PRINCETON STUDIES IN INTERNATIONAL FINANCE NO. 17

The Theory of Forward Exchange

Egon Sohmen

INTERNATIONAL FINANCE SECTION
DEPARTMENT OF ECONOMICS
PRINCETON UNIVERSITY · 1966

PRINCETON STUDIES
IN INTERNATIONAL FINANCE

THIS is the seventeenth number in the series called PRINCETON STUDIES IN INTERNATIONAL FINANCE, published from time to time under the sponsorship of the International Finance Section of the Department of Economics at Princeton University.

The author, Egon Sohmen, is Professor of Economics at the University of the Saar, in Saarbrücken, Germany. He has taught at the Massachusetts Institute of Technology, Yale University, and the University of Minnesota. His book on *Flexible Exchange Rates* (1961) is a major contribution to the literature in the field. His SPECIAL PAPER, entitled *International Monetary Problems and the Foreign Exchanges* appeared in 1963. He was one of the 32 economists participating in the conferences leading up to the volume *International Monetary Arrangements: The Problem of Choice*, published by the International Finance Section in 1964.

The present series is chiefly intended to be restricted to meritorious research studies in the general field of international financial problems, both policy and theory, which are too long for the journals and too short to warrant publication as books.

While the Section sponsors the Studies, the writers are free to develop their topics as they will. Their ideas and treatment may or may not be shared by the editorial committee of the Section or the members of the Department.

FRITZ MACHLUP
Director

Princeton University
May 1966

PRINCETON STUDIES IN INTERNATIONAL FINANCE NO. 17

The Theory of Forward Exchange

Egon Sohmen

INTERNATIONAL FINANCE SECTION
DEPARTMENT OF ECONOMICS
PRINCETON UNIVERSITY
PRINCETON, NEW JERSEY
1966

L.C. Card 66-26500

Printed in the United States of America by Princeton University Press
at Princeton, New Jersey

CONTENTS

THE THEORY OF FORWARD EXCHANGE

INTRODUCTION

After years of comparative neglect, increasing attention has recently again been paid to the theory of forward exchange markets. In view of their importance for public policy, this interest appears to be well deserved. In this paper, a concise survey of the subject will be presented emphasizing a few unduly neglected aspects.[1]

The traditional treatment of the theory of forward exchange has been in terms of one spot and one single forward market. The extension to any number of forward markets does not merely introduce additional variables into the model, but gives rise to new phenomena that are of considerable interest for policy matters. The widespread view that forward covering by exporters and importers amounts to a type of "insurance" that involves a risk premium, hence additional cost, will be shown to be incorrect. Another aspect to be discussed in greater detail is the response of forward exchange markets to monetary policy and the consequent effects on aggregate demand.

Forward-exchange operations will be classified according to the *function* of a particular transaction rather than the *person* who

[1] One of the earliest inquiries into the economic aspects of forward markets was Keynes' *Tract on Monetary Reform* (London: Macmillan, 1923), Chap. III, Part IV. Two monographs by Paul Einzig are devoted to forward exchange markets: *The Theory of Forward Exchange* (London: Macmillan, 1937) and his postwar book, *A Dynamic Theory of Forward Exchange* (London: Macmillan, 1962). Another important contribution is J. Spraos, "The Theory of Forward Exchange and Recent Practice," *Manchester School of Economics and Social Studies*, Vol. 21 (1953), pp. 87-117. The most detailed treatment of the simultaneous determination of equilibrium in the spot and one forward exchange market is presented in S. C. Tsiang's article, "The Theory of Forward Exchange and Effects of Government Intervention on the Forward Exchange Market," *International Monetary Fund Staff Papers*, Vol. 7 (1959), pp. 75-106. Essentially the same basic model was described, though in less detail and with the main emphasis on other policy aspects, in my doctoral dissertation (Massachusetts Institute of Technology, 1958). The chapter on forward markets is reproduced with minor changes in my *Flexible Exchange Rates* (Chicago: University of Chicago Press, 1961), Chap. IV. Peter B. Kenen has recently probed more deeply into the microeconomic underpinnings of forward-exchange theory in his paper, "Trade, Speculation, and the Forward-Exchange Rate," in Robert E. Baldwin *et al.*, *Trade, Growth, and the Balance of Payments*, Essays in Honor of Gottfried Haberler (Chicago: Rand McNally & Co., 1965), pp. 143-169. A useful survey in Swedish is B. Hansen's "Kursbildningen pa valutamark naderna," *Ekonomisk Tidskrift*, Vol. 63 (1961), pp. 173-200. Other literature references on specific aspects of the theory of forward exchange will be given in the appropriate contexts below.

undertakes it. For the purpose of theoretical analysis, it is most convenient to separate market transactions into "pure" hedging, "pure" arbitrage, and "pure" speculation, although real-world people will often perform two or more of these functions in the same transaction. Exporters and importers, for example, may occasionally or habitually carry exchange risks, in which case they also perform the functions of speculators. The approach chosen here follows the traditional practice of most writers on the theory of forward exchange.[2]

[2] Kenen is an important exception (in Baldwin *et al.*, *op.cit.*, p. 145). It is purely a matter of notational convenience whether the "functional" or the "personal" approach is chosen. The same assumptions concerning the behavior of market participants can obviously be incorporated in either one of the possible varieties in which a model of forward exchange markets can be set up, and they will then necessarily have to give the same answers. See also fn. 9.

1. COMMERCIAL TRADE AND FORWARD EXCHANGE MARKETS

What exactly happens when an exporter or importer purchases or sells forward exchange in the course of his regular business? Many people are inclined to believe that the forward sale of the expected foreign-exchange proceeds by an exporter is made possible only because the exchange risk is transferred to somebody else. Other participants in the forward market, so this reasoning continues, will be willing to assume this risk only against payment of an appropriate risk premium. For those who argue in this way, it appears obvious that forward covering by a commercial trader inevitably increases the cost of his transactions. In the view of many laymen, the spot rate of exchange for a currency is the strategic variable on which forward transactions are, in the last analysis, really based and to which the "risk premium" involved in a delayed payment in a foreign currency is merely added if the trader hedges by forward coverage.

To overcome this erroneous conception of forward exchange markets, let us first consider a model of a forward market that is fed *exclusively* by the transactions of exporters and importers—in other words, a market from which speculation as well as interest arbitrage are entirely absent. Let us assume that all those exporters and importers whose regular commercial contracts call for payment in, say, three months, never want to carry an exchange risk. To achieve this objective, they must always sell their expected foreign-exchange proceeds (or buy the foreign-exchange equivalent of their expected payments) on the three-month forward exchange market.[3]

It is important to realize, first of all, that these "pure" traders (and all commercial traders in the real world as well who contract for deferred payment but do not want to assume an exchange risk) are entirely unaffected by the level and the anticipated future movements

[3] Kenen is quite correct in pointing out the artificiality of the conventional view of what constitutes an exchange risk (*ibid*, fn. 5). To hold all of one's monetary assets in the currency of the country in which one happens to reside most of the time may involve a higher exchange risk, properly defined, than to distribute them among many currencies. Whoever holds anything at all incurs the risk of seeing its exchange ratio to other objects of economic value decline as well as rise over time. To meet the conventional arguments on their own grounds, I shall nevertheless throughout this paper follow the usual convention that an exchange risk is present whenever a net position in a *foreign* currency is held.

of the spot rate of exchange. Assuming that all other variables on which their behavior depends, such as domestic and foreign prices, interest rates, etc., are given, the export and import contracts they are ready to negotiate will depend exclusively on the level of the three-month *forward* rate. The properties of the demand and supply functions of forward exchange will then be determined by the supply and demand elasticities of the export and import commodities being traded by the group of exporters and importers who deal on this market.

