments may be true in the short run, if prices do not fall rapidly and the new equilibrium is not quickly attained. In the longer run, output, at least in this model, should increase as a reult of a deflationary monetary policy. It could be correctly argued that had this model been built with a fixed nominal wage, instead of a fixed real wage, then

Figure C.3



the slope of the supply curve could be positive, if real wages fell as the price level increased. The slope of the aggregate supply curve would depend on whether the reduction in real wages or the reduction in import levels dominated. However, the argument that the country was protecting real living standards by resisting deflation must be false, since the positively sloped supply curve depends on reducing real wages. In addition, this effect depends upon the increased labor inputs overcoming the reduction of imported inputs. However, the negative second partials of the production function for $\hat{Q}$ put limits on just how far labor can be used to substitute for imports, which will eventually force the supply curve to take on a negative slope.

An alternative or complementary method for expanding output is devaluation. This shifts the supply curve up, and output definitely rises (equation 37). Also, since P* increases, import rationing may be abolished at a higher price level.

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