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Black, S.W.

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9. ABSTRACT

An analysis of less developed countries' exchange policies, either pegged or floating, under the assumption that the world's major currencies will continue to float for the foreseeable future. Part I of this study contains a review of the theory and institutional structure of exchange markets and international money markets in developed countries, and a discussion of the institutional structure of money markets and exchange markets in LDC's, with appropriate modifications in the theory to allow for their special characteristics. Part II analyzes the macroeconomic implications in the choice between different types of exchange policies for the adjustment problems of LDC's in a framework of internal and external balance. Finally, Part III combines the institutional analysis of Part I with the macroeconomic analysis of Part II in a cost-benefit framework. The major thrust of the paper is that present exchange rate policies should be reevaluated by less developed countries to determine whether or not the policy should be changed.

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EXCHANGE POLICIES FOR LESS DEVELOPED COUNTRIES IN A WORLD OF FLOATING RATES

Stanley W. Black*

I. Characteristics of Exchange Markets and Money Markets in Less Developed Countries

I. 1. Introduction

The adoption of a system of floating exchange rates by the world's leading industrial nations in March, 1973, has posed two serious questions for many of the world's less developed countries (LDC's). The first concerns the position they should take in international monetary negotiations vis-a-vis the continuation of world-wide floating rates.[1] The second question is how their own exchange policies should adapt to the realities of the floating rate system with which they are now faced. As Helleiner has pointed out, "A more detailed consideration of the theoretical and practical merits and disadvantages of flexible exchange rates in less developed countries is by now certainly called for."

*Vanderbilt University. This study was completed under U.S.A.I.D. Contract No. AID/otr-C-1334. The computations in Part III were ably performed by Leonardo Cardemil. Useful comments on an earlier version were made by William Cline, David Dunlop, Anthony Lanyi, Danny Leipziger, and William Steel, although the usual disclaimer applies. I also wish to acknowledge useful discussions with a number of staff people at the IMF.

[1] This issue has been examined by G. K. Helleiner "The Less Developed Countries and the International Monetary System" Journal of Development Studies 10(3-4) (April/July 1974) and by William Cline, "Flexible Exchange Rates and the Developing Countries, the Brookings Institution. mimeo, 1975.

This paper is devoted to analysis of the choice of exchange policies, either pegged or floating, by LDC's under the assumption that the world's major currencies continue to float for the foreseeable future. While the theoretical benefits of a floating exchange rate are not necessarily limited to developed countries, the feasibility of such an exchange rate policy for LDC's depends on: (1) the development of an adequate structure of domestic financial markets integrated with world markets; and (2) the willingness of the government to allow the exchange market to operate in a context at least relatively free of the multitude of controls, special rates, and other devices so frequently utilized by LDC's. For one reason or another most of these countries have rejected the floating rate idea and have chosen to tie their exchange rates to one of the world's major trading currencies: the dollar, the pound, or the franc.

While avoiding certain problems, this choice in itself raises a number of additional difficulties. As pointed out by the Joint Economic Committee's Subcommittee on International Economics in its August 14, 1973 Report, "Among such costs are the need to adjust to exchange rate changes that result from events wholly external to developing nations and that may shortly be reversed." Numerous other difficulties were pointed out in testimony by Ricardo Arriazu of the International Monetary Fund on June 21, 1973, including shifts in the direction of trade induced by tying to particular currencies, effects of fluctuations in the tied rate on the domestic money supply and price level, fluctuations in the value of external assets and debts, needs for diversified holdings of reserves, and the effects of increased cost of covering short-term exchange risks.

The discussion of these problems and the design of policies to deal with them is hampered by the lack of an adequate theoretical framework in which to consider them. On the other hand, the tools with which to construct such a framework are readily available. This study attempts to lay out a theoretical framework for the consideration of these problems and to evaluate policies in that theoretical context.

Part I of the study begins by reviewing in section I.2 the theory and institutional structure of exchange markets and international money markets in developed countries. In section I.3, the institutional structure of money markets and exchange markets in LDC's is discussed, and appropriate modifications are made in the theory to allow for their special characteristics. The implications of this modified theory of exchange markets and money markets are then developed, especially concerning the depth, efficiency, and stability of the exchange market, as well as its responsiveness to internal and external disturbances. The basic conclusion is that capital has relatively low mobility in LDC's, in the sense that the interest-elasticity of capital movements is relatively low.

In Part II of the study, the macroeconomic implications of the choice between different types of exchange policies for the adjustment problems of LDC's are analyzed, in a framework of internal and external balance. Section II.1 develops the "small country" model of traded and non-traded goods for the case of a less developed country. The response of the model to various shocks under pegged and floating exchange rates is studied in section II.2.

The basic conclusion is that pegged rates are better if most shocks are from internal sources, while floating rates are preferred if shocks are external. Section II.3 broadens the framework to include world-wide multilateral floating rates and develops formulas for effective exchange rates. Section II.4 then considers the effects of alternative exchange policies on the economy, as measured by the variance of domestic prices of traded goods. The alternative policies include free floating, managed floating, pegging to a single currency, and pegging to the SDR. Managed floating appears to be the optimal policy, ignoring institutional costs.

Part III of the study combines the institutional analysis of Part I with the macroeconomic analysis of Part II in a cost-benefit framework. The framework developed in section III.1 is used to discuss specific exchange policies in Section III.2. Section III.3 deals with a number of other financial policy alternatives, such as development of forward markets, diversification of debt and reserve assets, clearing arrangements, and borrowing versus adjustment to the oil situation. Finally, section III.4 uses data on variances of effective exchange rates for one hundred less developed countries to discuss the effects of alternative exchange policies in the period 1970-1974. The reader interested mainly in discussion of policy alternatives can concentrated on Part III of the paper. The major thrust of the paper is that present exchange rate policies should be re-evaluated by less developed countries to determine whether or not the policy should be changed.

I. 2. International Money Markets and Exchange Markets in Developed Countries

Although the basic relationships between exchange markets and money markets in developed countries have been known for a long time,[1] recent work by the author has provided a more thorough theoretical and empirical analysis of these relationships as well as some short-cut graphical devices for developing their implications.[2] The following basic institutions and markets are assumed to be functioning effectively in both countries, taking the minimum number of countries needed for foreign trade and payments. The required institutions in each country are: central bank, commercial banking system, national Treasury, private business sector, securities brokers and dealers, and foreign exchange brokers and dealers (the latter will include most commercial banks). The required asset markets in each country are: short-term Treasury bills, both domestic and foreign, bank deposits, bank loans, currency, spot and forward foreign exchange. An alternative to a short-term Treasury bill market would be a market in private short-term paper, such as banker's acceptances or other paper eligible for discount at the central bank.

Not only should these institutions and asset markets exist in both countries, but they should function competitively, with the same price or interest rate

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[1] See S. C. Tsiang, "The Theory of Forward Exchange and Effects of Government Intervention on the Forward Exchange Market," IMF Staff Papers, 7 (April 1959), pp. 75-106, and J. M. Keynes, A Tract on Monetary Reform (New York: Harcourt, Brace and Co., 1924).

[2] Stanley W. Black, International Money Markets and Flexible Exchange Rates (Princeton: Studies in International Finance No. 32, 1973).

being charged to each participant (after correcting for differences in risk or other similar attributes). The markets must be broad enough, with a sufficient number of participants, to approximate the concept of an efficient market, in which current prices always fully reflect all available information.[1]

These requirements are sufficient in a two-country framework to allow one to define rigorously the excess demand functions for domestic and foreign securities and for spot and forward foreign exchange.[2] These excess demand functions can be shown to depend on domestic and foreign interest rates and spot and forward exchange rates. Therefore, equilibrium can be determined in the exchange and money markets, for any given state of demand for real goods and services. This financial and exchange market equilibrium will determine an LM curve and a Payments Balance (or BP) curve in each country, which together with the relevant IS curves and supply conditions will determine an overall equilibrium of incomes, prices, trade, and payments. For the purposes of this part of the study, I will focus on the financial market equilibrium, first for a pair of developed countries and then for less developed countries.

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[1]See Eugene F. Fama, "Efficient Capital Markets: A Review of Theory and Empirical Work," Journal of Finance XXV (2) (May 1970), pp. 383-417.

[4]See Black, op. cit., Chapter II.

Equilibrium in Money Markets and Exchange Markets[1]

Contemporary theories of equilibrium in exchange and money markets determine interest rates and exchange rates from conditions of stock equilibrium: rates must move to a configuration that will induce private (and governmental) holders of domestic and foreign securities and of domestic and foreign currency, spot and forward, to be willing to hold the existing stocks of these various types of assets. The existing stocks of securities can only be changed (net) by flows of saving and investment, which take time. The existing amount of domestic holdings of foreign exchange can only be changed (net) by trade or service flows, which also take time.

Willingness to hold assets of any kind, domestic or foreign, denominated in one currency or another, depends on the expected one-period yields on both the specific asset and alternative assets, including both the monetary returns and the implicit service flows from holding the asset, such as for transactions or precautionary purposes. Define the domestic short-term interest rate as Rd, the foreign short-term interest rate as Rf, the spot price of foreign exchange as x and the forward price of foreign exchange for delivery in three months as y.

Then the demand to hold domestic securities depends positively on the domestic interest rate, negatively on the foreign interest rate, and positively on the forward discount on foreign exchange (x-y). The forward

[1] Based on Black, ibid., Chapters II and III.

discount is a cost based on market expectations of movements in exchange rates that must be subtracted from interest earned on holdings of the alternative asset, foreign securities. These considerations apply to <u>all</u> forms of domestic securities holdings that bear interest at market rates. Thus we find that the aggregate excess demand to hold domestic securities is a function (1.1) of interest rates and exchange rates (where the signs above the variables indicate the signs of the relevant partial derivatives). In equilibrium the excess demand equals zero.

$$D(\overset{+}{Rd}, \overset{-}{Rf}, \overset{+}{x}, \overset{-}{y}) = 0. \tag{1.1}$$

This equation indicates that the demand for domestic securities depends positively on the interest paid on such securities, negatively on the foreign interest rate, and positively on the forward discount on foreign exchange, as stated earlier.

Likewise the excess demand to hold <u>foreign</u> securities (1.2) depends on the four rates, but in this case the effect of an increase in the domestic interest rate is negative, reducing the demand for foreign securities, while higher foreign interest rates or lower forward discounts will raise the demand for foreign securities.

$$F(\overset{-}{Rd}, \overset{+}{Rf}, \overset{-}{x}, \overset{+}{y}) = 0 \tag{1.2}$$

These demands to hold domestic and foreign securities (which implicitly include the demands to borrow at home or abroad as well) together with demand

to hold deposits in the two countries, determine the balance sheet or capital account of the foreign sector of the domestic economy (ignoring long-term capital for simplicity at this point). Equilibrium in this balance sheet matches the desire of foreigners to hold domestic assets or liabilities against the desire of domestic residents to hold foreign assets or liabilities. The balance determines the total demand to hold domestic vs. foreign-currency denominated assets. The spot exchange rate, or price of foreign currency in terms of domestic currency, must move to equilibrate this balance, given the net worth of the domestic and foreign sectors as determined by previous saving and net foreign investment flows. As a result the excess supply of spot foreign exchange can be written as a function (1.3) of the various interest rates and exchange rates.

$$X(\overset{+}{Rd}, \overset{-}{Rf}, \overset{+}{x}, \overset{-}{y}) = 0 \tag{1.3}$$

An increase in the domestic interest rate will increase the demand to hold domestic-currency assets, and therefore reduce the demand (increase the supply) of foreign exchange. An increase in the foreign interest rate or decrease in the forward discount on foreign exchange (x-y) will reduce the excess supply of foreign exchange.

Finally, we must consider the forward market, which depends crucially on exporters' and importers' needs to cover the risk on their foreign exchange assets and liabilities, both current and future. In the developed country context, foreigners will also be covering their risks on domestic currency assets and liabilities in the forward market. Cover of an existing foreign currency asset

is obtained by selling forward the expected foreign currency proceeds of the asset, so that increased holdings of domestic-currency assets, shown by equation (1.3), typically lead to increased sales of domestic currency in the forward market. Conversely, increased spot holdings of foreign-currency assets lead to sales of foreign currency forward. On the liability side of the balance sheet, increased foreign-currency liabilities lead to increased purchases of foreign currency forward. All of this boils down to an excess supply function (1.4) for forward foreign exchange with signs opposite to those for the spot market equation.

$$Y(\overset{-}{Rd}, \overset{+}{Rf}, \overset{-}{x}, \overset{+}{y}) = 0 \tag{1.4}$$

Speculative transactions based on expectations about the future spot exchange rate (denoted by w) can occur in both spot and forward markets. Unless these transactions are predominantly based on mistaken expectations as to the underlying economic situation, they will be stabilizing and hence will reinforce the effects shown in the various demand functions. On the other hand, if speculation is based on mistaken expectations, it may be destabilizing and reverse some of the signs assumed above. Likewise, an adjustable peg system may induce speculation about changes in the level of the pegged exchange rate.

Graphical Analysis[1]

Assuming flexible exchange rates, stabilizing speculation, and well-behaved markets, we can construct in three diagrams a simple graphical picture of equilibrium in exchange markets and money markets. The first diagram shows equilibrium in the two money markets, given by equations (1.1) and (1.2) above. For given values of the spot and forward exchange rates, and hence the forward discount (x-y) on foreign exchange, equations (1.1) and (1.2) can be solved together for equilibrium interest rates in each market. In Figure 1.1, the DD curve shows the locus of domestic and foreign interest rates that will produce equilibrium in the domestic money market, given exchange rates. The curve has a positive slope because an increase in the domestic interest rate would raise demand for domestic securities.

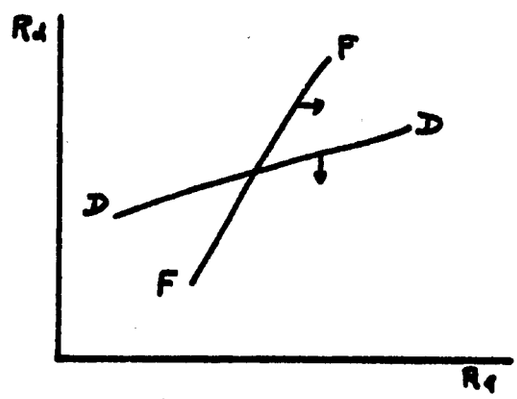

Figure 1.1. Equilibrium in Money Markets*

*Arrows show effects of increased forward premium.