Under our introductory assumption that commercial traders are the only parties negotiating contracts on the forward exchange markets (which also implies the absence of official interventions in forward markets), the equilibrium level of the forward rate will be determined by the condition that commercial supply and demand of forward exchange shall be equal at that rate. Commercial traders would, under these assumptions, settle all forward-exchange deals between themselves. No exporter or importer in our model carries an exchange risk, in spite of the fact that there is no other market participant who would take over the exchange risks "unloaded" by commercial traders.

As will be shown later, the verdict that forward coverage does not involve an intrinsic risk premium remains correct *even if* there is speculation in the forward market (see Section 4.7 below).

What has been said here about the behavior of commercial traders who have contracted for payment in three months is likely to hold for all forward exchange markets—that is, for markets calling for payment in six, nine, or twelve months, and longer periods. Only for contracts requiring immediate payment (which should normally be a small fraction of all international trade) is the spot rate of exchange the strategic variable determining the level of trading activity of non-speculating exporters and importers. For all other transactions, "pure" traders who shun exchange risks will always have to use the forward exchange market of the maturity date closest to the moment at which their payments (or receipts) fall due.[4] In the absence of both specula-

[4] Certain credit operations can serve as a substitute for forward transactions by commercial traders. An exporter who expects to receive payment in a foreign currency in three months is able to dodge the exchange risk in the following way: he may borrow the same amount of foreign currency now, sell it spot, and repay his debt in three months with the receipts from his exports. This alternative to a forward sale is a rather complicated process and is usually only available to large internationally known corporations. Even for them, it will usually be more ex-

tion and arbitrage, the forward-exchange rates for every maturity, as well as the spot rate, would be determined independently of each other by the transactions of commercial exporters and importers.[5]

Much of what follows (in particular, the analysis of monetary policy in Chapter V) will crucially depend on what has been concluded above about the behavior of commercial traders who are unwilling to assume net positions in foreign currencies. It is in this respect that my analysis differs most from that of other recent writers on the subject. In Tsiang's model, it is assumed that all exporters and importers hedge on the single forward market.[6] This would only portray the real world reasonably correctly if all trading contracts called for payment at the maturity date of the unique type of forward-exchange contract that is available. Kenen assumes in the main part of his article that all trading contracts call for cash payment.[7] Later, he briefly explores the changes that would be called for in his model if payment were always stipulated in 90 days.[8]

The essential similarity (and consequent unrealism) of all these models is that they assume that all traders use the market with the same maturity date at all times. The decisive feature of commercial forward activity is likely to be that hedging is taking place *on different markets for different trading contracts*, and that deliveries of the commodities bought and sold in these contracts will presumably affect domestic business activity at different times.[9] The assumption that the

---

pensive and cumbersome than forward coverage. We shall therefore limit its discussion to this footnote.

[5] The careful reader will raise one apparently serious objection to this statement. Would not divergences between the spot and the various forward exchange rates lead to postponement or acceleration of imports or exports so as to import at the lowest possible prices and to export at the highest possible prices in terms of domestic currency? Commercial demand and supply on a particular forward market would therefore, so one might be tempted to argue, not be independent of the level of other forward rates and the spot rate of exchange, as claimed in the text. A detailed discussion of this aspect would lead us into areas that will only be covered later; we shall return to this question in Section 4.5 below.

I am indebted to Professor Yasukichi Yasuba of the University of Osaka for having called my attention to this point.

[6] Tsiang, *op.cit.*, p. 94. [7] In Baldwin *et al.*, *op.cit.*, p. 145. [8] *Ibid.*, p. 163.

[9] Kenen is apparently unaware of the essential difference between our basic assumptions concerning traders' behavior when he contrasts his own conclusions as to the behavior of traders on forward exchange markets with mine (*ibid.*, pp. 156-158). He also appears to have interpreted the assumption that trade responds to changes of forward rates as having been intended to encompass, in addition,

commodity demand and supply functions underlying the demand and supply functions of commercial hedgers for forward exchange have the usual shape (in other words, that the demand elasticities of the respective groups of commodities are negative, supply elasticities positive) does not, of course, imply that the demand and supply elasticities of *forward exchange* derived from them must necessarily exhibit the same signs. This will be taken to be the normal case in most of the subsequent discussion (see, however, Section 4.3 below), but by no means as a necessary consequence of the assumption that commercial trade responds (however little) to changes of forward-exchange rates.

---

an assumption that the elasticities of commercial excess demand for *forward exchange* always exhibit the "normal" signs. This was not intended.

2. INTEREST ARBITRAGE

2.1. *Competitive Arbitrage under Full Currency Convertibility*

With free currency convertibility, covered interest arbitrage provides a link between the spot and the forward markets of different maturities. If the transfer of funds from one country to another did not involve any (opportunity) cost or risk and if the interest rates for loans of all possible maturities were the same at home and abroad, it is easily seen that equilibrium would require that the spot rate and all forward rates be identical.[10] If the forward rate for any maturity were higher than the spot rate, it would obviously pay to use one's own or borrowed funds to purchase the currency in question on the spot market and sell it simultaneously at the higher forward rate, keeping these funds in a foreign bank (where it is assumed they earn the same interest as in domestic banks) until the day when the forward contract becomes due. Competitive arbitrage will make the profit margin disappear.

If interest rates differ, the analysis becomes slightly more complicated. We shall use the following notation:

r_o ..... spot rate of exchange at time 0.

r_t ..... forward rate of exchange for delivery at time t (t is expressed in terms of fractions of a year).

i_d and i_f ..... domestic and foreign rates of interest for instantaneous compounding of interest. Though compounding is always discontinuous in practice, the notation is considerably simplified by the assumption of continuous compounding. The modifications required to change to the discontinuous case are elementary.

δ ..... forward discount on domestic currency, expressed as *per cent per annum* of the spot rate of exchange,

$$\text{that is,} \quad \delta = \frac{r_t - r_o}{r_o \cdot t} \quad .$$

With a domestic interest rate i_d, one unit of domestic currency will grow to $e^{i_d t}$ at time t (where e is the basis of the natural logarithms)

[10] As usual, we are here concerned with "pure" interest rates, net of any risk of default.

when invested at home. If capital movements between countries are unrestricted, funds can alternatively be transferred abroad. Given spot and forward exchange rates r_o and r_t, a foreign interest rate i_f, and assuming initially that transfer is costless, covered interest arbitrage will yield $\frac{r_t}{r_o} e^{i_f t}$ units of domestic currency at time t for every unit invested abroad. Competitive arbitrage will tend to make the returns from both types of investment equal in equilibrium. This leads to the equation

$$\frac{r_t}{r_o} = 1 + t\delta = e^{t(i_d - i_f)} \qquad (1)$$

or, to a first-order approximation,

$$\delta = i_d - i_f . \qquad (2)$$

Equation (2) expresses the familiar fact that, under the assumed idealized conditions, the premium or discount (*per annum*) tends to equal the interest differential, the currency of the country with the lower interest rate being the one that exhibits a forward premium. It is to be noted that the fulfillment of (2) requires not only the absence of transfer charges and risks, but also perfect competition among interest arbitrageurs.

2.2. *Modifications*

In the real world, various risks and transfer charges will prevent exact equality in (2). The willingness of arbitrageurs to move their liquid funds from one country to another can be expected to be a (rising) function of the covered interest differential, $i_d - i_f - \delta$ (where the direction of movement of arbitrage funds depends on the sign of that difference). The less-than-perfect elasticity of supply of arbitrage funds that can be observed in the real world finds its principal explanation in the rising opportunity cost of arbitrage compared to the alternative uses of the same funds, given the increasing risk of investing more and more funds in the same asset. Abstract reflection as well as empirical observation suggests, however, that the opportunity cost of arbitrage should normally not rise very steeply. Appreciable divergences between forward premium and interest differential have usually occurred only when exchange controls were in effect, or when their imposition appeared imminent. Recent contributions to the theory of forward exchange have perhaps overstated

the degree to which deviations of forward premia from interest differentials can occur under normal conditions.[11]

Apart from outright controls, obstacles to interest arbitrage often take the less obvious form of moral discouragement by central banks of all forward operations not directly linked to commercial trade. In most countries, central banks find it relatively easy to make such discouragement effective. Its avowed purpose is usually the prevention of speculation. There is little doubt that many central bankers are sincerely convinced that any forward operation not directly linked to commercial trade must be of a speculative nature, and that all speculation ought to be discouraged as much as possible. The effect of moral dissuasion is precisely the same as that of direct controls: the link between spot and forward markets is, if not completely broken, at least weakened, and forward premia may diverge from interest differentials by appreciable margins.

It is a mistake to believe that speculation alone is sufficient to produce an excessive divergence between interest differentials and forward premia. Whenever speculative short sales of a currency make it depreciate on the forward markets by more than the discount indicated by the difference in interest rates of the two countries, covered interest arbitrage becomes profitable and reduces or eliminates the excessive discount. One might perhaps wonder why interest arbitrageurs would ever want to undertake forward purchases of a currency that is generally expected to depreciate (as they would have to in order to reduce its forward discount). Arbitrageurs who undertake forward purchases of a currency simultaneously sell it on the spot market, however. Failure to arbitrage would imply that they continue to hold this currency anyway, and this must, under the conditions we have assumed, always be a less profitable alternative, regardless of whether or not speculators' anticipations of depreciation turn out to be correct. Holders of the currency may well decide to

[11] As a rule, professional interest arbitrage is performed predominantly by banks and large international corporations. They are in the best position to observe the movements of exchange rates and interest rates in the different countries from day to day and have command over sufficiently large funds to make arbitrage transactions pay even when the profit margins are very small. According to Keynes, profitable arbitrage required a minimum difference of ½ per cent per annum between forward premium and interest differential during the 1920's. (*Tract on Monetary Reform*, [London: Macmillan, 1923], p. 128.) Today, funds move when the difference between forward premium and interest differential is only a fraction of this figure. See P. Einzig, "Some Recent Changes in Forward Exchange Practices," *Economic Journal*, Vol. 70 (1960), pp. 86-88.

sell it spot without forward coverage, but this would again tend to reduce the forward discount.

There is usually more than one interest rate in each country. The interest differential relevant to a particular forward market may therefore not be unambiguously determinable. The most realistic assumption presumably is that the interest rate relevant for a forward market of a given maturity is the interest return on the asset with lowest yield among all assets with the same maturity date. This will obviously be the asset with minimal risk.

2.3. *Triangular Arbitrage*

The introduction of more currencies does not change the substance of our argument. Triangular spot arbitrage in conjunction with bilateral interest arbitrage between each pair of countries will tend to ensure that the forward cross rates between all currencies are exactly in line with one another. If the other two types of arbitrage work effectively, there is thus no need for triangular forward arbitrage, and no scope for any profits from it.[12]

Let us illustrate by the relations between three financial centers: New York, London, and Frankfurt. We shall denote the interest rates ruling in the three centers by i_N, i_L and i_F and exchange rates by $(r)_{\substack{L \\ N}}$ etc., where the upper subscript denotes the center whose currency is quoted (in our standard fashion) in the center indicated by the lower subscript. Thus, $(r_o)_{\substack{L \\ N}}$ is the spot price of one pound sterling in terms of U.S. dollars.

From (1) above, we can state the equilibrium conditions for bilateral interest arbitrage between every pair of financial centers (assuming again, so as not to complicate this part of the analysis

[12] See esp. J. Spraos, "The Theory of Forward Exchange and Recent Practice," *Manchester School of Economics and Social Studies*, Vol. 21 (1953), pp. 89-90; and H. G. Grubel, "A Multicountry Model of Forward Exchange: Theory, Policy, and Empirical Evidence 1955-1961," *Yale Economic Essays*, Vol. 3 (1963), pp. 117-118. Grubel appears to regard the transmission to other currencies of effects brought about by official interventions of the monetary authorities in the forward market for one foreign currency as a possibly dangerous consequence of triangular arbitrage. But pairs of currencies obviously cannot (and should not) be compartmentalized in a system of multilateral convertibility. Since triangular *forward* arbitrage is rendered unnecessary by the bread-and-butter business of arbitrageurs, triangular *spot* arbitrage and bilateral interest arbitrage (a fact of which Grubel is well aware), it is difficult to understand, moreover, why he attaches such importance to the potential consequences of triangular forward arbitrage. See also Grubel's paper, "A Neglected Aspect of Forward Exchange Theory and Policy," *The Journal of Finance*, Vol. 18 (1963), pp. 537-548.

unnecessarily, that arbitrage funds are in perfectly elastic supply, that risks are absent, and that transfer costs are zero):

$$\left(\frac{r_t}{r_o}\right)_{\substack{L\\N}} = e^{t(i_N - i_L)} \quad ,$$

$$\left(\frac{r_t}{r_o}\right)_{\substack{F\\N}} = e^{t(i_N - i_F)} \quad , \qquad (3)$$

$$\left(\frac{r_t}{r_o}\right)_{\substack{L\\F}} = e^{t(i_F - i_L)} \quad .$$

It is seen without difficulty that conditions (3) imply

$$\left(\frac{r_t}{r_o}\right)_{\substack{L\\N}} = \left(\frac{r_t}{r_o}\right)_{\substack{F\\N}} \cdot \left(\frac{r_t}{r_o}\right)_{\substack{L\\F}} . \qquad (4)$$

Triangular spot arbitrage, on the other hand, ensures that

$$(r_o)_{\substack{L\\N}} = (r_o)_{\substack{F\\N}} \cdot (r_o)_{\substack{L\\F}} \quad , \qquad (5)$$

which, together with the preceding equation, implies

$$(r_t)_{\substack{L\\N}} = (r_t)_{\substack{F\\N}} \cdot (r_t)_{\substack{L\\F}} \quad , \qquad (6)$$

as was to be shown. It is easily seen that, alternatively, triangular spot and forward arbitrage together with interest arbitrage between two pairs of centers would, in equilibrium, establish the correct forward premium between the remaining pair of currencies even without any direct capital movements between the two financial centers.

3. SPECULATION ON FORWARD MARKETS

3.1. *"Pure" Speculators*

The forward exchange market is a particularly convenient instrument for speculative activity because a speculator does not have to possess any liquid funds at the time when he enters his speculative commitment (apart from the collateral demanded by his bank). For the purpose of our analysis, we shall, in fact, assume that speculators operate *exclusively* in the forward markets. This assumption is adopted not merely for convenience of exposition; it is, in fact, forced upon us if we want to maintain our strict separation of all forward transactions into commercial hedging, arbitrage, and speculation.[13] If a speculator happens to purchase a foreign currency on the spot market in the expectation that he will be able to sell it at a profit, he performs a combination of speculation and arbitrage, for his eventual profits from the operation will not only depend on the present and future spot rate of exchange, but also on the difference between domestic and foreign interest rates. Uncovered spot purchases of foreign exchange can conceptually be separated into (1) a spot purchase of the foreign currency, (2) a simultaneous forward sale of the foreign currency (a pure arbitrage operation), and (3) a simultaneous forward purchase of foreign currency for the same maturity (a purely speculative operation)—the two imaginary forward transactions cancelling each other.

The pure speculator in our model will never actually take possession of any foreign currency. Instead, he will buy or sell foreign currencies on forward markets and, on the day when his contract falls due, merely pay his market partners the difference between the actual spot rate on that day and the forward rate he has contracted for. His requirements for cash on any given day are thus limited to the loss he incurs on his earlier forward commitments if the spot rate happens to be unfavorable to him.