[1]Based on Black, ibid., Chapter III.

In order to keep equilibrium in the domestic money market, the foreign rate would have to rise more than the domestic rate, assuming that the demand for domestic securities is more responsive to its own interest rate than to the rate on foreign securities. Therefore the slope of the curve is less than unity. An increase in the forward discount on foreign exchange would make foreign securities less attractive and require a decrease in the domestic interest rate to maintain equilibrium, resulting in a downward shift in the DD curve, shown by the arrow.

Equilibrium in the market for foreign securities is shown by the FF curve, which has a slope greater than unity, under the assumption that foreign securities are more responsive to their own interest rate than to the domestic interest rate. Thus an increase in the domestic rate, given exchange rates, would require a smaller increase in the foreign interest rate to maintain equilibrium in the foreign market. An increase in the forward discount on foreign exchange will make foreign securities less attractive (domestic securities more attractive), leading to a rise in the foreign interest rate, shown as an outward shift in the FF curve in the direction of the arrow. The intersection of these two curves determines money market equilibrium for any given set of spot and forward exchange rates.

Since an increase in the forward discount causes both curves in Figure 1.1 to shift in the directions of the arrows, it can be seen that the domestic interest rate must fall more than the foreign rate to maintain equilibrium. The result is an increase in the interest differential Rf-Rd. This result of money

market equilibrium is shown in Figure 1.3 below as the MM curve, relating an increase in the forward discount x - y to a smaller increase in the interest differential, on the assumption that exchange rates have less effects in money markets than do interest rates.

Exchange market equilibrium is shown in Figure 1.2 and the resulting EM curve of Figure 1.3. For given values of the interest rates, equations (1.3) and (1.4) are used to find the combinations of spot and forward exchange rates that produce equilibrium in the spot and forward exchange markets. In the market for spot foreign exchange shown by the XX curve, an increase in the spot exchange rate will tend to reduce the demand for foreign exchange and require an increase in the forward rate to keep the forward discount relatively unchanged so as to maintain equilibrium. The slope is greater than unity if the spot rate has a larger effect on the spot market than does the forward rate. An increase in the interest rate differential Rf - Rd will raise the demand for foreign exchange and cause the XX curve to shift to the right, as shown by the arrow.

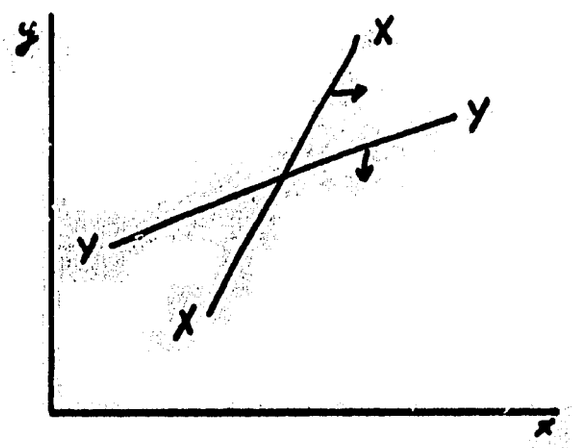

Figure 1.2. Exchange Market Equilibrium*

*Arrows show effects of increased interest differential Rf - Rd.

Likewise, equilibrium in the forward market is shown by the YY curve. An increase in the forward rate would discourage forward purchases of foreign exchange, but equilibrium in the forward market can be maintained by a rise in the spot rate. The reason is that the higher forward discount x - y will reduce spot purchases of foreign currency and simultaneously reduce the associated covering forward sales of foreign exchange. Therefore the YY curve slopes up, with slope less than unity on the assumption that the spot rate has less effect on the forward market than the forward rate has. An increase in the interest differential Rf-Rd causes the YY curve to shift down as shown by the arrow, since the forward discount x - y would have to increase to keep foreign securities from becoming relatively more attractive. Then the forward rate must fall relative to the spot rate. Since an increase in the interest differential shifts both curves in Figure 1.2 in the direction of the arrows, the spot rate will rise relative to the forward rate. The resulting increase in the forward discount on foreign exchange (x - y) is shown as the EM curve in Figure 1.3. The curve has slope steeper than unity if we assume that exchange rates have greater effects on exchange markets than interest rates have.

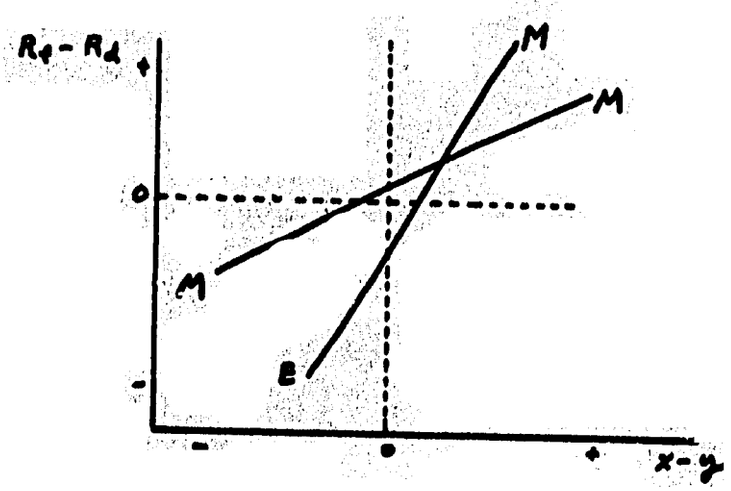

Figure 1.3. Exchange and Money Market Equilibrium

Overall short-period equilibrium in the model is determined by the intersection of the MM and EM curves. Given the interest differential and forward discount as determined by Figure 1.3, Figures 1.1 and 1.2 then determine the absolute levels of interest rates and exchange rates. It can be shown that the model is stable if the relative slopes of the curves are as shown in the Figures. The effects of disturbances and policies affecting the various markets can then be studied by shifting the relevant curves and observing the outcomes.[1] As time passes, change in the exchange rates as determined from stock equilibrium conditions will affect trade flows and the values of net foreign indebtedness and other stocks which are held constant in the short run.

I. 3. Characteristics of Less Developed Exchange Markets and Money Markets

A major question of this part of the study is in what ways do the exchange markets and money markets of less developed countries differ from the institutional and market structure described above, and therefore from the theoretical model? To begin with, it is perfectly obvious that there is a wide range of degrees of financial development within the set of countries usually called "less developed." Some data which will help to establish degrees of financial development in different countries will be introduced at a later stage in the study. Nevertheless, a survey of relevant institutional literature and discussion with knowledgeable staff people at the IMF has turned up six major aspects in which the financial markets of most LDC's differ from those of most developed countries. (i) There is a low degree of substitutability between domestic

[1] See Black, ibid., Chapter III for some examples.

and foreign securities, including a thin market for domestic securities and absence of a network of securities brokers and dealers. (ii) Because of low substitutability of domestic and foreign assets and because of much higher uncertainty concerning political and economic developments, speculation is more likely to be destablizing. (iii) There is no forward market. (iv) Interest rates on domestic securities are likely to be pegged at unrealistically low rates, leading to fragmentation of the securities markets and a multiplicity of interest rates paid in a disorganized market. There may be no market in short-term securities. (v) The government is likely to have an exchange control regime involving government monopoly of exchange dealings with multiple discriminatory exchange rates frequently in use. As a result the domestic network of exchange dealers will be tightly controlled and have a minute capital position. (vi) Finally, LDC's tend to have relatively small financial markets, at least small relative to those of developed countries. The implications of each one of these six characteristics will now be developed (one at a time) in the context of the theory of section I.2, assuming that the domestic country is less developed and the foreign country is highly developed.

(i) Effects of poor domestic securities market

Low substitutability of domestic and foreign securities in the portfolios of both domestic and foreign residents is a major effect of a thin, illiquid, or even non-existent market for domestic securities. In the context of the model developed in section I.2, low substitutability will shift the DD curve in Figure 1.1 toward the vertical. In other words, changes in one country's money

market conditions will tend to have less effect on the other country's money market. As a result, changes in exchange market conditions will have less effect on interest rates, and the MM curve of Figure 1.3 will be flatter. The reduced amount of substitutability, or reduced capital mobility, will mean that changes in money market conditions will tend to have bigger effects at home and smaller effects abroad.

Likewise, factors which cause exchange market conditions to change, shifting the EM curve in Figure 1.3, will have smaller effects on the interest differential. Suppose there is speculative flight from the domestic currency, causing the XX curve to shift out and the YY curve to shift up in Figure 1.2. Normally one would expect the YY curve to shift up by more, since forward market speculation requires less capital to be tied up. The result is a fall in the forward discount, or a backward shift in the EM curve of Figure 1.3. With a flatter MM curve due to low capital mobility, the interest differential will fall by less. The final result is that the curves in Figure 1.2 then shift again in directions opposite to the arrows, due to the fall in the interest differential. But this shift is smaller because of low capital mobility, and the spot foreign exchange rate thus appreciates relatively more and the forward rate by relatively less than with high capital mobility. Thus speculative episodes will have more violent effects on exchange rates if money markets are poorly developed in the LDC.

Going beyond these formal results from the model, if the domestic securities market is relatively poor, then the main interest rates relevant for the model become the relative costs of trade credit at home and abroad. These costs are likely to be relatively much higher at home than interest rates on

securities would be if there were a developed securities market. Therefore the MM curve will be relatively lower in Figure 1.3, leading to a large forward discount on the domestic currency ($x - y < 0$). This will make the cost of forward cover of domestic currency assets much more expensive.

(ii) Effects of destabilizing speculation

As discussed in section I.2 following equation (1.4), destabilizing speculation can change the signs of the effects of exchange rates on demand for spot or forward foreign exchange. But that kind of effect is not necessary for speculation to destabilize the model. All that is required for an unstable market is that the YY curve in Figure 1.2 should cut the XX curve from below. This can happen if the elasticity of expectations about the future spot exchange rate is sufficiently high. Thus an increase in the price of foreign exchange (fall in the value of domestic currency) could generate expectations of an even larger increase (decline in domestic currency) in the future. The result is that an increase in the spot exchange rate requires an even larger increase in the forward rate to equilibrate the forward market, generating a relatively steep YY curve.

This sort of instability is even more likely when combined with low capital mobility as argued in section I.3 (i). Unstable exchange markets can and presumably will be stabilized by the introduction of pegged exchange rates, although there are also other reasons for pegging exchange rates. In Figure 1.4, the effects of restraining an unstable spot exchange rate between upper and lower pegs ($\bar{x}$, $\underline{x}$) is shown by the vertical segments of the XX curve.

The unstable equilibrium at A has been replaced by stable equilibria at B and C. Such pegging can be achieved either by means of government purchase or sale of foreign exchange in unlimited amounts at the pegs, or by means of exchange controls.

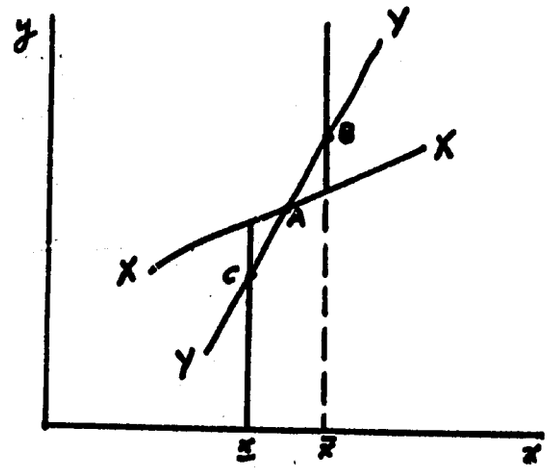

Figure 1.4. Destabilizing Speculation and Pegging

(iii) Effects of no forward market

In the absence of a forward exchange market, foreign currency assets must be held either without cover against exchange risk, or balanced against foreign currency liabilities. In practice, there is usually less concern about risk on foreign currency assets than there is about uncovered foreign currency liabilities and domestic currency assets.

In the context of the model, the absence of a forward market between the domestic and foreign currencies renders Figure 1.2 inoperative. As long as speculation remains stabilizing, an increase in the spot exchange rate will still cause the curves of Figure 1.1 to shift in the direction of the arrows and raise

the interest differential. Thus, Figure 1.5 can be derived, combining the MM and XX curves. In this situation one would expect capital to be

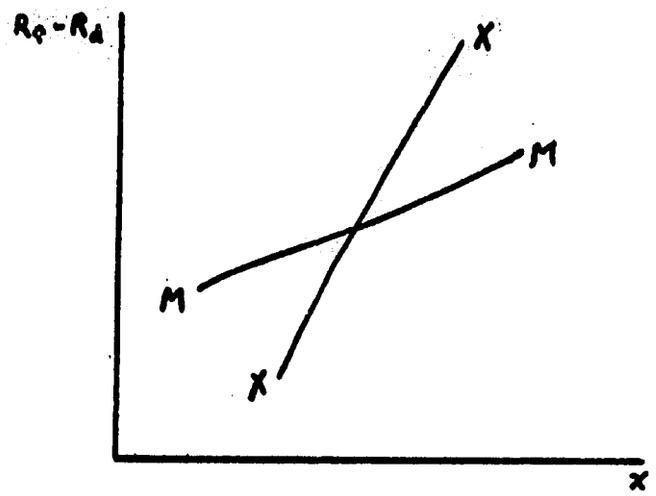

Figure 1.5. Absence of Forward Market

relatively less mobile also, leading to a flatter MM curve. The result is that shocks in the exchange market would have to be borne almost completely by changes in the exchange rate (if the exchange rate were not pegged), rather than having the cushioning effects of stabilizing capital flows available. The relative weakness of stabilizing capital flows would imply that the movement of the exchange rate over time might then become influenced more largely by the trade account. In the presence of the so-called "J-curve,"[1] which indicates that the short-run response of the trade account to a change in exchange rates may be perverse because of low short-run elasticities,

[1]See Stephen P. Magee, "Currency Contracts, Pass-Through, and Devaluation," Brookings Papers on Economic Activity 1973:1, pp. 303-323.

stabilizing capital flows are required for the overall stability of the balance of payments. Thus instability may be more likely without a forward market.

(iv) Pegged domestic interest rates and fragmented securities markets

The pegging of interest rates in the domestic securities market by the central bank merely replaces the DD curve of Figure 1.1 with a horizontal line at the pegged rate. This curve will then also be independent of changes in exchange rates, including the premium on forward foreign exchange. The result is that changes in the forward discount have a smaller effect on the interest differential, since they only affect the foreign interest rate. Therefore the MM curve will be flatter, just as in case (i) of low substitutability. The general effects of this case appear to be similar to those of case (i).

(v) Exchange control and/or multiple exchange rates

Exchange control regimes are usually adopted when the exchange rate is pegged at a disequilibrium level. Thus the device of Figure 1.4 showing a pegged exchange rate can be used even without the assumption of destabilizing speculation leading to an unstable market. When the chosen tool of pegging is exchange control rather than reserve movements, imports will be limited to the amount of foreign exchange earned by exporting at the disequilibrium exchange rate, plus capital inflows. This will always be less than the amount of imports demanded, if the exchange control is effective, with the result that the domestic price of imports will tend to exceed their foreign exchange cost translated into domestic currency. The familiar litany

of misallocated resources can be recited here: excessive production of high-cost import substitutes, insufficient production of low cost exports, distorted consumption patterns, excessive production of home goods relative to foreign-trade goods, distorted distribution of income.[1] These problems are obviously worsened if multiple exchange rates are adopted involving government use of monopoly power to raise revenue from the foreign exchange business.

The decreased efficiency of the economy generated by exchange controls will show up on the supply side of the economy rather than in financial markets per se. However, the use of exchange controls will also strongly discourage the sort of two-way capital mobility that helps exchange markets to work smoothly between developed countries. Thus capital will become less mobile, as in case (i).

(vi) Small relative size of domestic financial market

Even the best developed financial market in Europe is much smaller than the New York market. The consideration of relative size is even more important for a less developed country. Having a small financial market means that it will not be economic to develop the wide network of broker-dealer relationships, inter-bank markets, and organized exchanges, that larger volumes in industrial centers can support. Under these conditions, an LDC will typically make extensive use of the facilities of its partner's financial market, rather than trying to make do with its own inadequate,

[1] See Anne Krueger, "Balance of Payments Theory," Journal of Economic Literature (March 1969), section 3.

relatively slow and expensive facilities for financing trade and capital movements. A thorough study of the extent of such behavior in the ECAFE region demonstrates its significance.[1]

In terms of the model, a relatively small domestic financial market means that the FF and DD curves of Figure 1.1 both become relatively steeper, since the domestic market has less effect on the foreign interest rate, but the foreign market has more effect on the domestic rate. In the exchange market, small size has more serious disadvantages. Fewer traders and investors will want to hold the currency of a relatively small country, since its trade and investment position must both be relatively small. This is of course ceteris paribus, as the case of Switzerland makes clear.

II. Effects of Floating Exchange Rates on LDC's in a Model of Internal and External Balance

II. 1. A Model of Internal and External and External Balance for LDC's

In order to analyze the effects on less developed countries of floating exchange rates among the developed countries, one must have a model of the typical less developed country. As is well-known, there is no such thing as a "typical" less developed country. There are vast differences in culture,

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[1] See S. Mookerjee, A. Chandavarkar, and D. Cleary, "Existing International Banking and Credit Facilities in the ECAFE Region," IMF Staff Papers 16 (November 1969), pp. 391-433.

structure of production, resources, education, health, climate, etc. But from the point of view of this study, all of these long-run factors may be taken as given. Furthermore, let us assume that the exchange markets and financial markets have the general characteristics discussed in Part I of this study. Thus capital mobility will be low. For most LDC's, it will also be appropriate to assume that the economy is open, but is too small to be able to affect the world prices of its exports or imports. In addition, domestic resources may be under-utilized, relative to standards of efficiency customary in developed countries, but more efficient utilization may not be readily obtainable due to local culture, tradition, habits and training.

It is obvious that the standard Mundellian model of internal and external balance assuming high capital mobility, a developed financial market, and Keynesian supply conditions cannot realistically be applied to such economies.[1] Therefore, the following simple model of a small, open, underemployed economy with a poor capital market has been assembled from materials readily available in the literature.[2]

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[1] For Mundellian models assuming capital mobility and substantial short-run flexibility of supply, see the analyses of Jerome Stein, "The Optimum Foreign Exchange Market," American Economic Review LIII(3) (June 1963) and Victor Argy and Michael G. Porter, "The Forward Exchange Market and the Effects of Domestic and External Disturbances under Alternative Exchange Rate Systems," IMF Staff Papers XIX(3) (November 1972).

[2] See W. E. G. Salter, "Internal and External Balance: The Role of Price and Expenditure Effects," The Economic Record XXXV (71) (August 1959); Bent Hansen, "Simulation of fiscal, monetary and exchange policy in a primitive economy: Afghanistan," Economic Structure and Development (North Holland, 1973), pp. 215-237; also Martin F. J. Prachowny, "The Effectiveness of Stabilization Policy in a Small, Open Economy," Weltwirtschaftliches Archiv 109(2), (1973).

Since the terms of trade cannot be affected by changes in the domestic economy, exportables and importables can be collapsed via Salter's technique into a single tradable good.[1] There is also a non-tradable, or domestic, good. The supply functions of the two goods are assumed to depend on relative prices.[2] This production structure is described by a "feasibility locus" (FF) in Figure 2.1, indicating that resources may be underemployed. Full production possibilities (PP) could only be realized by some thorough-going structural changes.

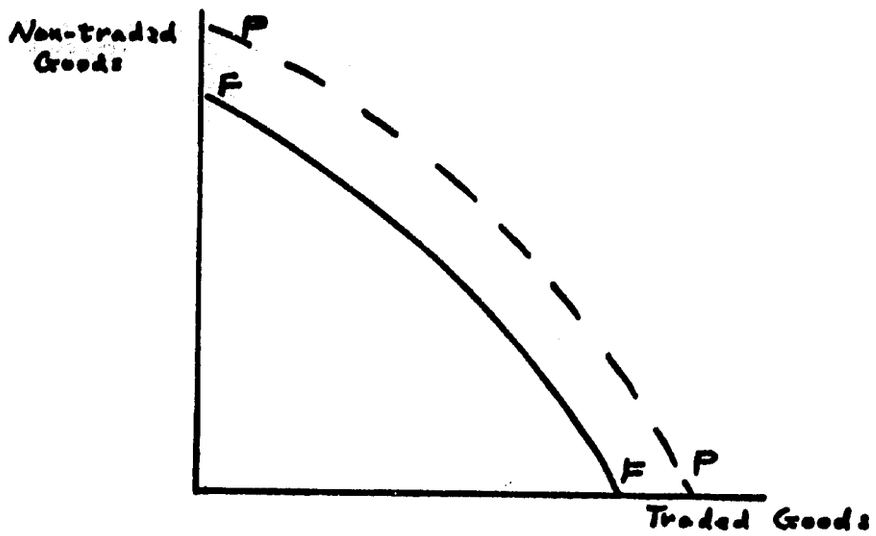

Figure 2.1 Feasible Production

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[1] Since relative prices are fixed, there is no difficulty in dealing with exports which do not compete in consumption or imports which do not compete in production. Such goods become part of the composite "tradable."

[2] In some cases, it may be desirable to assume that supplies depend to some extent on real money balances, on the grounds that availability of finance may be a real constraint on production in many cases. See Ronald I. McKinnon, Money and Capital in Economic Development, (Brookings, 1973), Chapter 6.

Domestic demand for each of the two goods is assumed to depend on relative prices, real income, and real money balances. Net exports of tradables are equal to the excess of domestic production over consumption. These conditions are described by equations (2.1) and (2.2), equating demands to supplies in each market:

(2.1) $$A_n(\overset{+}{p_t}, \overset{-}{p_n}, \overset{+}{pY}, \overset{+}{M}) = Y_n(\overset{-}{p_t}, \overset{+}{p_n})$$

(2.2) $$A_t(\overset{-}{p_t}, \overset{+}{p_n}, \overset{+}{pY}, \overset{+}{M}) + X = Y_t(\overset{+}{p_t}, \overset{-}{p_n})$$

These functions are assumed differentiable and homogeneous of degree zero in the nominal variables (p_t, p_n, pY, M). The signs of the partial derivatives are given above the arguments. Money income (pY) is equal to the factor cost of production plus the excess of government spending over taxes (assumed exogenous for simplicity). It is assumed that government buys only labor services.

(2.3) $$pY = p_tY_t + p_nY_n + \bar{G} - \bar{T}$$

The price level (p) is a weighted average of the domestic prices of tradables and nontradables.

(2.4) $$p = \alpha_t p_t + \alpha_n p_n$$

The balance of payments shows the domestic currency value of additions to reserves (ΔF) as equal to the value of net exports (p_tX) plus exogenous net

capital imports ($\bar{K}$) valued at the current exchange rate of the domestic currency (r = units of local currency per dollar).

(2.5) $$\Delta F = p_t X + r\bar{K}$$

The change in the money supply (ΔM) is equal to foreign exchange accumulation plus the government deficit plus credit granted to domestic business ($\Delta \bar{L}$)

(2.6 $$\Delta M = \Delta F + \bar{G} - \bar{T} + \Delta \bar{L}$$

Finally, the domestic price of tradable goods is equal to the exogenous world (dollar) price of tradables ($\bar{p}_t^f$) times the (dollar) exchange rate of local currency (r). Thus foreign demand for tradables is infinitely elastic.

(2.7) $$p_t = \bar{p}_t^f r$$

Under pegged exchange rates ($r = \bar{r}$) these seven equations suffice to determine the seven variables (p_t, p_n, p, Y, M, X, F). Such pegged rates can be achieved in any of three ways: (a) reserve movements, as assumed in equation (2.5); (b) official borrowing to finance deficits, which makes capital inflows (K) endogenous and reserve flows exogenous ($\bar{F}$); (c) import controls, which also make reserve flows exogenous, but break the equality (2.7) between the domestic and world prices of tradable goods.

Under a flexible rate system the exchange rate moves to guarantee payments balance so again $\Delta F = 0$. This may be achieved by government management of the exchange rate, if market floating is not feasible, given the institutional structure of exchange markets and financial markets.

The solution of this model in the case of flexible rates is quite simple. Since $\Delta F = 0$, from equation (2.6), the money stock is an exogenous variable controlled by the Central Bank. Net exports must equal the value of capital outflow ($X = -\bar{K}/\bar{p}_t^f$). Then equation (2.3) can be substituted into (2.1) and (2.2) for money income, leaving two equations in two unknowns, the prices of tradables (or equivalently the exchange rate) and nontradables. The solution of these two equations can be seen in Figure 2.2, where NN is the locu of pairs (p_t, p_n) that equilibrate the market for non-tradables and TT is the corresponding locus for tradables. It is shown in section 1 of the Appendix

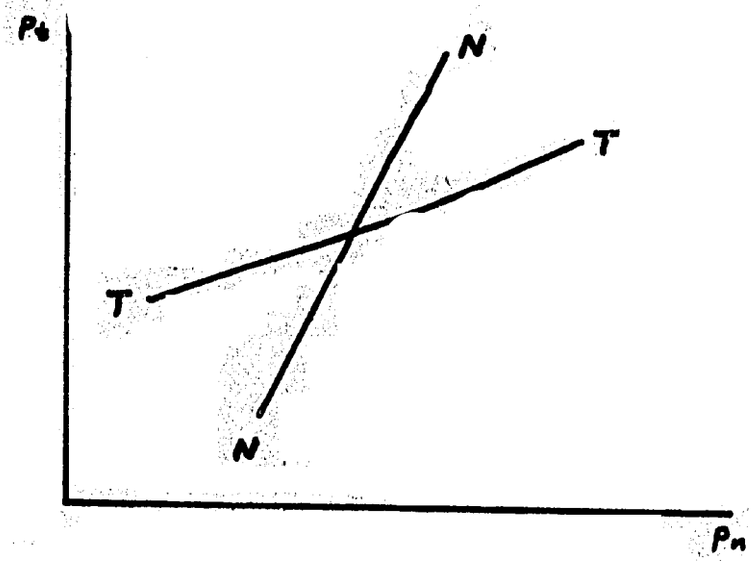

Figure 2.2 Equilibrium with a Flexible Exchange Rate

that the slope of the NN curve is greater than unity, while the slope of the TT curve is less than unity, using the assumed signs and homogeneity properties of (2.1) and (2.2). The argument about relative slopes goes as follows. A

proportional increase in both prices (along a 45 degree line through the intersection point) would leave supply unaffected and reduce demand in both markets, because of the exogenous money supply. Thus equilibrium in the market for non-tradables requires the price of non-tradables to rise less than proportionately, as shown by the steep NN curve. Likewise, equilibrium in the market for tradables would require the price of tradables to rise less than proportionately, giving a relatively flat TT curve. Under pegged exchange rates, achieved either by reserve movements or borrowing, the TT curve would be replaced by a horizontal line at the level $p_t = \bar{r}\bar{p}_t^f$.

II. 2. Internal and External Balance: Response to Shocks

In this model, internal balance requires equality of supply and demand for the home good. The infinite elasticity of foreign demand for the tradable good implies that disequilibrium in that market can easily be resolved. Along the NN curve, then, there is no tendency for inflation or deflation in the domestic market. The TT curve may be taken to reflect external balance, since along that curve, international payments are in balance. (It might be more appropriate to regard the TT curve as obtained by substituting from (2.2) into the balance of payments equation (2.5), rather than vice versa.) Let us now consider several types of shocks to the economy and the effects of pegged versus floating exchange rates.