Any speculative purchase of a currency will in due course lead to a sale of the same amount of this currency, even though the speculator may not perform this sale himself. His market partners (com-

[13] See also Tsiang, "The Theory of Forward Exchange and Effects of Government Intervention on the Forward Exchange Market," *International Monetary Fund Staff Papers*, Vol. 7 (1959), pp. 86-92.

mercial traders and arbitrageurs) have, at the time the forward deal was concluded, undertaken forward sales of the amount that was bought by the speculator. When these contracts become due, these other market participants will consequently want to deliver an equivalent amount of spot currency, with the speculator paying or receiving the difference between the spot rate and the stipulated forward rate if he does not actually execute the deal himself. In summary, a speculative transaction in forward markets has a lagged effect on the spot market of foreign exchange that is equal in magnitude and opposite in direction to the original speculative transaction.

It may be useful to go through the details of a numerical example. Let us assume that an American exporter of wheat has just signed a contract involving the sale of $2 million worth of wheat payable in U.S. dollars in three months. The foreign importer is unwilling to assume the risk of a possible parity change either of the U.S. dollar or of his own currency and therefore decides to purchase $2 million in the three-month forward market. This transaction, taken by itself, will make the three-month forward dollar appreciate. Let us assume that this induces a speculator to sell an amount of $1 million forward in the expectation that the spot rate for the dollar three months later will be lower than the forward rate at which he sold. The remaining $1 million worth of forward dollars bought by the foreign importer are supplied by commercial traders and arbitrageurs, for whom transactions leading to the sale of forward dollars have become profitable as a result of the change in the forward rate.

Suppose that the speculator's expectations are disappointed. On the day on which the deal has to be executed, the spot rate happens to be one percent above the level of the forward rate quoted for the same day three months earlier. Our speculator now incurs a loss of $10,000, irrespective of his choice between two alternatives open to him. He could acquire $1 million on the spot market and sell this amount to his market partner at a loss of $10,000, or he may let his market partner acquire the million dollars himself and pay him the difference of $10,000 between the actual spot rate and the rate he contracted for. In both cases, there will be an additional demand for $1 million on the spot market.[14]

[14] What might have happened in practice (and would have led to exactly the same result) is that the importer decided to cover forward only half of his expected dollar commitment, assuming the speculative risk on $1 million himself.

In accordance with our basic definitions, it was assumed that the speculator waited until the day for which he concluded his original forward deal before he bought spot dollars (or before he let his market partner buy this amount, reimbursing him for the difference). In the real world, this may not be (in this subjective view) the most advantageous course of action. The spot rate for the dollar may very well before that date reach the lowest level he believes he can hope for. He may therefore (provided he can mobilize the sum required for this purpose) decide to purchase the $1 million of spot dollars then, rather than wait until his forward contract matures. Whereas the effect of the speculator's action at the time of his original forward deal is perfectly clear (it will, taken by itself, either depress the forward dollar or restrain its tendency to appreciate), the (opposite) effect on the spot market, but not the exact timing of his covering action, can be predicted.

It is not difficult to see how this type of behavior can be analyzed within the framework of our model. Let us assume that the speculator buys spot dollars 17 days before the maturity date of his forward contract. Under the definitions we have adopted, his new transaction will have to be treated as an arbitrage transaction involving the spot purchase of $1 million and the simultaneous sale of the same amount on the 17-day forward market, combined with the speculative purchase of $1 million on the same forward market, the two imaginary forward deals cancelling one another. The conceptual difficulty in establishing the correspondence to the real world is that forward exchange markets for such odd maturities as 17 days do not normally exist. But this is not a real problem in our case because it will, in any case, only be the spot exchange rate 17 days before the date of expiration of the original forward contract that will feel the impact of the covering transaction by the speculator, the forward deals being purely imaginary.

In a theoretical model, we have no difficulty in assuming the existence of any number of forward markets with maturities as odd as we please, so it will be most convenient for the purpose of analyzing speculation to assume that forward markets exist for every single future day. The desire for earlier covering by speculators, as in the example just given, could then be realized on any day they chose, without any cash commitments, by a compensating forward deal, this new forward transaction becoming effective on the maturity

date of the original forward contract. In our previous example, the speculator could cover his original forward sale by a purchase on the 17-day forward market 17 days before the maturity date of the original forward deal. With arbitrage working smoothly, he would be entirely indifferent between this transaction and coverage on the spot market at the same time because the difference between the spot and the 17-day forward rate would correspond rather closely to the interest differential, and this latter variable would also have to be taken into account by the speculator who is contemplating spot coverage.[15]

3.2. *The Determinants of Speculative Activity*

Which factors are likely to be most important in determining the direction and the level of speculative activity in forward markets? The decisive variable is obviously the difference between the current forward rate for a given maturity date and the expected future spot rate for the same date. The larger this difference, the more active will speculation be. The supply of speculative commitments ought to be much less elastic than the supply of arbitrage funds, however, in view of the fact that one strategic variable, the expected future level of exchange rates, is uncertain. Under the assumption that expectations about future spot rates are determined independently of the actual level of the *current* forward rate for the same dates,[16] the speculative

[15] Every forward deal by a speculator should actually be treated as a transaction in its own right. There is indeed no reason why we should not regard the 17-day forward transaction just described as an independent operation, quite unrelated to any earlier deals the speculator may have undertaken. The only conceivable reason for it must be that the 17-day forward rate makes a forward purchase for this maturity appear profitable by comparison with the spot exchange rate that is expected for that date. Given this expectation, there are good reasons for a forward purchase even if the speculator had not previously concluded a forward deal for this date.

[16] This assumption is certainly not entirely realistic. Our conclusions would not be materially affected by dropping it. If we go to the opposite extreme and assume that expected future spot exchange rates always move (in the view of market observers) exactly in proportion to the current forward rates for the same dates, this would imply that speculative demand for forward exchange is entirely independent of the present forward rate for the same maturity. It is to be expected, in any case, that other factors will usually be more important determinants of speculative behavior than changes in forward rates. For the purpose of our analysis, these other factors have merely been taken as given.

Decisions on how to distribute one's liquid funds among different currencies, and one's aggregate position in each currency among the various maturities, obviously lend themselves well to the analysis developed in the theory of asset preferences. See J. L. Stein, "The Simultaneous Determination of Spot and

forward demand for a particular currency can be taken to be a declining function of the forward rate at any time. With given expectations, speculative demand can therefore be expected to reinforce the negative elasticity of the net demand for forward exchange from commercial sources.

Changes of interest rates affect speculation in the following way. A rise of domestic interest rates, for instance, tends to shift the import-demand function downwards and the export-supply function upwards as a consequence of its effect on business activity. These changes presumably take some time to make themselves fully felt. It is therefore reasonable to assume that credit restriction will make domestic currency appreciate over the long run (by comparison with previous anticipations concerning future exchange rates). The inducement to undertake speculative purchases of domestic currency (or lower planned sales) will consequently be increased when interest rates are raised.

It is an open question, to be decided only by actual empirical evidence (which is in this case notoriously difficult to come by), how important speculative activity in the exchange markets is by comparison with other market components and in what forms it primarily appears. One principal manifestation of speculative activity is undoubtedly the "leads and lags" of trade. Depending on their expectations as to the future movement of exchange rates, commercial traders who ordinarily cover their future commitments by forward hedging may at certain times fail to do this. They are then taking speculative positions in other currencies. Under the "adjustable peg," in which expectations of possible exchange-rate changes are often extremely one-sided, these leads and lags are probably the major form of speculative activity.[17]

Futures Prices," *American Economic Review*, Vol. 51 (1961), pp. 1012-1025; H. G. Grubel, "A Multi-country Model of Forward Exchange: Theory, Policy, and Empirical Evidence, 1955-1961," *Yale Economic Essays*, Vol. 3 (1963); P. B. Kenen, in Robert E. Baldwin *et al.*, *Trade, Growth, and the Balance of Payments*, Essays in Honor of Gottfried Haberler (Chicago: Rand McNally & Co., 1965), pp. 150-158.