Domestic Crop Failure

As shown in Figure 2.3, this reduction in supply of the home good can be regarded as a rightward shift in the NN curve, leading to a depreciation

of the exchange rate from A to B under flexible rates. The fact that the price of the home good rises more than that of the foreign good increases the consumption

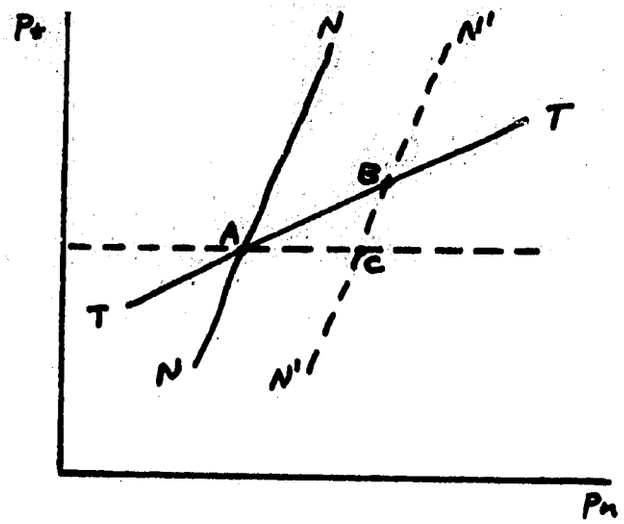

Figure 2.3 Crop Failure

of the foreign good and increases production of the home good. If the crop failure is expected to be temporary, a more appropriate exchange policy would be to peg the exchange rate at the intitial level given by the dashed horizontal line through A, either by reserve loss or foreign borrowing. By holding down the domestic price of tradable goods, more demand could be shifted over to the traded goods sector, reducing hardship in the country. The balance of payments deficit is indicated by the fact that the point C is below the external balance line TT. The reserve outflow at C would reduce the money stock, shifting N'N' and TT left and down, respectively.

Differential Inflation Rate

If world prices rise more rapidly than domestic prices, this can be shown as a (relative) rise in the world price of tradable goods. (The opposite case

would yield a fall in $\bar{p}_t^f$). Assuming that the country is a capital importer with a trade deficit ($\bar{K} > 0$), the real value of capital inflow falls, and the TT curve shifts up. Under a flexible rate, the country appreciates its currency, but by less than the rise in world prices in order to earn the additional foreign exchange needed. The domestic prices of both goods rise. If the exchange rate were pegged, the rise in the domestic price of traded goods would generate a surplus in the balance of payments, leading to reserve gains and monetary expansion. A capital exporter with a trade surplus would have to appreciate by more than the rise in world prices, in the flexible rate case.

Fall in Terms of Trade

As Salter (op. cit.) has shown, a fall in the terms of trade changes the definition of the traded good. Therefore it is necessary to go back to first principles.[1] Consider first a rise in import prices. The demand for foreign exchange rises or falls according to whether demand for imports is inelastic or elastic, since the supply of imports is infinitely elastic in this model. Assuming inelastic demand, the exchange rate depreciates, further raising the price of imports, and that of exportables as well. The result is probably a shift of demand towards home goods and supply away from home

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[1]See James Meade, The Balance of Payments (London: Oxford U. Press, 1951) Ch. VIII and Murray Kemp "The Balance of Payments and the Terms of Trade in Relation to Financial Controls," Review of Economic Studies 37(1) (January 1970), pp. 25-31 for discussion of the terms of trade effects of devaluation which can be manipulated to give the exchange rate effects of changes in the terms of trade.

goods, thus raising their price as well, although the result depends on the strength of substitution and/or complementarity relations between the three types of goods in both production and consumption. With pegged exchange rates and inelastic demand for imports, all prices would rise less, since the depreciation is avoided (or postponed).

On the other hand, if import demand is elastic, the exchange rate appreciates, reducing the magnitude of the increase in import prices and lowering the domestic price of exports. Home goods prices rise by less than in the inelastic case, if at all. Pegged exchange rates would cause import prices to rise more and prevent export prices from falling.

Now let us consider a fall in export prices. The reduction in foreign exchange earnings will result in a depreciation of the exchange rate, partially offsetting the reduced domestic price of exports and raising the price of imported goods. If the demand for imports is inelastic, the higher price will further increase the demand for foreign exchange; the exchange rate will depreciate further, so that the domestic price of exportables may even increase. The reverse occurs with elastic demand. Home goods prices may rise or fall, depending on the strength of the substitution towards exportables and away from imports.

Pegged exchange rates would eliminate the depreciation, so that import prices could not rise. In this case demand would shift towards exportables and supply towards home goods, thus reducing the price of home goods.

Exchange Rate Policies for Stabilization

Since any economy is frequently buffeted by random shocks of various types, stabilization policies can be defined as policies devoted to maintaining internal and external balance in the face of such shocks. In the context of this model of a less developed country, the optimal exchange rate policy from a stabilization point of view depends on the type of shocks to which the economy is most frequently exposed. For example, if most shocks are generated by changes in the level of world prices relative to domestic prices, then the goals of internal and external balance will be served best by a flexible exchange rate policy which will tend to insulate domestic prices from the effects of fluctuations in world prices. For example, in Figure 2.4 a country with no net capital imports is faced with random fluctuations in world price levels. A flexible exchange rate could allow the TT curve to remain unaffected by the world price fluctuations. But a pegged exchange rate would cause domestic prices of tradables to fluctuate, say from RR to R'R', so that prices would fluctuate from point A to point B.

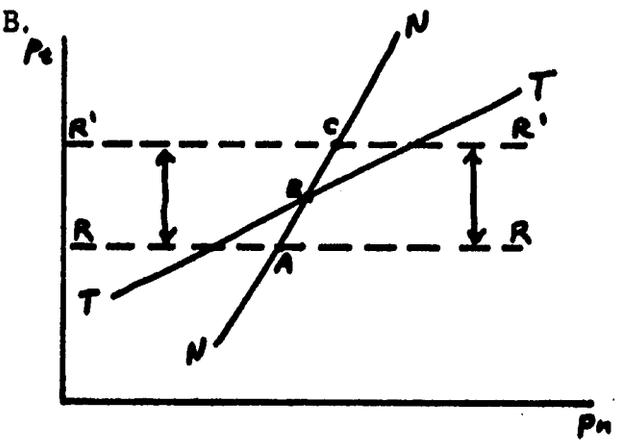

Figure 2.4 Fluctuations in Inflation Rate

On the other hand, if most shocks come from temporary fluctuations in harvests or other domestic production, a pegged exchange rate policy is optimal. In Figure 2.5 we consider fluctuations in domestic production of the non-traded good. It is obvious that price fluctuations will be substantially reduced by pegging the

exchange rate at a level indicated by the line RR, since the range is reduced from AB to CD. This result holds with much more force in case of fluctuations in domestic production of the traded good, since the pegged exchange rate can wipe out the effects on prices of shifts in the TT curve.

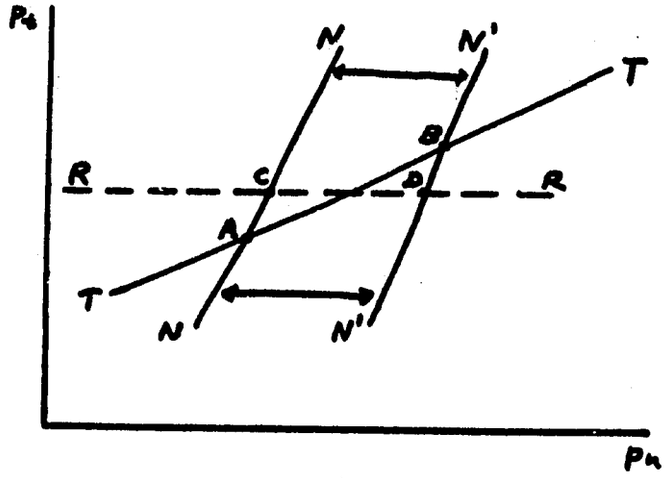

Figure 2.5 Fluctuations in Domestic Production

If most shocks come from temporary shifts in the terms of trade, the situation is more complex. Let us begin with the case of elastic demand for imports and assume that either export prices fall or import prices rise. Then pegging the exchange rate prevents the other traded good price from moving in the opposite direction. Then home goods prices will move <u>more</u> under pegged exchange rates, as will the <u>average</u> price of traded goods. On the other hand, if import demand is inelastic, a deterioration in the terms of trade will raise all prices under flexible exchange rates. Pegging the exchange rate will prevent the increase in the domestic price of the traded good whose world price has not changed, and will therefore lead to a smaller movement in the price of home goods.

II. 3. The Effects of World-wide Floating Exchange Rates

When the exchange rates of most of the major trading nations are floating, the model developed above needs to be modified to take account of the multiplicity of foreign price levels for tradable goods. The standard technique for dealing with a group of floating rates is the concept of effective exchange rate.[1] In the model of this study, the movement of the dollar exchange rate may give a very inaccurate idea of real changes in the international purchasing power of the local currency.

The effective exchange rate for a country can be defined as a weighted average of the exchange rates of its trading partners, with all rates being measured relative to some base year. An index can then be computed by comparing the actual exchange rate of the country to the weighted average of the rates of its trading partners. The simplest type of weighting system is a bilateral system of weights, using either export shares or import shares or an average of both. For example, an export-weighted effective rate index can be defined as in equation (2.8), where

$$e_j = \sum_{k \neq j} E_{jk} r_k, \qquad \text{index} = r_j / e_j \tag{2.8}$$

the rates r_k are defined as units of currency k per dollar and $E_{jk} = X_{jk} / \sum_{k \neq j} X_{jk}$ = share of j's total exports going to k where X_{jk} is the flow from j to k. Similarly, an import-weighted index is defined in (2.9), where

[1] See Economic Report of the President (Washington: U.S. Government Printing Office, 1974), pp. 220-226.

$M_{kj} = X_{kj} / \sum_{k \neq j} X_{kj}$ = share of j's imports coming from k.

(2.9) $$e_j = \sum_{k \neq j} M_{kj} r_k, \qquad \text{index} = r_j / e_j$$

These indexes give extremely useful information concerning the effect of shifts in world exchange rates on the competitive position of a given country. Nevertheless, they have at least two major shortcomings from the point of view of this study. One generally acknowledged drawback is that bilateral weight indexes ignore the effects of competition between the products of countries j and k in third markets. An additional problem is that an index of exchange rates is not a price index of tradable goods. Both of these limitations can in principle be resolved through the use of the IMF's Multilateral Exchange Rate Model (MERM).[1]

The following simplified version of the MER Model assumes that there is only one class of tradable good. It is also assumed for simplicity that incomes and prices of non-traded goods are held constant by policy in all countries, while exchange rates are allowed to fluctuate, in response to exogenous shocks. For any country k, the tradable "good" Z^k is assumed to be a composite function of the "products" of the n trading partners.

$$Z^k = f^k(Z_1^k, \ldots, Z_n^k)$$

In order for this aggregate tradable good to be identifiable with the tradable good in the model of this paper, it must be assumed that the marginal rate of

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[1]See Jacques Artus and Rudolf Rhomberg, "A Multilateral Exchange Rate Model," IMF Staff Papers, XX(3) (November 1973), pp. 591-611.

substitution between any two "products" in (2.10) is independent of the consumption of the non-tradable good.[1]

Under these assumptions, the proportionate change in the demand for exports from country j to country k can be written as

$$\overset{*}{Z}{}_j^k = \sum_{i=1}^{n} \eta_{j/i}^k (\overset{*}{P}_i - \overset{*}{T}_k), \tag{2.11}$$

where $\overset{*}{P}_i$ = proportionate change in the dollar price of the product of country i, $\overset{*}{T}_k$ = proportionate change in the dollar price of country k's currency, $\eta_{j/i}^k$ = price elasticity of demand in country k for product j with respect to price i.[2] Defining $X_j^k = P_j Z_j^k$ as the dollar value of exports from j to k, the share of j's total product of tradable goods exported to k is $W_j^k = X_j^k / \sum_{k=1}^{n} X_j^k$. The percentage change in the total value of production of tradables in j is then

$$\overset{*}{X}_j = \sum_k W_j^k \overset{*}{X}{}_j^k = \overset{*}{P}_j + \sum_k W_j^k \overset{*}{Z}{}_j^k . \tag{2.12}$$ [3]

Finally, we assume that the price elasticity of supply of tradables produced in country j is β_j, so that the proportionate change in the value of tradables

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[1] See Paul S. Armington, "A Theory of Demand for Products Distinguished by Place of Production," IMF Staff Papers, XVI (1) (March 1969), pp. 159-176.

[2] Artus and Rhomberg, op. cit., equation (1), simplified.

[3] Ibid., equation (3), simplified.

in country j is

$$\overset{*}{P}_j + \beta_j (\overset{*}{P}_j - \overset{*}{T}_j). \quad (2.13)$$ [1]

Equating value of demand and supply for each country j, we have the equilibrium conditions

$$\sum_{k=1}^{n} W_j^k \sum_{i=1}^{n} \eta_{j/i}^k (\overset{*}{P}_i - \overset{*}{T}_k) = \beta_j (\overset{*}{P}_j - \overset{*}{T}_j), \quad j = 1, \ldots, n. \quad (2.14)$$

It is shown in part 2 of the Appendix that these equations have the solution:

$$\overset{*}{P}_j = \sum_{k=1}^{n} m_{jk} \overset{*}{T}_k, \quad (2.15)$$

where the m_{jk} are the elements of a matrix depending on the trade shares and the demand and supply elasticities. The implication of this result for the problem of this study is that the changes in exchange rates $\overset{*}{T}_k$ now have definite implications for the changes in prices of tradable goods produced in each country. It is further shown in the Appendix that if the supply elasticities β_j are infinite, the m_{jk} of (2.15) equal unity for j=k and zero otherwise, implying that $\overset{*}{P}_j = \overset{*}{T}_j$ for all j. (This is obvious from (2.14), after dividing both sides by β_j).

Finally, we need to relate the prices (P_j) of the "products" (Z_j^i) of each country j to the price (P^i) of the tradable "good" (Z^i) consumed in country i. This can be done by means of the following price index. Let

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[1] Ibid., equation (15), simplified, with the supply elasticity β_j defined in volume terms.

$S_j^i = X_j^i / \sum_{j=1}^{n} X_j^i$ = the share of i's total use of the tradable good that is imported from j. Then Armington shows that a price index for the tradable good can be defined as[1]

$$\overset{*}{P}{}^i = \sum_{j=1}^{n} S_j^i \overset{*}{P}_j. \tag{2.16}$$

Making use of (2.15), we have a relation between the changes in exchange rates in all countries and the world price of tradable goods in country i.

$$\overset{*}{P}{}^i = \sum_{j=1}^{n} S_j^i \sum_{k=1}^{n} m_{jk} \overset{*}{T}_k = \sum_{k=1}^{n} \left(\sum_{j=1}^{n} S_j^i m_{jk} \right) \overset{*}{T}_k. \tag{2.17}$$

When supply elasticities are infinite, this simplifies to

$$\overset{*}{P}{}^i = \sum_{k=1}^{n} S_k^i \overset{*}{T}_k , \tag{2.18}$$

which is very close to the bilateral import-weighted index given by equation (2.9). In fact, if we define Z^k to be the <u>foreign</u>-source tradable good, (2.18) would be exactly the same as (2.9) except that the exchange rates are defined inversely. Thus the data used below in section III.4 based on formula (2.9) may be considered to be consistent with the MER Model under certain rather special assumptions.