[17] See S. I. Katz, "Leads and Lags in Sterling Payments," *Review of Economics and Statistics*, Vol. 35 (1953), p. 75-80.

4. SIMULTANEOUS EQUILIBRIUM IN SPOT AND FORWARD MARKETS

4.1. *The Case of a Single Forward Market*

We now proceed to assemble the various components of supply and demand for spot and forward exchange in order to determine the conditions for equilibrium. Equilibrium in any one of the forward markets cannot be determined independently, but, in view of the link provided by interest arbitrage, only simultaneously with the spot market and all other forward markets. Before attacking the general case, we begin with the conventional model involving only one single forward market in addition to the spot market.

Equilibrium requires (1) that the demand for spot exchange by arbitrageurs, A (a decreasing function of the covered interest differential in favor of the domestic economy, $i_d - i_f - \delta$), be equal to the excess supply by the other participants in the spot market, and (2) that the simultaneous supply of forward exchange by arbitrageurs, $Ae^{i_f t}$, be equal to the excess demand for forward exchange from other sources. It is easily seen that the arbitrage supply of forward exchange in the second equation must equal the arbitrage demand for spot exchange *plus* the interest accrual abroad.[18]

The components of the excess supply of *spot* exchange from other than arbitrage sources are the excess supply from commercial trade, $X_o - M_o$ (where X_o and M_o stand for those exports and imports that call for immediate payment), the speculative supply of spot exchange, S_o, and the net supply of spot exchange by the monetary authorities, G_o. Other things being given, the excess supply by traders will normally be an increasing function of the current spot rate of exchange, r_o. According to our basic definitions, the spot supply of foreign exchange by pure speculators, S_o, is merely a residual of past speculative commitments and should therefore be independent of the present spot rate. We recall that, while S_o is *determined* by the earlier operations of speculators, these spot transactions are not normally

[18] Most previous writers on the theory of forward exchange (Kenen is an exception) have not taken the interest accrual to arbitrageurs into account. This may be a factor of negligible importance in a model involving only one forward market of very short maturity, but not for the longer maturities that have to be taken into account if several forward markets are considered.

executed by the speculators themselves but by their market partners with whom they merely settle the difference between the actual spot rate and the previous forward rate for the same date.[19]

The private excess demand for *forward* exchange from other than arbitrage sources is composed of the excess demand by commercial traders, $M_t - X_t$, and the speculative demand for forward exchange, $-S_t$. Both of these will, other things being given, normally be decreasing functions of the forward rate, r_t. In addition, there may be (positive or negative) excess demand for forward exchange by the monetary authorities, $-G_t$.

We obtain two equations,

$$A\,(i_d - i_f - \delta) = X_o\,(r_o) - M_o\,(r_o) + S_o + G_o \qquad (7)$$

and

$$A\,(i_d - i_f - \delta)\,e^{i_f t} = M_t\,(r_t) - X_t\,(r_t) - S_t\,(r_t) - G_t \qquad (8)$$

where the items in parentheses indicate the variables on which the associated market components are assumed to depend. Interest rates at home and abroad are assumed to be determined by monetary policy and are thus exogenous to the system considered here. We have two equations to determine the two unknowns, r_o and r_t.

The equilibrium is shown graphically in Figure 1. It is assumed here, as in the text, that interest rates are higher abroad than in the domestic economy and that arbitrage consequently produces a forward discount for foreign currency. Supply and demand by commercial traders operating in the spot market are, in accordance with our basic definition of pure traders, independent of supply and de-

[19] A purely notational difference between Tsiang's treatment and mine is apt to trouble some readers. Spot coverage by speculators does not explicitly appear as a speculative operation in his equations; what appears instead are the realizations of coverage transactions by traders and arbitrageurs with whom speculators have concluded forward deals in the past. These transactions are always equal in value and in direction to the ones which speculators would undertake if they were to carry out their coverage transactions themselves.

Though this is certainly in no way intended by Tsiang (it is, indeed, pointed out as a possible misconception by him), his choice of notation might perhaps convey the erroneous impression to some readers that the transactions of commercial traders (who deal exclusively on forward exchange markets in his model) are, after all, assumed to be affected by the spot exchange rate that happens to hold at the time when their forward contracts become due. These spot transactions are always predetermined in direction and in magnitude by the past commitments of commercial traders and therefore do not change in the least, however much the actual spot rate may differ from the forward rate previously quoted for this date.

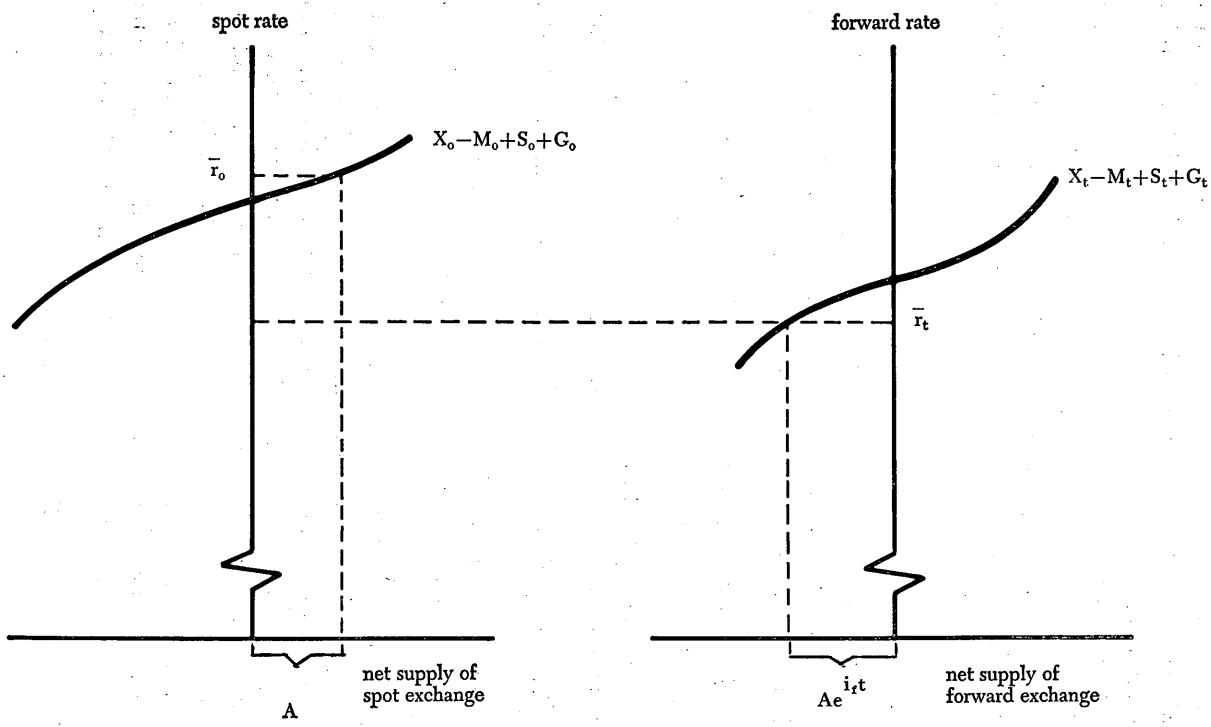

FIGURE 1

Equilibrium in the Spot and One Forward Exchange Market

mand by commercial traders operating in the forward market. Every trader always uses the market whose maturity date is closest to the date at which his obligations to pay or his expected receipts of foreign exchange fall due.

Speculators never desire to hold any currency (or more exactly, claims to future delivery) for its own sake, but only for the purpose of selling it eventually at a profit. Over a sufficiently long time interval, purchases and sales of foreign exchange by speculators can therefore be expected to cancel each other.

4.2. *The General Case*

The extension to any number of forward markets is straightforward. We assume that there are n forward markets, that the excess supply functions of traders, speculators, and arbitrageurs,

$$X_t - M_t = f_t(r_t),\ S_t = g_t(r_t) \qquad (\text{where } t = 0,\ 1,\ \ldots n),$$

$$A_t = h_t(\delta_t - i_{dt} + i_{ft}) \qquad (t = 1,\ \ldots . n), \qquad (9)$$

and the excess supply of foreign exchange of each maturity by the monetary authorities, G_t $(t = 0,\ 1,\ \ldots n)$, are given. As before, $\delta = \dfrac{r_t - r_o}{r_o\ t}$. The symbols i_{dt} and i_{ft} denote the domestic and foreign interest rates for loans of duration t. When interest rates at home and abroad are given, A_t becomes a (rising) function of the difference $r_t - r_o$ only.

Though less directly, the other market components will also be influenced by foreign and domestic interest rates. For obvious reasons, the effect of interest rates on commercial excess supply is likely to be increasingly important as the maturity dates of forward markets are longer. So as not to complicate the notation unduly, this dependence has not been explicitly indicated since it will not be too important in the present context, in which interest rates are assumed to be given.

Normally, the first derivatives will have the following signs (but see the remarks at the end of Chapter 1 and pages 22-23 below):

$$\frac{\partial(X_t - M_t)}{\partial r_t} > 0, \quad \frac{\partial S_t}{\partial r_t} \gtreqless 0, \quad \frac{\partial A_t}{\partial(r_t - r_o)} > 0. \qquad (10a)$$

When the dependence on interest rates is explicitly taken into account, we also have

$$\frac{\partial(X_t - M_t + S_t)}{\partial i_{d\tau}} > 0, \qquad \frac{\partial(X_t - M_t + S_t)}{\partial i_{f\tau}} < 0$$
$$(\tau = 1, \quad \ldots n), \tag{10b}$$

and, of course, $\dfrac{\partial A_t}{\partial(i_{dt} - i_{ft})} < 0.$

It is to be noted that the excess supply by non-arbitrageurs on each forward market will generally be a function of the interest rates for *all* maturities, whereas the arbitrage supply on each market should depend only on the difference between the foreign and domestic interest rates for the *same maturity*.

There are $n + 1$ equilibrium conditions,

$$X_t - M_t + S_t + A_t + G_t = 0. \tag{11}$$
$$(t = 0, 1, \quad \ldots n)$$

In addition, there is the equilibrium condition for arbitrage operations,

$$\sum_{t=0}^{n} A_t e^{-i_{ft}t} = 0. \tag{12}$$

Equations (11) say that the aggregate excess supply from all sources in each market has to add up to zero, equation (12) states that the algebraic sum of the discounted excess supplies by arbitrageurs in all forward markets has to equal their excess demand for spot exchange. The symbol i_{ft} denotes the foreign interest rate for investments of length t, where t represents, as before, fractions of a year. This formulation takes into account that interest rates for different maturities may differ. By definition, speculative excess supplies in the different markets are assumed to add to zero over a sufficient time interval. Official market interventions are determined by discretionary decision of the authorities and are therefore taken as given for our purposes.

We have $4n + 4$ independent equations in (9), (11), and (12) to determine the equilibrium values of the $4n + 4$ variables (excess demand by commercial traders, speculators and arbitrageurs in the spot and n forward markets *plus* the spot and forward rates of exchange). Conditions (10) ensure that the equilibrium will be unique and stable, but these conditions are not necessary for uniqueness of equilibrium. The interested reader is referred to the Appendix for details.

4.3. *Stable Equilibrium with Individual Markets Unstable*

The possibility that low demand elasticities might produce unstable equilibria in foreign-exchange markets has received its due share of attention for many years.[20] No more will be said about this subject here than that the existence of several forward markets also tends to reduce the likelihood of unstable equilibria in any one of these markets. The simple case involving one spot and one forward market will suffice to illustrate the point. We assume that the interest differential to the rest of the world is zero, since complications arising from a positive interest differential are extraneous to our present problem. In addition, the supply of arbitrage funds is assumed to be perfectly elastic. The monetary authorities do not intervene in the markets.

Figure 2 shows a spot market with an unstable equilibrium at U and a normally shaped excess-supply function for forward exchange, CD. Under the assumed conditions, the spot demand by arbitrageurs will be the mirror image (except for the small discrepancy due to the interest accrual) of the excess supply of forward exchange by commercial traders and speculators. In Figure 2c, it has been superimposed (DC) on the excess-supply function of spot exchange by other market participants (AB). Although the spot market was unstable in isolation, the activities of arbitrageurs produce, with the assumed shapes of the market schedules, a unique stable equilibrium at S.[21] Interest arbitrage has, so one might explain this phenomenon, "superimposed" the elasticities of the forward market on the spot market. The more forward markets there are, the stronger will be the presumption that the general equilibrium of all spot and forward markets is unique (and stable). Arbitrage will also serve as a buffer smoothing out the movements of exchange rates caused by sluggish reactions of traders to random shocks. This conclusion presupposes,

[20] For a detailed discussion and literature references, see my *Flexible Exchange Rates* (Chicago: University of Chicago Press, 1961), Chap. I.

[21] It is even possible to imagine cases in which both the spot and the forward market (in a system comprising one of each) is unstable in isolation and arbitrage between them produces a unique stable equilibrium. Mention of this possibility is not intended to indicate that the writer regards it as in any way relevant to the real world. Crucially important is the fact, on the other hand, that commercial excess demand is the more likely to be statically stable the longer the maturity of a forward market. Low short-run elasticities on the spot and the closer forward markets will therefore be all the more easily compensated for by arbitrage the more forward markets there are.

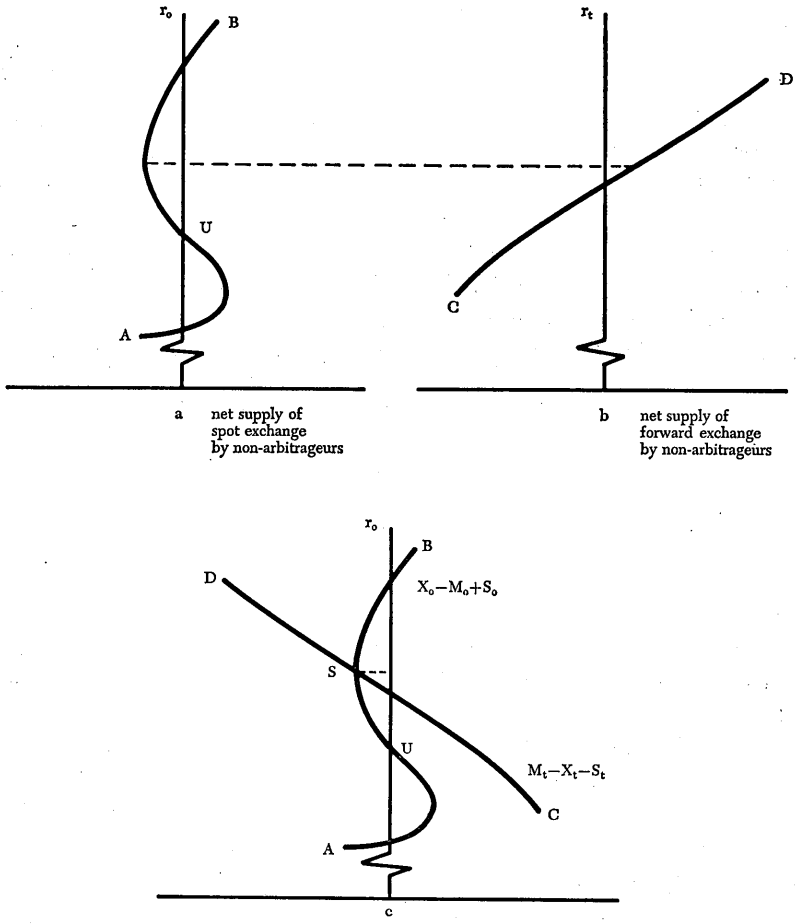

FIGURE 2

Unstable Spot Market and Stable Forward Market Producing Stable Arbitrage Equilibrium (2c)

of course, that capital movements are not inhibited by exchange controls or moral dissuasion.