[1] <u>op. cit.</u>, footnote 29, p. 174.

Application to Less Developed Country Model

The model of section II. 1 assumes that the LDC, say country j, is too small to affect the world prices of its traded goods. On the export side, this implies that the foreign elasticities of demand with respect to P_j are infinite ($\eta_j^k/j = \infty$, for all $k \neq j$). On the import side, the foreign supply elasticities are all infinite ($\beta_k = \infty$, for all $k \neq j$). Thus the price of the LDC's "product" P_j will be determined by the following modification of equation (2. 14) for the case of infinite demand elasticities:

(2. 19)
$$\sum_{k \neq j} W_j^k \overset{*}{P}_j = \sum_{k \neq j} W_j^k \overset{*}{T}_k$$

or

(2. 20)
$$\overset{*}{P}_j = \sum_{k \neq j} E_{jk} \overset{*}{T}_k ,$$

where $E_{jk} = W_j^k / \sum_{k \neq j} W_j^k$.. This is identical to (2. 8), based on export weights. Similarly, the price of the composite "good" Z^j consumed in country j when all <u>other</u> countries have infinite supply elasticities is known from (2. 18) to be identical to (2. 9), based on import weights. Thus in the special case of the country facing fixed world prices, formulas (2. 8) and (2. 9) give good measures of the effects of floating rates on export prices and import prices, respectively.

II. 4. The Choice of Exchange Rate Policy in a World of Floating Rates

Utilizing the results of the previous three sections, we can now turn to the choice of exchange rate policy for a less developed country in a world of floating rates. The main focus is on the design of exchange rate policy for stabilization, as discussed in section II.2. Thus an optimal policy is defined as one which minimizes the variance of the domestic relative price of tradable goods. Choice of the variance as a single criterion implies that stabilization is a goal and further that the average or mean future price is not really subject to choice. If the future movements of floating exchange rates among the major nations are not predictable, then exchange rate policy cannot be designed to affect the mean price of tradable goods. On the other hand, in a world of managed floating, changes in exchange rates may be predictable when central banks intervene to delay upward or downward movements in exchange rates. If it is possible to predict movements in exchange rates, then a country may choose to peg its currency to a major currency that is expected to appreciate or depreciate, depending on whether the country in question needs to appreciate or depreciate from its own point of view. Such possibilities will be ignored in the following discussion.

The variance of relative price is used as a measure of instability for a number of reasons. Stiglitz has shown that consumers in a two good world of the sort developed in section II.1 will pay an insurance premium to

avoid uncertainty if they are sufficiently risk averse.[1] The amount of the premium depends positively on the degree of risk aversion and net purchases of the traded good, negatively on the compensated price elasticity and income elasticity of demand for the traded good, and positively on the variance of the relative price of the traded good. The basic reason for this result is that individuals with diminishing marginal utility of income will value increases in income due to favorable price outcomes as less significant than losses in income due to unfavorable outcomes. Thus consumers will be better off if the variance of prices can be reduced without excessive cost in terms of the resources devoted to the effort.

With respect to production, Sandmo and others have shown under fairly general conditions that risk-averse firms will produce less if prices are random than if prices are known (and equal to the mean of the random prices).[2] Diminishing marginal utility of profits implies that increments to profits from high prices are worth less than losses due to low prices. This increased variance of prices is likely to reduce production, if firms are averse to risk.[3]

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[1] See Joseph E. Stiglitz, "Portfolio Allocation with Many Risky Assets," in G. P. Szegö and Karl Shell (eds.), Mathematical Methods in Investment and Finance (Amsterdam: North Holland, 1972), especially pp. 109-125.

[2] See Agnar Sandmo, "On the Theory of the Competitive Firm Under Price Uncertainty," American Economic Review LXI(1) (March 1971), pp. 65-73.

[3] Under some conditions, it is possible for uncertainty to make the country better off, as shown by S. J. Turnovsky, "Technological and Price Uncertainty in a Ricardian Model of International Trade," Review of Economic Studies XLI(2) (April 1974), pp. 201-217.

Choice of Weights

It has been shown above that fluctuations in the world price of tradable goods to a given country can be measured by a weighted average of fluctuations in exchange rates (and, of course, other factors causing changes in prices). The specific weights in that average will obviously have great influence on the type of policy that will minimize the variance of the domestic price of tradables. The weights chosen should exclude barter trade, since it is presumably not price-elastic. The weights could be based on exports, imports, or an average of the two. They may be based on merchandise trade or total trade in goods and services, or even on the balance of payments (i.e., payments and receipts).

If it is assumed that capital flows are exogenously determined because of low capital mobility, then weights based on the balance of trade in goods and services appear to be the most appropriate. Such weights will take into account not only changes in prices of goods that move in international trade, but also changes in the prices of services, of which the most important are payments for the use of foreign capital and receipts from tourism. To the extent that exchange rate fluctuations affect the value of such payments and receipts, it is essential to include them in the measure of price changes for tradables.

A further technical point affecting the choice of weights is the

"currency-contract" issue.[1] For one thing, the short-run variance of, say, weekly or monthly data on domestic prices of tradable goods is affected by the currency of denomination of trade contracts. If short-run variance is being minimized, the appropriate weights should not be based on origin and destination of trade, but rather on currency of denomination of trade, whether we are speaking of trade in goods or services. On the other hand, these short-term risks due to changes in exchange rates during the period of a contract are often hedged in one way or another. For example, exports may be offset against imports in the same currency by a trader. Alternatively, forward cover may be used to offset such risks. Finally, the contract itself may provide for the other party to assume some or all of the exchange risk during the contract period. Where the risks have been hedged in such ways, the trade weights should be reduced by the fraction of trade so hedged.

More fundamentally, however, currency-contract risk is less significant than the longer-run risks of engaging in trade versus production of non-traded goods. Such risks depend more on the long-run variance of prices of traded goods. Since the currency of denomination is only of significance in the short run, the longer-run analysis should instead be based on direction of trade.

Finally, to the extent to which the country cannot be considered a price-taker in international trade, the more complicated weights (2.17) from

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[1]See Stephen P. Magee, "Currency Contracts, Pass-through, and Devaluation," Brookings Papers on Economic Activity (1:1973), pp. 303-323, and "U.S. Import Prices in the Currency-Contract Period," Brookings Papers on Economic Activity (1:1974), pp. 117-166.

the Multilateral Exchange Rate Model should be adopted. To summarize, for an LDC which faces given but fluctuating world prices, stabilization policy should focus on a weighted average of exchange rate movements, with weights based on the direction of trade in goods and services, discounted for the proportion of trade that is hedged or carried out by barter.

Choice of Exchange Rate Policy

For a given country, then, the benefits of different exchange rate policies can be compared in terms of their effects on the variance of domestic relative prices. The institutional costs of adopting different policies will be considered later. The following policies will be considered: free market floating, managed floating, pegging to the SDR, and pegging to a single currency such as the dollar or pound sterling. Let us assume that a given set of weights α_i has been chosen for the country's index of changes in the world price of tradable goods. Recall that T_i = the dollar price of currency i and $r_i = 1/T_i$ = the local currency price of the dollar, so $\overset{*}{r}_i = -\overset{*}{T}_i$. Then the percentage change in the world price of tradable goods in country j can be written as

$$\overset{*}{P}{}^{f}_{tj} = \sum_{i \neq j} \alpha_i \overset{*}{T}_i \tag{2.21}$$

while the percentage change in the domestic relative price of tradables is

$$\overset{*}{P}_{tj} - \overset{*}{P}_{nj} = \overset{*}{r}_j + \overset{*}{P}{}^{f}_{tj} - \overset{*}{P}_{nj} = \overset{*}{r}_j - \sum_{i \neq j} \alpha_i \overset{*}{r}_i - \overset{*}{P}_{nj}. \tag{2.22}$$

Floating Exchange Rate

By free market floating, a country with sufficiently developed exchange and financial markets can allow the market to determine its exchange rate vis-a-vis the dollar and all other currencies. In the context of the theory developed above, the exchange rate will then depend on movements in the domestic price of tradable goods as given by the diagram and (exogenous) movements in the world price of tradable goods as given by equation (2.21). As pointed out in the discussion of stabilization policy in section II.2 above, such a policy will minimize the variance of domestic prices when the most important shocks come from (exogenous) changes in world prices relative to domestic prices or from (exogenous) changes in exchange rates. Free floating will not be optimal if most shocks come from internal sources such as crop failures. If most shocks come from changes in the terms of trade, a country with elastic demand for imports will have less variance in its prices under floating exchange rates than under pegged rates, generally speaking. The converse is true for a country with inelastic demand for imports, as argued in section II.2 above. Furthermore, if the country is very open, in the sense that the proportion of non-traded goods is very low, a floating rate will not be optimal. In such cases the NN curve essentially collapses into the TT curve, leaving the relative price of traded and non-traded goods (and hence the exchange rate) indeterminate.

A result similar to free floating can be obtained by government managed floating designed to stabilize the domestic relative price of tradable goods. By setting $\overset{*}{r}_j$ equal to $\sum_{i \neq j} \alpha_i \overset{*}{r}_i - \overset{*}{P}_{nj}$, a country can insulate its domestic relative price of tradables from the effects of exchange rate fluctuations

elsewhere or domestic inflation. In other words, the country acts so as to stabilize its effective exchange rate, discounted for the domestic rate of inflation. This policy will be appropriate when most shocks come from changes in exchange rates among the major countries. On the other hand, changes in world prices of tradable goods that are not due to changes in exchange rates will be passed through to the domestic economy by a policy of stabilizing the effective exchange rate. In such cases the actual dollar exchange rate should be allowed to appreciate relative to the weighted average effective rate in order to offset the effect of world inflation. (This policy is the reverse of depreciating when the domestic economy is inflating faster than world prices are rising.)

In the absence of changes in world prices, stablization of the effective exchange rate by managed floating is also optimal policy with respect to domestic disturbances. For in this case the domestic price of tradables is held constant in the face of shifts in domestic demand and supply, thus allowing the foreign sector to absorb the effects of the disturbances (see Figure 2.5).

Pegging to the SDR

Since the SDR itself has been floating since July, 1974, an attractive possibility for many countries to consider is that of pegging to the SDR. Such a policy might generate many of the benefits of the managed float discussed above, while having an appearance of greater stability as well as various technical advantages. The SDR is now defined as a weighted average of a

group of sixteen major currencies. In terms of our notation, the percentage change in the dollar price of the SDR is $\sum_{i=1}^{16} w_i \overset{*}{T}_i$. Alternatively, the percentage change in the SDR price of the dollar is

$$\overset{*}{s} = \sum_{i=1}^{16} w_i \overset{*}{r}_i. \tag{2.23}$$

A policy of pegging the domestic currency to the SDR then involves putting $\overset{*}{r}_j = \overset{*}{s}$, so that the local currency price of the dollar changes exactly as does the SDR price of the dollar. From equation (2.22), this implies that the percentage change in the domestic price of tradables is equal to

$$\overset{*}{P}_{tj} = \sum_{i=1}^{16} w_i \overset{*}{r}_i - \sum_{i \neq j} \alpha_i \overset{*}{r}_i. \tag{2.24}$$

Unless the SDR weights w_i are equal to the effective exchange rate weights α_i of the country, this policy will clearly be inferior to the policy of managed floating.

Now since many of the trading partners of the LDC in question may either be themselves pegged to the SDR or else be among the group of sixteen major countries, this condition of equal weights ($w_i = \alpha_i$) is not as farfetched as it might seem. It is shown in section 3 of the Appendix that an SDR peg will have the same properties as a managed float if for each $k = 1, \ldots, 16$, the share of country j's trade with other countries that are pegged to a member k of the group of sixteen is equal to the weight of country k in the SDR (w_k) times the share of country j's trade with all such countries that are pegged to a member of the group of sixteen major countries.

This criterion would hold, if, for example, 33% of the country's trade with non-SDR pegged countries was with countries pegged to the dollar, 12.5% with countries pegged to the Deutschemark, etc. Otherwise, the variance of the domestic price of tradables will be positive. The more countries that peg to the SDR, the more likely is the criterion for pegging to the SDR to hold for any given country.

Minimizing Variance by Choice of Peg

If neither managed floating nor an equivalent SDR peg is chosen, then various choices of peg may be evaluated in terms of their effects on the variance of the domestic price of tradable goods. This variance will essentially be a linear combination of the variances and covariances of the exchange rate of the trading partners, with the weights depending on the choice of the peg.

Let $V = [v_{ij}]$ denote the matrix of variances (v_{ii}) and covariances (v_{ij}) of the percentage changes in the dollar prices of the various currencies ($\overset{*}{T}_i$). If i=1 for the dollar, the first row and column of V are all zeroes. Pegging currency j to a given currency k implies that $\overset{*}{T}_j = \overset{*}{T}_k$. The percentage change in the domestic price of country j's tradable good is then

(2.25) $$\overset{*}{p}_{tj} = \sum_{i \neq j} \alpha_i \overset{*}{T}_i - \overset{*}{T}_k.$$

As shown in section 4 of the Appendix, the variance of $\overset{*}{p}_{tj}$ will be minimized by choosing to peg on currency k which has the smallest value of

(2.26) $$\sum_{i \neq j} \sum_{h \neq j} \alpha_i v_{ih} \alpha_h + (1 - 2\alpha_k) v_{kk} - 2 \sum_{j \neq k} v_{kj} \alpha_j.$$

When the dollar is chosen as the peg, $k = 1$ and the last two terms of (2.26) vanish. A non-dollar peg should be chosen if and only if the sum of the last two terms is negative. The choice thus depends both on the shares and the variances and covariances. The optimal choice, if not the dollar, is a large trading partner with a currency whose dollar exchange rate has a low variance and a high covariance with the rates of other important trading partners. If there is no such country k with the last two terms of (2.26) negative, the optimal choice is the dollar.

This formula brings out the importance of considering all of the major trading partners. Pegging on a low-variance trading partner will not be optimal if other trading partners are negatively correlated with the low-variance country. Similarly, the major trading partner may not be the best choice of peg, if it has a high variance in its dollar exchange rate.

III. Policy Choices and the Experience of LDC's in a World of Floating Exchange Rates

III. 1. Framework for Analysis of Policy Choices

In part I of this study, a number of institutional features of the exchange markets and financial markets of less developed countries were outlined. Each of the possible exchange policy choices discussed in Part II of the study has implications for changes in the institutional structure of exchange and financial markets. For example, successful adoption of free market floating exchange rates in a less developed country may require abandonment of exchange controls, greater stability of domestic political and economic policies, development of a forward exchange market, abandonment of pegged interest rates on domestic

securities, the development of a domestic securities market, including a network of brokers and dealers in securities and foreign exchange. Such changes would have substantial costs in terms of the required commitment of both financial and human resources, substantial benefits in the form of improved resource allocation and reduced control apparatus, as well as political costs involved in a move towards a market determination of exchange rates and interest rates. Against such costs and benefits must be weighed the benefits of market floating as discussed in Part II compared to other policies with less significant political and resource costs. For example, managed floating may be able to achieve many of the benefits of market floating without requiring nearly as many institutional changes. Pegging to a major currency, the traditional policy, may in some cases be the solution with the greatest net benefits.

A simplified picture of the type of analysis that conceptually should be applied for a specific country can be constructed as follows. Ignoring political costs for the moment as even less quantifiable than economic costs, one may try to evaluate the resource costs involved in any given exchange policy, including the costs of changing institutions and the costs of holding different levels of reserves. Likewise, one may try to evaluate the probable effects of each policy on the variance of traded goods prices, following the precepts of Part II of this study. The results of such calculations might generate a trade-off locus between resource costs (R) and standard deviation of traded goods prices (σ) such as the curve AA in Figure 3.1. The various policies (placed along the curve quite arbitrarily) are:

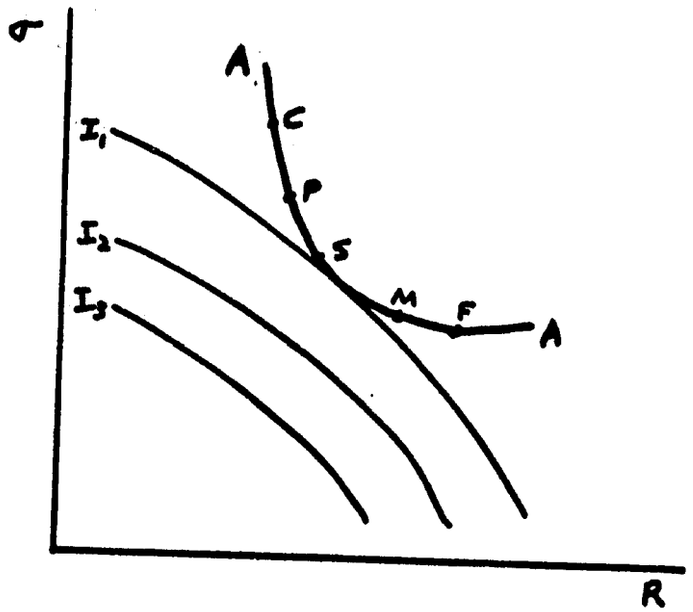

Fig. 3.1 Optimal Choice of Exchange Policy

(C) Exchange controls or import quotas plus reluctant adjustment of single currency peg;

(P) optimally chosen and managed single currency peg;

(S) SDR peg; (M) managed float; (F) free market float. If it is assumed that the decision maker's loss function is an increasing function of both variance and resource cost, with nice curvature properties for convenience, the indifference loci can be sketched in as the curves I_1, I_2, I_3. Political costs of various policy choices must of course be super-imposed on this economic analysis in some third, non-quantifiable dimension, fortunately not visible on the printed page.

In this context, the shift to floating exchange rates among the major trading nations has had the effect of increasing the variance that will face individual countries following a policy of pegging to a single currency. Thus the portion of the locus including the points C and P will have shifted up,

making points such as F or M or S relatively more attractive to policy-makers.

Now it is not seriously proposed that the calculations involved in Figure 3.1 actually be carried out in full. The main purpose in presenting the Figure is to provide an organizing framework for analysis. The basic point is that each policy alternative should be evaluated in terms of its institutional costs, reserve needs, stabilization benefits, and political costs. Some net balancing of these costs and benefits must then be made by the decision-makers.

It is important to recognize that the framework of analysis proposed here includes the costs and benefits usually dealt with under the rubric of "optimal currency areas." For example, Aliber has recently categorized these costs and benefits as "utilization costs" and "efficiency costs."[1] Utilization costs include the adjustment costs of maintaining excessive unemployment or shifting resources between sectors, which can be measured by the costs of holding reserves that are used to avoid such costs.[2] Efficiency costs, on the other hand, include the resource costs of operating an exchange market and the costs of the differing degree of uncertainty about the prices of traded

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[1] Robert Z. Aliber, "Uncertainty, Currency Areas, and the Exchange Rate System," Economica 39 (Nov. 1972), pp. 432-441.

[2] See H. R. Heller, "Optimal International Reserves," Economic Journal 76 (June 1966), pp. 296-311, for the argument that the demand for reserves depends on the cost of adjustment.

goods. Thus all of the costs considered by Aliber are included in Figure 3.1, although they are broken down in a different way.

The next section of this study discusses in more detail the ways in which the various possible exchange rate policies may be evaluated for a particular country in terms of resource costs and variance of the prices of traded goods, using the analysis of Parts I and II of this study. Following this is an attempt to look at some of the data on the experience of less developed countries during the period 1970-1974.

III. 2. Costs and Benefits of Different Exchange Policies

The five different exchange policies portrayed in Figure 3.1, as well as other possible exchange policies have different implications for the kinds of institutional arrangements that were discussed in Part I of this study. They also have different implications for the use of reserves and the variance of prices. This section will discuss the kinds of differences that should be examined and quantified, if possible, for a given country. Table 3.1 gives a tabular summary of the main differences.

TABLE 3.1 Hypothetical Costs of Alternative Exchange Policies
(H=High, M=Medium, L=Low)

				Institutional Requirements			
	Variance	Resource Misallocation	Reserves	Official Controls	Private Exchange Market	Forward Market	Securities Market
Controls	H	H	L	H	L	-	-
Peg to single currency	M	M	H	L	L	-	-
SDR Peg	L/M	L	M	L	M	M	-
Managed Float	L	L	M	L	M	M	-
Free Floating	L	L	L	L	M	M	M

Policy C, utilizing exchange controls or import quotas and capital controls to peg to a single currency, is probably the most prevalent form of exchange policy now practiced among the less developed countries. For example, the 25th Annual Report on Exchange Restrictions of the International Monetary Fund listed 56 less developed countries as maintaining restrictions on current and capital account payments. Most of these countries were pegged to a single foreign currency. This type of policy requires a substantial commitment of resources to the mechanism of exchange control,[3] but relatively little commitment to development of market institutions. Forward exchange

[3]See James Meade, The Balance of Payments (London: Oxford U. Press, 1951), Part V, for a discussion of the required supervision involved in exchange control, import quotas, and capital controls.

markets and domestic securities markets are relatively neglected in most such cases. Even spot exchange markets are typically thin, with most transactions taking place either directly with the exchange authority or with authorized dealers acting on behalf of the exchange authority.

While policy C saves on the resource costs of holding reserves or borrowing reserves, it probably incurs substantial costs of resource misallocation due to the maintenance of inappropriate exchange rates. The result is a distortion of production away from traded goods towards home goods and a suppressed distortion of consumption away from home goods onto traded goods. Furthermore, the occasional very large devaluations that become inevitable in such a system give rise to high variances in effective exchange rates, as will be seen in the empirical computations in section III. 4 below.

Policy P, pegging on a single foreign currency by means of reserves or borrowing, eliminates the costs of exchange control but implies greater costs of reserve holding than policy C. In this situation, it is no longer necessary for the exchange authority to monopolize all exchange transactions, so that the private exchange market may take greater resources. It is more or less obvious that an inappropriate exchange rate cannot be maintained as long through reserve use as it can through exchange controls. As a result the resource misallocation involved will probably be much less than with policy C. Since required devaluations will probably occur more frequently, the high variance contributed by very large devaluations will be mitigated. It is even probable that greater exposure to the "discipline of the balance of payments"

will result in more responsible domestic policies and less need for devaluations.

Of course in a world of floating exchange rates, pegging to a single currency will not minimize the variance of traded goods prices. But there is, as shown in Part II, a choice of single currency peg that is "best" among such choices. If this involves a different currency than the traditional peg, there are costs involved in changing the peg. Using a different intervention currency implies holding balances in a different currency and building working relationships with a different foreign financial center. New communications arrangements may be required, and new lines of credit developed to replace existing facilities. The extent of such facilities made available by the foreign financial center may be an important qualification to considerations of minimizing fluctuations in traded goods prices.

Development of a forward exchange market is a feasible option under policy P, although it would require an investment of resources in development of the market. Given a world of floating rates, such facilities have become more desirable as a means of reducing short-term exchange risks. It is unlikely that many less developed countries should try to develop forward facilities vis-a-vis more than one or at most two foreign currencies. The provision of forward facilities vis-a-vis the intervention currency should suffice for most countries. If banks in the foreign center will agree to make available forward facilities between the intervention currency and other major trading currencies, there is no reason why effective forward cover cannot be provided in this indirect way between the domestic currency and any major trading currency.

The forward facilities discussed above would probably have to be operated by the exchange authority, unless a considerable additional investment were to be made in developing the local securities market, including the loan market. Unless there are a sufficient number of comparable borrowing and/or lending alternatives available in both the domestic and foreign markets, the type of covered arbitrage that is essential for the efficient operation of a private market in forward exchange will not be able to develop.

Policy S; pegging to the SDR, might substantially reduce the variance of the effective exchange rate if the country's pattern of trade approximates the weights of currencies in the SDR package. On the other hand, it would not avoid the need for a single intervention currency, since the SDR itself is not a currency but a means of settlement. In this case the exchange authority would need to obtain daily quotations from the IMF of the SDR value of the intervention currency. Then buying and selling rates for the intervention currency would be set daily so as to maintain the SDR value of the domestic currency. Settlement would be by means of reserves or borrowing, including SDR's.

This policy would require more frequent calculations and communications between the exchange authority and authorized dealers in foreign exchange, since it involves the same techniques as a managed float. Furthermore, this policy almost requires the development of forward facilities vis-a-vis the intervention currency, since the domestic currency would now float relative to the intervention currency. These facilities must either be provided by the

central bank, or else private securities and loan markets must be developed sufficiently to enable arbitrage to become a viable force in the market.

The need for reserves might be reduced by an SDR peg if it approximated closely to stabilizing the effective exchange rate under non-inflationary conditions. On the other hand, it is perfectly conceivable that a country with the bulk of its trade with a single partner could find itself using more reserves under an SDR peg than under a single currency peg.

Policy M, the managed float designed to stabilize the effective exchange rate or move it in the direction indicated by differential inflation rates, is more difficult than the SDR peg because the country itself must compute the weighted average of exchange rates of its trading partners. Otherwise it is similar to the SDR peg in requiring a single intervention currency with an ever-changing quotation in terms of domestic currency. The advantage of the managed float is that it can reduce the variance in the relative price of traded goods essentially to zero.

Since the managed float reduces the impact of external disturbances by moving the exchange rate and reduces the impact of internal disturbances by not moving the rate, it has the greatest potential for reducing reserve holdings as well as other adjustment costs. On the other hand, the operation of a managed float would clearly require a substantial increased investment in exchange market facilities for many less developed countries. The choice of appropriate weights in itself involves a significant amount of analysis, as

indicated above in Part II. In addition, data would have to be collected daily on the exchange rates of currencies in the average, presumably quotations in the financial center of the intervention currency. The resulting quotations for the intervention currency in terms of domestic currency would have to be disseminated quickly and regularly to all authorized exchange dealers.

Since the domestic currency would be floating relative to the intervention currency, forward exchange facilities vis-a-vis the intervention currency would be essential.[1] If these facilities were to be provided by the central bank, the bank should scrupulously maintain a balanced position sheet, with any imbalance in the forward position in the intervention currency matched by an opposite imbalance in the spot position. Such a policy would avoid the temptation that might arise to avoid losses on an imbalanced position by breaking the managed float formula. Alternatively, resources could be devoted to developing a genuine private forward exchange market, with the implied further development of the domestic loan and securities markets.

It is useful to compare the formula-managed float suggested in this study with the formula-managed float of Brazil. That country changes its exchange rate at frequent intervals, with the amount depending on the domestic rate of inflation (relative to the foreign rate of inflation). Of course, this policy was devised prior to the adoption of floating exchange rates by the major trading

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[1] See Richard H. Miller, "Forward Exchange Facilities in Developing Countries," Finance and Development, 1975, for a good discussion of this issue.

nations. The managed float suggested in Part II of this study changes the exchange rate in accordance with (a) changes in the exchange rates of major trading partners and (b) changes in the differential rate of inflation.

Policy F, free market floating, probably requires a substantial further commitment of resources to the development of exchange markets and related financial markets for most less developed countries. Such a policy clearly requires well-developed spot and forward exchange markets, including substantial networks of dealers in foreign exchange, together with well-developed domestic financial markets. Only a few less developed countries can claim such facilities, for example, Israel, Lebanon, Kuwait, or Singapore. One crude measure of the breadth of foreign exchange markets is the ratio of commercial bank holdings of foreign currency assets to central bank holdings of foreign currency assets. Table 3.2 below shows the distribution of this ratio for the 83 less developed countries with country pages in International Financial Statistics.[1] It is obvious from the table that in the large majority of countries, the commercial banks, and presumably other private dealers, are not allowed to maintain any substantial holdings of working balances of foreign exchange.

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[1] This includes all the countries listed in Table 3.4 below except Bahamas, Bahrein, Bangladesh, Barbados, Equatorial Guinea, Fiji, Guinea, Khmer Rep., Laos, Liberia, Malta, Oman, Qatar, Rumania, United Arab Emirates, Western Samoa, and Yemen Arab Rep. Source: IFS. In a few cases 1972 or 1971 data are used in the absence of 1973 figures. When the ratio exceeds unity, the commercial banks' holdings of foreign exchange are greater than the central bank's holdings. Such countries include Kuwait, Lebanon, Costa Rica, Israel, and for some reason the Central African Republic.