4.4.* *Swaps between Forward Markets*

With more than one forward market, interest arbitrage might (in theory) not only take the customary form of a spot purchase and

* Sections 4.4 and 4.5 cover rather esoteric points and may be skipped without loss of continuity.

simultaneous forward sale of a currency, but also that of a swap between two forward markets with different maturities. To qualify as genuine arbitrage, however, the interest rate at which the funds acquired in the forward purchase can be invested (at the time when the arbitrageur takes possession) must be *known in advance.* The additional transactions needed to eliminate the risk occasioned by possible interest-rate changes could, for example, take the form of the purchase of a bill and the simultaneous acceptance of another bill with a different maturity, both denominated in the same foreign currency. To take a concrete example, an arbitrageur in the United States might simultaneously undertake the following transactions:

(1) purchase of pounds sterling 3-months forward,
(2) sale of pounds sterling 6-months forward,
(3) acceptance of a 3-month draft denominated in pounds sterling,
(4) acquisition of a 6-month bill denominated in pounds sterling.

Transactions (3) and (4) imply that the arbitrageur's net foreign-exchange position during the first three months is zero. At that time, he acquires a position in pounds sterling for three months that is not only fully covered against the exchange risk, but whose interest return is also predetermined. It is thus excluded that a later change in foreign or domestic interest rates might wipe out the expected profits of the arbitrage transaction proper.[22] I do not want to suggest that transactions of this rather complicated type are indeed performed in the real world. Nothing more is intended than to demonstrate that the elimination of the interest risk involved in forward arbitrage is technically feasible. There is actually no need for such intricate transactions to establish simultaneous equilibrium in all forward markets; separate arbitrage of the customary type between the spot and each forward market suffices (see Section 5.2 below).

[22] Grubel states that arbitrage between different forward exchange markets can never be true arbitrage, but is always "double-barreled speculation" ["A Multicountry Model of Forward Exchange: Theory, Policy, and Empirical Evidence 1955-1961," *Yale Economic Essays*, Vol. 3 (1963), p. 139]. Einzig and Lipfert have expressed themselves in similar terms. See Einzig, *A Dynamic Theory of Forward Exchange* (London: Macmillan, 1962), p. 254; and H. Lipfert, *Devisenhandel* (Frankfurt: Knapp, 1958), p. 103. They appear to overlook the possibility of hedging against the risk of interest-rate changes, illustrated in the example above.

4.5. *Commercial Trade as a Substitute for Interest Arbitrage*

Let us next investigate the issue that was briefly touched upon in fn. 5 above. The question raised there was whether the commercial excess demand on each exchange market was likely to be influenced not only by the exchange rate on this market, but also by the exchange rates on all other (spot or forward) markets. In other words, one might ask whether the excess-supply functions in (9) above ought to be written as $X_t - M_t = f_t(r_o, r_1, \ldots, r_n)$, with $\frac{\partial(X_t - M_t)}{\partial r_j} < 0$, for $j \neq t$, instead of only $f_t(r_t)$.

To begin with an obvious qualification, it must be assumed here that divergences between the exchange rates for different maturities do not correspond exactly to possible differences in the forward quotations (or expected prices) of the same commodities for the different maturity dates of foreign-exchange contracts. So as to concentrate on the essentials, let us assume in what follows that this condition is fulfilled.

The point at issue is brought out most clearly if we start by analyzing a situation in which full arbitrage equilibrium (equality of forward premia and interest differentials) holds all the time in a regime of full currency convertibility. With a given interest differential, equilibrium spot and forward rates for all maturities will be determined, and with them, a certain (positive or negative) excess supply of forward exchange by commercial traders on each market. Suppose that the interest differential is changed by a rise of domestic interest rates. The change of interest rates will, of course, affect the commercial excess supply on each market via the general change in business conditions it brings about. Will commercial demand and supply for forward exchange of a particular maturity be affected, *in addition*, by the changes of the exchange rates for other maturities that are induced by the change in the interest differential?

A "pure" trader always avoids exchange risks by hedging all commitments to pay or to receive foreign exchange by purchases or sales of forward exchange for the same date. By definition of a pure trader, these commitments must always arise out of purchases or sales of commodities (including services), and it seems natural to assume that the date of payment always coincides fairly closely with the date at which the buyer takes legal possession of the commodities. In the last

analysis, the question to be answered is whether a change of relative forward rates is likely to lead to a reallocation of the flows of exports and imports for different future time periods.

The reader should have no trouble in convincing himself that there will be no inducement for accelerating or postponing exports or imports because of changes in *relative* forward rates—the effect of changes in the *absolute* level of each forward rate is already taken into account in relations (9) above—*as long as full arbitrage equilibrium holds at all times.* When other economic variables are given, domestic demand for each commodity in each time period will be determined. Acceleration of imports of a particular commodity (a phenomenon which might, at first sight, appear profitable as home currency appreciates on the spot and closer forward markets by comparison with the more distant ones when credit is restricted by the domestic central bank) would consequently imply that domestic inventories are being increased. But inventory accumulation becomes more expensive for domestic businesses when domestic interest rates have been raised. The interest cost will, in fact, exactly compensate for the inducement to accelerate imports that is caused by the relative appreciation of domestic currency on the spot and the closer forward markets as long as full arbitrage equilibrium is preserved. It is an easy exercise to convince oneself that the same holds (with all signs reversed) for the dispositions of exporters and foreign importers.

An inducement to accelerate or postpone imports (and vice-versa for exports) arises indeed in the real world whenever full arbitrage equilibrium does not hold at all times (as a consequence of exchange controls, for instance). Closer analysis will show that commercial transactions then merely serve as a substitute for interest arbitrage. As an example, assume that spot and futures prices of a certain staple commodity, as well as domestic and foreign interest rates, are equal and that domestic currency exhibits a forward discount. It will then become profitable to acquire spot exchange, to use it for purchasing the commodity abroad and to sell it on the commodity-futures market, simultaneously selling the eventual foreign-exchange proceeds forward. In the process, a bit of conventional interest arbitrage has been performed: a spot sale combined with the simultaneous forward purchase of the currency that exhibits a forward discount. In a model without friction or transactions costs, *nothing* but interest arbitrage would, in fact, occur. Since spot and futures prices of the commodity

were assumed to have been equal in the initial equilibrium, these commodity markets must now be in disequilibrium; pure commodity deals in reverse will become profitable. In the absence of all friction, equilibrium will be restored only when these reverse transactions equal the original arbitrage deals in volume. What remains for the market as a whole is a pure interest-arbitrage transaction.

Given the fact that financial arbitrage is always considerably less expensive than its substitution by acceleration or postponement of commodity flows, we can rest assured that the latter will never be of any importance in the real world as long as full currency convertibility is preserved. Commercial excess supply of foreign exchange on the various markets will then always be a function only of the "own" forward rate (or spot rate) and not of the exchange rates on the markets for other maturities.