TABLE 3.2 Distribution of Ratios of Commercial Bank Holdings to Central Bank Holdings of Foreign Exchange Assets, Dec. 1973

Ratio	Number of countries	Percent of countries
0- .099	35	42.2
.1- .199	18	21.7
.2- .299	8	9.6
.3- .399	3	3.6
.4- .499	2	2.4
.5- .599	2	2.4
.6- .699	3	3.6
.7- .799	1	1.2
.8- .899	0	0
.9- .999	2	2.4
1.0-1.099	2	2.4
1.1-1.199	0	0
1.2-1.299	2	2.4
1.3-2.9	2	2.4
3.0+	3	3.6

The development of an extensive set of private markets for foreign exchange and domestic securities is not the only cost of relying on a free market floating exchange rate. It would surely be necessary for the exchange authorities to be prepared to intervene in the market to smooth out minor fluctuations in exchange rates that would tend to disrupt the market. This is necessary even in the largest and most developed financial centers. The expertise required to carry out such operations is a scarce commodity in any part of the world.

Since one of the requirements for free market floating would be a substantial liberalization and expansion of the domestic loan and securities market, there may be substantial political costs attached to this solution. If

minority groups hold substantial economic power, these political costs may be very high. On the other hand, there may also be substantial gains for the efficient allocation of resources and the mobilization of domestic savings resulting from such reforms.[1]

While the resource costs of policy F may be large, its savings in reserves and in the variance of traded goods prices may well be significant, assuming that the exchange market is in fact stable. The balancing of these costs and benefits is, of course, what is suggested in Figure 3.1 and Table 3.1.

The policy of dual exchange markets has also been recommended as an alternative to the policies discussed above, especially where it is desired to control disequilibrating capital movements.[2] Under this type of policy, capital account transactions are conducted at a variable "free market" rate, while current account transactions occur at a pegged "official" exchange rate. The effect is that of a tax on the purchase of foreign securities by residents and a subsidy to the purchase of domestic securities by foreigners. Many less developed countries now have a variant of this policy, in which only a favored subset of current account transactions may pass through the "official" market. The difficulty with dual markets in less developed countries is their tendency to turn into a discriminatory multiple rate scheme.

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[1] For the argument, see Roland I. McKinnon, Money and Capital in Economic Development (Washington, D. C.: The Brookings Institution, 1973).

[2] See J. Marcus Fleming, "Dual Exchange Markets and Other Remedies for Disruptive Capital Flows," IMF Staff Papers, XXL(1) (March 1974), pp. 1-27.

III. 3. Other Means of Reducing Adjustment Costs

The choices depicted in Figure 3.1 and Table 3.1 between types of exchange policies do not exhaust the possibilities open to less developed countries for improving their welfare in a world of floating exchange rates. In particular, the following types of policies should also be evaluated as possible components of a well-designed response to the current situation: development of forward market facilities, choice of currency denomination of debt issue, choice of reserve mix, regional reserve pooling or clearing arrangements and borrowing versus adjustment to worsened terms of trade. This section will discuss these issues briefly, giving some suggestions for the major considerations to be weighed in each case.

Forward Markets have been mentioned as a potential component of most of the exchange policies discussed above.[1] Their independent contribution to reducing instability in the prices of traded goods is subject to several limitations. First, the availability of forward facilities even in the advanced industrial countries has never succeeded in convincing all traders to cover their exchange risks. In less developed countries the extent of use of such facilities would probably be quite limited. Secondly, forward cover can only reduce the variance of prices due to exchange rate fluctuation within the period of the contract. Price variation between contracts will still affect

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[1] See Richard H. Miller, op. cit., for further discussion.

producers of exported goods and consumers of imported goods. On the other hand, forward cover does protect domestic consumers of exportables and domestic producers of importables from the fluctuations in traded goods' prices due to exchange rate movements, to the same extent that traders themselves are protected. Finally, forward facilities seem most needed when the exchange rate is not pegged to a single foreign currency, since there is a floating spot exchange rate.

While forward cover offers a type of insurance against certain types of exchange risk, other sorts of insurance schemes are also conceivable. Many foreign concerns operating in countries without forward facilities protect themselves against exchange risk by maintaining roughly equal assets and liabilities in the weak currency. Domestic exporters and importers can similarly hedge their foreign currency risks if they can match up foreign currency claims arising from exports to liabilities arising from imports. This should be feasible since most LDC exports and imports are thought to be denominated in hard currencies.[1]

An alternative approach that has been adopted in some contracts involves the use of a hard currency price that is to be adjusted according to some agreed average of the movements of a group of major trading currencies.

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[1] See S. Mookerjee, A. Chandavarkar, and D. Cleary, "Existing International Banking and Credit Facilities in the ECAFE Region," IMF Staff Papers, XVI (March 1969), Table 2, p. 401.

The oil producers in particular have sought this type of protection against floating exchange rates.[1]

Currency denomination of debt issue is usually a function of the market in which the borrowing is done. Thus diversification among sources of borrowing would be a prudent policy to follow. The share to be borrowed in each market should be roughly the same as the share of the specific foreign currency in the merchandise trade balance of the country. As a result, fluctuations in debt service would be approximately offset by fluctuations in net earnings from foreign trade in goods. The same policy can be followed with respect to reserve holdings, which should be coordinated with debt service and merchandise trade to hedge against the impact of shifts in exchange rates.

The implications of such diversification can be seen through an example given in Table 3.3 below.

TABLE 3.3 Diversification of Debt and Reserves

Currency	Exports	Imports	Mds. Bal.	Debt Service	Reserve Earnings	Service Balance	Current Balance
Dollar	100	50	50	80	30	-50	0
Sterling	70	100	-30	10	40	30	0
Deutschemark	100	20	80	110	30	-80	0
	270	170	100	200	100	-100	0

The country shown in Table 3.3 has a merchandise surplus of 100 to pay net debt service of 100. The debt and reserve holdings have been diversified

[1]See Stephen Silard, "Maintenance of Value Arrangements in International Transactions," Law and Policy in International Business, 5 (1973), pp. 398-439 and Silard, "The Effects of Current International Monetary Uncertainties on Exporters," Revue de la Banque (1974), pp. 77-84.

so as to match the pattern of net debt service to net merchandise balances. Suppose the country's currency is pegged to the pound sterling and that the dollar depreciates ten percent relative to sterling while the D-mark appreciates ten percent. Then the merchandise and service balances in dollars fall to 45 and -45, respectively, while the D-mark balances rise to 88 and -88, leaving the current account unaffected. The diversification rule implicit in Table 3.3 is "borrow from countries you export to and lend to countries you import from." This reverses the typical practice of trade finance, but then much LDC trade is financed in foreign centers.[1]

The benefits to be gained from such diversification can be calculated in terms of reduced uncertainty about the exchange value of payments and receipts on reserves and debt, which reduce the certainty-equivalent interest rates for countries with risk averse governments. This gain must be weighed against possible losses due to floating exchange rates. Tabulations of the effects of the exchange rate realignments of 1971 and 1973 on the values of reserves and debts are given in the IMF Annual Reports for 1972 and 1973 (pp. 22-23 and 29-31). These figures make it clear that borrowing an over-valued currency can be beneficial, while holding reserves in such form is potentially dangerous. But the gains that many less developed countries achieved in these two episodes were due to correction of the long-standing over-valuation of the dollar. Such events are both less likely and less predictable in a world of floating exchange rates.

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[1]See Mookerjee, Chandavarkar, and Cleary, op. cit.

Clearing arrangements have also been suggested as alternative means for less developed countries to reduce their exposure to the effects of floating exchange rates among developed countries. The major way in which such benefits would arise is by the use of a regional unit of account for denomination of balances arising through intraregional trade. As Michalopoulos has pointed out, about 85 percent of intraregional transactions in the Central American Common Market area are handled through the clearing union, compared to a figure of 40 percent in the Latin American Free Trade Area.[1] Exchange risk on such transactions is absent, since they take place under exchange-rate guarantees.

Thus it would be expected that the advantages of participation in such agreements would be higher under a regime of floating exchange rates. Unfortunately, the cost of participation may also be higher, for the cost to the union of providing the exchange guarantee can be expected to increase with with increased flexibility among the member countries' currencies. Of course, if all members peg to the same foreign currency, this problem does not arise.

Borrowing versus adjustment to the worsened terms of trade implied by soaring oil prices is a major problem for all countries at present. The

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[1] Constantine Michalopoulos, "Payments Arrangements for Less Developed Countries: The Role of Foreign Assistance," Princeton Essays in International Finance, No. 102 (November 1973).

less developed countries that are not members of OPEC must inevitably follow a relatively passive policy, relying on the major nations to negotiate a decline in the oil price and, in the interim, negotiate such charitable lending as the OPEC nations are willing to provide. Most LDC's are fortunate in having relatively high reserves at present, due largely to the dramatic inflation in the prices of their primary commodity exports in 1973.

Nevertheless, this cushion of reserves will not suffice to delay adjustment for very long, and some countries such as Bangladesh of course have no cushion at all. If a less developed country were facing a ceteris paribus increase in the price of oil, the scenario would go as follows. Given inelastic demand for oil, the balance of payments deteriorates, even though demand for oil declines in the face of higher prices. If the exchange rate is allowed to depreciate, the domestic price of imported oil will rise even further, thus cutting down on oil demand (and demand for other imports) even further. If the country had been facing buoyant export demand and the resulting inflationary pressures prior to the increased oil price, a contractionary monetary and fiscal policy could substitute for the relatively inflationary exchange depreciation. Either policy would tend to reduce consumption of traded goods, though depreciation of the exchange rate would also tend to increase their production and thereby facilitate adjustment.

Unfortunately, ceteris paribus does not hold in this case, with a vengeance. First of all, many countries face the same choices. It is a fallacy of composition to think that all can improve their trade balances by

adjustment, especially vis-a-vis the OPEC countries. If the better-off countries borrow and resist depreciation, more room will be left for the worse-off to adjust, given their inability to borrow. The solution to the problem, of course, does not ultimately lie with adjustment, but with a fall in oil prices, combined with increased assistance from the better-off countries.

The other major violation of ceteris paribus is the effect of fluctuations in major currency exchange rates on the less developed countries. A country pegged to the dollar, say, could easily find its exchange rate appreciating in the face of rising oil prices, the opposite of the policy recommended above. To avoid this situation the country should devalue relative to its peg if the currency to which it is pegged rises in an undesirable fashion. An example of this sort of problem was Italy's decision to drop out of the EEC "snake" in January 1973 because of a tendency for the snake to rise against the dollar while the Italian balance of payments was in deficit.

III. 4. The Experience of LDC's under Floating Exchange Rates

Table 3.4 below shows estimates of the variances of monthly data on import-weighted effective exchange rates for 100 less developed countries, for the periods January 1970-May 1972 and June 1972-April 1974. The indexes, which weight the effective rates by shares in imports of manufactured goods, were kindly made available by the staff of the International Monetary Fund. These indexes are of the type given in equation (2.9) of section II.3 above. The countries are grouped in the table according to the exchange rate policy

they were following in mid-1973, as reported in Appendix Table I.1 of the 1973 Annual Report of the IMF.[1] It should be noted that the currencies tied formally to gold or the SDR were in effect pegged to the dollar during this period except on the two occasions when the gold-SDR-dollar ratio changed: December 1971 and February 1973. The reader should be aware of significant limitations in the quality of the data, with respect to both the import weights and the exchange rate data. Furthermore, as pointed out in Part II of this paper, current account balance weights taking account of elasticities of foreign demand and supply would be more appropriate for most purposes.

The first period, January 1970-May 1972, covers the last period of the adjustable peg system, including the exchange rate realignments of the Smithsonian agreement of December 1971 as well as the limited floating of the yen, D-mark and pound sterling during August-December 1971. This period ends with the floating of the pound in June 1972, followed by generalized floating in March 1973. The second period, June 1972-April 1974, thus covers the beginning of the current system of floating rates among the major currencies.

The first thing that is evident from Table 3.4 is that countries which maintain drastically over-valued exchange rates and then devalue them sharply suffer high variances in their effective exchange rates, as shown by the entries

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[1]With the exception of Afghanistan, which is formally pegged to the dollar, but conducts most transactions at a free market rate for the dollar quoted in the bazaar.

marked with asterisks for large and/or continuous devaluations. The next conclusion is that the African countries pegged to the franc and the peseta have achieved very low variances in effective exchange rates, because the bulk of their trade is with the country to whom they peg.

A third striking conclusion is that countries pegged to sterling have suffered a dramatic seven-fold increase in the average variance of their effective exchange rates in the period of floating. This is a much larger increase in variance than has been observed for any other group. Compared to the experience of the franc or dollar groups, it probably reflects the much smaller fraction of trade the countries of the sterling group have with each other and with the U.K. A natural result has been for such countries to break away from the sterling group. In fact, Cyprus, Malaysia, Malta, and Singapore had broken away to the flexible rate group by mid-1973, Jamaica broke away to the dollar in the same year, and Malawi began floating in late 1973. From the data in Table 3.4, some other countries are also obvious candidates for departure from sterling, notably Fiji, Gambia, Sierra Leone, and Trinidad and Tobago.

The dollar group has suffered a more modest increase in the variance of effective rates, with an average increase from 7 to 14 for both the formally pegged and the de facto group. Within this large group, several divergent groups can be noted. Among the Latin American countries, one subgroup has a moderately increased variance (El Salvador, Guatemala, Panama, Paraguay, Peru), while another subgroup still has quite a low variance, despite being tied to the floating dollar (Bahamas, Haiti, Honduras, Mexico, Nicaragua,

TABLE 3.4 Variances of Import-weighted Effective Exchange Rates for 100 Less Developed Countries. Period I: Jan. 1970-May, 1972, Period II: June 1972-April 1974

Countries Pegged to Gold or SDR (Dollar, de facto)

	I	II
Algeria	0.7	4.2
Bahrein	1.8	19.4
Bolivia	7.9	249.6*
Burma	69.7*	5.5
Burundi	17.4	9.1
China	20.3	6.7
Dominican Rep.	4.6	6.1
Ecuador	162.4*	4.8
Ethiopia	2.1	11.4
Guinea	1.4	15.6
Haiti	4.3	6.5
Iran	11.6	8.2
Iraq	1.4	13.8
Israel	104.7*	11.8
Jamaica	4.2	36.5
Jordan	11.7	9.2
Kenya	11.3	8.0
Kuwait	2.0	9.5
Libya	1.6	16.2
Nepal	17.4	27.5
Nigeria	1.8	17.5
Oman	1.9	38.4
Pakistan	122.7*	1.5
Qatar	1.8	16.5
Panama	9.1	13.4
Rumania	2.0	15.4
Rwanda	4.6	15.0
Saudi Arabia	1.8	22.2
Somalia	6.6	14.2
Tanzania	13.2	12.3
Thailand	18.5	14.6
Tunisia	1.1	18.1
Turkey	311.3*	9.7
Uganda	13.6	11.1
United Arab Emir.	2.0	10.2
Western Samoa	1.8	2.4
Yemen P.D.R.	2.4	12.7
Zaire	12.9	22.3
Zambia	10.8	11.5
Average**	6.7	14.4

Countries Pegged to Dollar

	I	II
Argentina	634.6*	1.7
Bahamas	2.8	3.8
Chile	154.9*	464.5*
Costa Rica	5.9	32.1
Egypt	8.3	10.6
El Salvador	7.8	13.7
Ghana	207.2*	6.3
Guatemala	6.8	11.7
Honduras	2.9	5.3
Laos	261.3*	2.4
Liberia	22.9	21.6
Mexico	2.4	6.0
Nicaragua	3.7	6.4
Paraguay	10.7	22.4
Peru	6.7	13.3
Sudan	9.5	19.8
Syria	13.0	23.5
Venezuela	1.9	4.8
Averages**	7.5	13.9

*indicates large and/or continuous devaluation during the period.

**including only those countries with no asterisk in both periods.

TABLE 3.4 (Continued)

Countries Pegged to Sterling

	I	II
Bangladesh	251.5*	5.1
Barbados	2.9	19.6
Fiji	2.7	49.5
Gambia	2.4	58.7
Guyana	6.5	20.4
India	1.8	11.8
Malawi	1.8	34.0
Mauritius	2.0	11.5
Sierra Leone	2.0	41.6
Sri Lanka	14.4	13.5
Trinidad and Tobago	2.3	26.9
Average**	3.8	28.8

Countries Pegged to French Franc

	I	II
Cameroon	0.4	2.0
Central African Rep.	0.4	0.7
Chad	0.3	0.6
Congo	0.6	1.0
Dahomey	1.0	1.6
Gabon	0.4	1.5
Ivory Coast	0.5	2.4
Malagasy	0.5	1.0
Mali	2.0	8.2
Mauritania	0.5	3.4
Niger	0.5	0.7
Senegal	0.4	1.0
Togo	1.5	3.1
Upper Volta	0.2	0.3
Average	0.7	2.0

Country Pegged to Spanish Peseta

	I	II
Equatorial Guinea	0.1	1.5

Flexible Exchange Rate

	I	II
Afghanistan	27.8	136.0
Brazil	111.5*	12.9*
Colombia	49.1*	27.1*
Cyprus	1.7	5.0
Indonesia	101.9*	16.0
Khmer Rep.	797.7*	33.8
Korea	135.6*	9.7*
Lebanon	1.9	55.4
Malaysia	0.6	18.8
Malta	6.7	3.9
Morocco	0.9	3.3
Phillipines	162.9*	10.5
Singapore	0.5	13.7
Uruguay	373.1*	44.6
Vietnam	7.0	228.8*
Yemen Arab Rep.	52.8	20.6
Yugoslavia	169.8	6.5
Average**	11.6	32.1

Venezuela). The countries of the East African Monetary Union (Kenya, Tanzania, and Uganda) do not appear to have suffered, nor have Zambia and Burundi. On the other hand, Liberia, Ethiopia, Guinea, Rwanda and Somalia have high or increased variance.

The Arab countries which are tied directly or indirectly to the dollar have mostly incurred significantly higher variance (Bahrein, Libya, Kuwait, Oman, Qatar, Saudi Arabia, Sudan, Syria, Tunisia, United Arab Emirates, and Yemen P.D.R.), with the exception of Egypt and Iran (a non-Arab country). On the other hand, Morocco, which began floating in May 1973, has maintained a low variance.

The members of the floating rate group are about equally divided between those countries that have followed inflationary domestic policies and that rely on floating exchange rates for continuous devaluation (shown by asterisks) and others. Considering the latter group, it appears that generalized floating has also increased the variance of effective rates for the floating group. The average increase from 11.6 to 32.1 is less than the increase for the sterling group but more than the increase for the dollar and franc/peseta groups. The countries which contributed most of this increased average variance are Afghanistan, Lebanon, Malaysia and Singapore, all of which have appreciated rather sharply relative to the dollar. These are all countries whose terms of trade have improved substantially due to the increase in primary product prices such as oil, tin, rubber, cotton, hides. In addition, Lebanon and Singapore, which

act as banking centers for the Near East and Southeast Asia, have been the recipients of large recorded and unrecorded inflows of private capital. These countries have chosen to follow a very different exchange policy than the Arab countries which have kept their currencies pegged to the dollar while accumulating huge foreign exchange reserves.

III. 5. Conclusion

The major issue dealt with in this study has been the design of exchange policies for less developed countries in a world of floating exchange rates. The paper has attempted, no doubt imperfectly, to explore the important questions that enter into the design of such policies. Such questions include the existing structure of exchange markets and money markets, the geographical pattern and price elasticity of foreign trade, and the types of disturbances that most significantly affect the economy: changing inflation, changing domestic production, or changing terms of trade.

Simplified overall conclusions do not readily flow from careful analysis of the array of questions that have been explored. Each argument has a qualification, and an accumulation of qualifications makes each country into a special case. Nevertheless, there is a certain broad pattern to the discussion which can be summarized here.

Most less developed countries also have less developed financial markets. This fact implies that capital does not have high mobility on a two-way basis and that market institutions for operating freely floating exchange

rates are somewhat lacking. LDC's typically have relatively small influence over their terms of trade, so that the main channel through which exchange rates affect the economy is the ratio of traded goods prices to non-traded goods prices. A key concept in a world of floating exchange rates is the trade-weighted index of the effective exchange rate, showing the movement of a country's exchange rate relative to a weighted average of rates of its major trading partners. The stability of the economy will generally be greater if the effective exchange rate is pegged in the face of fluctuating domestic production of export crops or food crops. On the other hand, an economy which faces fluctuating inflation rates can more appropriately let its effective exchange rate float. In the face of fluctuating terms of trade, a floating rate appears possibly better if import demand is elastic, and a pegged rate if import demand is inelastic, but the qualifications to these findings are especially strong.

The costs and benefits of various exchange policies such as controls, pegging to a single currency with reserves, pegging to the SDR, managed float, or free market float, can at least conceptually be analyzed in terms of resource costs, institutional costs, instability costs, and political costs. The choice of exchange policy should consider carefully each of these costs, quantifying those which can be measured. A strong recommendation can be made to all countries that have not recently evaluated their exchange policy that such a re-evaluation should be carried out in the near future. Such studies should not be done simplistically, however, as there are a wide variety of important considerations that bear on the question.

In closing, let me make a general comment suggested by study of the empirical results in Table 3.4. A superficial conclusion from the Table is that floating exchange rates since mid-1972 have increased the variance of effective exchange rates and therefore of traded goods prices. One is tempted to conclude that adjustment costs have increase pari passu. This may be true, but it is also possible that reserve usage by LDC's has changed significantly in this period. If reserve usage has increased, then it seems clear that adjustment costs have also increased. On the other hand, if reserve usage has decreased substantially while exchange rate variation has increased, then adjustment costs may even have been lower for some less developed countries.

APPENDIX

1. The Relative Slopes of NN and TT

After performing the indicated substitution in (2.1) and (2.2) for the flexible rate case, we have

$$\text{(A.1)} \qquad A_n(\overset{+}{p_t}, \overset{-}{p_n}, p_tY_t + p_n\overset{+}{Y_n} + \bar{G} - \bar{T}, \overset{+}{\bar{M}}) = Y_n(\overset{-}{p_t}, \overset{+}{p_n})$$

$$\text{(A.2)} \qquad A_t(\overset{-}{p_t}, \overset{+}{p_n}, p_tY_t + p_n\overset{+}{Y_n} + \bar{G} - \bar{T}, \overset{+}{\bar{M}}) - \bar{K}/\bar{p}_t^f = Y_t(\overset{+}{p_t}, \overset{-}{p_n}).$$

Assume that the initial values of prices are $p_t = p_n = 1$. The total differential of (A.1) with respect to p_t and p_n yields the slope of the NN curve:

$$\text{(A.3)} \qquad \left.\frac{dp_t}{dp_n}\right|_{nn} = -\frac{(A_{npn} + A_{ny}Y_n) - Y_{npn}(1-A_{ny}) + A_{ny}Y_{tpn}}{A_{npt} - Y_{npt}(1-A_{ny}) + A_{ny}(Y_t + Y_{tpt})} > 1.$$

The denominator is positive because of the sign assumptions. Hence the slope will be greater than unity if and only if

$$\text{(A.4)} \qquad -(A_{npn} + A_{ny}Y_n) + Y_{npn}(1-A_{ny}) - A_{ny}Y_{tpn} >$$

$$A_{npt} - Y_{npt}(1-A_{ny}) + A_{ny}(Y_t + Y_{tpt})$$

or

$$\text{(A.5)} \qquad A_{npn} + A_{npt} + A_{ny}(Y_n + Y_t) < (1-A_{ny})(Y_{npn} + Y_{npt}) - A_{ny}(Y_{tpn} + Y_{tpt})$$

But homogeneity and the initial $p_t = p_n = 1$ imply that

$$\text{(A.6)} \quad \begin{cases} Y_{npn} + Y_{npt} = 0, & Y_{tpn} + Y_{tpt} = 0, \\ A_{npn} + A_{npt} + A_{ny}(Y_n + Y_t) = -A_m M < 0. \end{cases}$$

Since the right-hand side of (A.5) is equal to zero and the left-hand side is less than zero, (A.5) will hold and the slope of NN must be greater than unity. A similar proof shows that the slope of the TT curve, given by (A.7), is less than unity.

$$\text{(A.7)} \qquad \left.\frac{dpt}{dpn}\right|_{tt} = -\frac{A_{tpn} - Y_{tpn}(1-A_{ty}) + A_{ty}(Y_n + Y_{npn})}{A_{tpt} - Y_{tpt}(1-A_{ty}) + A_{ty}(Y_t + Y_{npt})} < 1.$$

2. <u>Solution of the MER Model (2.14)</u>

$$\text{(2.14)} \qquad \sum_{k=1}^{n} W_j^k \sum_{i=1}^{n} \eta_{j/i}^k (\overset{*}{P}_i - \overset{*}{T}_k) = \beta_j (\overset{*}{P}_j - \overset{*}{T}_j), \quad j = 1, \ldots, n$$

The demand equations have the property that

$$\text{(A. 8)} \qquad \sum_{i=1}^{n} \eta^{k}_{j/i} = \eta^{k},$$

since an equal proportionate increase in the tradable goods prices of all countries will reduce demand in country k depending onthe demand elasticity in k. After dividing through by β_j, (2.14) can be written as

$$\text{(A. 9)} \qquad \sum_{i=1}^{n} \left(\frac{1}{\beta_j} \sum_{k=1}^{n} W_j^k \eta^k_{j/i} - \delta_{ij}\right) \overset{*}{P}_i = \sum_{k=1}^{n} \left(\frac{1}{\beta_j} W_j^k \eta^k - \delta_{jk}\right) \overset{*}{T}_k ,$$

where $\delta_{ij} = 1$ if i=j and zero otherwise, and similarly for δ_{jk}. In matrix terms, (A. 9) can be written as

$$\text{(A. 10)} \qquad A\overset{*}{p} = B\overset{*}{t}$$

with solution

$$\text{(A. 11)} \qquad \overset{*}{p} = A^{-1}B\overset{*}{t} = M\overset{*}{t}.$$

Note that if all $\beta_j = \infty$, $A = B = -I$.

3. <u>Properties of SDR Peg</u>

Let $\alpha_{i(k)}$ = the weight in the effective exchange rate index of a country whose currency is pegged to that of a major country k included in the definition of the SDR (k = 1, . . . , 16). Let k = 0 for all countries pegged to the SDR. Then

$$\text{(A. 12)} \qquad \sum_{i \neq j} \alpha_i \overset{*}{r}_i = \sum_{k=0}^{16} \alpha_{i(k)} \overset{*}{r}_i = \sum_{i(o)} \alpha_{i(o)} \overset{*}{s} + \sum_{k=1}^{16} \sum_{i(k)} \alpha_{i(k)} \overset{*}{r}_k$$

$$= \sum_{k=1}^{16} \left(w_k \sum_{i(o)} \alpha_{i(o)} + \sum_{i(k)} \alpha_{i(k)}\right) \overset{*}{r}_k,$$

using (2.23) for $\overset{*}{s}$. The weights in the last expression of (A.12) will be equal to w_k if

(A.13) $$w_k \sum_k \alpha_{i(k)} = \sum_{i(k)} \alpha_{i(k)},$$

since $\sum_{i(o)} \alpha_{i(o)} + \sum_k \alpha_{i(k)} = 1$.

4. <u>Minimizing Variance by Choice of Peg</u>

The variance of $\overset{*}{p}_{tj}$ when country j pegs on country k can be written as

(A.14) $$E[(\alpha^j - \delta_k)' t^*]^2 = (\alpha^j - \delta_k)' V(\alpha^j - \delta_k) = \alpha^{j\prime} V \alpha^j - 2\delta_k' V \alpha^j + \delta_k' V \delta_k,$$

where $\alpha^{j\prime} = (\alpha_1, \ldots, 0, \ldots, \alpha_n)$, with a zero in the j-th place, $\delta_k' = (0, \ldots, 1, \ldots, 0)$ with a one in the k-th place and zeros elsewhere, and $\overset{*}{t}' = (\overset{*}{T}_1, \ldots, \overset{*}{T}_k)$. This simplifies to expression (2.26) in the text.