4.6. *Different Rates of Inflation*

A question not only of theoretical, but of considerable practical interest is how forward exchange markets will behave in a situation in which a country continuously shows a higher (or lower) rate of inflation than the rest of the world. Without loss of generality, we may assume that the price level remains perfectly stable in the rest of the world, while the domestic economy experiences a steady rate of inflation per year. We maintain the assumption of unrestricted convertibility. The intrinsic features of such a situation are brought out most clearly if it is assumed that *everybody foresees this development precisely.* In order not to get involved in intricate index-number problems, let us assume that all prices rise by the same percentage every year and that, on the average, the country's currency also depreciates continuously by the same percentage *per annum.*

Under the assumption of perfect foresight, the actual spot rate of exchange on each day cannot diverge from the forward rate previously quoted for the same day by more than the marginal (opportunity) cost to speculators of bridging the residual difference.[23] Arbitrage equilibrium, on the other hand, dictates that the forward premium for each maturity shall deviate by no more than the marginal opportunity cost of arbitrage from the interest differential between the

[23] Under the assumption of perfect foresight, the term "speculation" becomes somewhat inappropriate for this activity. This assumption, which can obviously never be exactly fulfilled in the real world, has only been introduced in this connection to bring out the essential characteristics of the case under discussion as clearly as possible.

home economy and the rest of the world. Together, these two conditions imply that interest rates in the home economy must exceed interest rates in the rest of the world by the expected rate of depreciation of domestic currency (apart from the small divergences made possible by transactions costs). As long as these conditions are satisfied, but only then, it will be possible to preserve full currency convertibility while maintaining equilibrium in all spot and forward exchange markets. The stringency of these conditions for dynamic exchange-market equilibrium is attenuated by the less-than-perfect foresight of traders and speculators in the real world. Foresight cannot, as a rule, be safely expected to be so imperfect, however, that monetary policy could for long ignore the dynamic equilibrium conditions for the term structures of forward exchange rates and interest differentials. It should not be necessary to elaborate on the fact that there is not the remotest possibility of preserving full convertibility for any length of time if rates of inflation diverge and exchange rates are *not* free to adjust.

4.7. *The "Insurance Theory" of Forward Coverage*

Let us finally return to the argument that forward coverage involves a risk premium—hence additional cost to exporters and importers, that tends to reduce the volume of world trade if exchange rates are not officially fixed. It was shown in Chapter 1 that it is not at all necessary for speculators to enter forward exchange markets in order to make forward covering possible for exporters and importers. After our general analysis of simultaneous equilibrium in the spot and forward markets, it can now be seen that no risk premia are involved in forward coverage even if there is speculation and arbitrage, provided full convertibility is maintained at all times.

That no risk premia are involved can be easily shown for the simplest case, in which domestic interest rates are the same as those abroad so that arbitrage produces equality of spot and all forward rates (apart from small divergences due to the opportunity cost of arbitrage). Forward coverage can then cost no more than the purchase or sale of the same currency on the spot market, no matter how active speculation may be. When foreign and domestic interest rates differ, spot and forward rates diverge indeed, but even then the forward premium or discount cannot be interpreted as a "risk premium." If lower interest rates in the rest of the world create a forward premium for foreign currencies, traders who have assumed commit-

ments to pay in foreign currencies have to pay more for forward than for spot exchange, but other traders who sell their expected foreign-exchange receipts forward receive more in exactly the same proportion. For commercial trade as a whole, forward coverage can consequently not be said to be more expensive than spot transactions. Whatever divergence between spot and forward rates there may be at any time as a consequence of interest differentials is, moreover, not pocketed by speculators (in which case their earnings might, after all, be characterized as compensation for risks assumed by them), but accrues to market participants who do not assume any exchange risks. The profits of speculators do not derive from the divergence between the spot and forward rates quoted at any *given* time, but from differences between exchange rates at two *distinct* moments in time.

The deep-seated conviction of so many people that a risk premium is associated with forward coverage is primarily explained by their experience under the present system. The relatively small limits within which exchange rates are now allowed to vary under normal conditions do not make it appear worth-while for many participants in international trade to trouble about forward coverage. Only when a chronic disequilibrium makes a parity change appear possible will it become increasingly important to guard against the exchange risk. More precisely, it will only be two types of exchange risks against which it is important to insure oneself: the risk of depreciation of a "weak" currency, and the risk of appreciation of a "strong" currency. There is not much point in hedging against the risk of depreciation by a country experiencing large payments surpluses, or appreciation by a country plagued by huge deficits. It is amply clear that forward markets become extremely one-sided under such conditions. The rising forward supply of the weak currency by commercial traders creates forward discounts that make temporary capital exports by arbitrageurs increasingly profitable as long as the central bank keeps the spot rate pegged. But it is precisely then that central banks, threatened by the loss of all their reserves, attempt to discourage arbitrage. With arbitrage impaired by various devices, the weak currency may be driven to an appreciable forward discount, making hedging against its possible devaluation rather expensive. Occasionally (as during the weeks following the revaluation of the D-Mark in March 1961), forward exchange markets may break down altogether. Although it remains just as true that forward hedging in the *opposite*

direction must always be less expensive in exactly the same proportion, very few people have an interest in this type of hedging in the asymmetrical situation typical of all balance-of-payments crises under a system of administratively pegged spot rates. Hedging against the only type of risk worth insuring seems to be loaded with a heavy cost.

Such apparent risk premia arise exclusively from the current practice of limiting the movement of spot exchange rates while providing no support for forward rates, combined with the attempt to inhibit or discourage movements of arbitrage funds. Forward discounts exceeding interest differentials by sizable margins could never arise in a system of flexible rates and full currency convertibility. Even under the current system of fixed spot rates, forward rates could hardly ever move outside the relatively narrow margins prescribed by international interest differentials, together with bank and brokerage charges, if central banks did not inhibit capital movements at times of speculative uncertainty. It is most remarkable that the appearance of large forward discounts and the occasional breakdown of forward markets—both phenomena being so intimately and characteristically associated with the present system of (adjustably) *pegged* exchange rates—are so often pointed out as evidence of the prohibitive cost (or actual impossibility) of forward coverage for traders in a system of *flexible* exchange rates.[24]

Another possible reason why the "insurance theory" of forward coverage is so readily accepted is perhaps that an invalid analogy is drawn with the phenomenon of "normal backwardation" on commodity-futures markets. On most of these markets, there is normally a majority of hedgers who desire to sell rather than buy futures (the case of flour millers usually cited in the textbooks, for example). This has the effect that futures prices are, on the average, below the spot prices realized later for the same dates. The difference between their averages implies a risk premium which hedgers as a group are ready to pay for the opportunity of avoiding the risk of price fluctuations.[25]

It is important to realize that no such asymmetry arises on forward markets of foreign exchange. Since we can assume that forward covering appears worth their while to approximately the same proportion

[24] See the review of my *Flexible Exchange Rates* by O. Emminger, *Weltwirtschaftliches Archiv*, Vol. 88 (1962), p. 94*; or R. Meimberg, *Zur Problematik des flexiblen Wechselkurses der Währung eines relativ preisstabilen Landes* (Berlin: Duncker & Humblot, 1966), p. 18 and the literature cited there.

[25] See J. M. Keynes, *A Treatise on Money*, Vol. II (London: Macmillan, 1930), pp. 143-144.

of traders in all countries, and since the (algebraic) sum of the export surpluses of all countries is identically zero, there cannot be a perennial excess supply of *all* currencies simultaneously on the forward markets. The desire to sell one currency necessarily goes hand in hand with the desire to purchase another one in exchange for it. The very forces that depress the rating of one currency produce an equivalent tendency for others to appreciate.

There remains the question of whether forward coverage might not, after all, involve higher *transactions costs* (in the form of bank charges, etc.) by comparison with spot-exchange deals. If these charges are sometimes higher now, this can only be explained by the fact that forward-exchange transactions are still somewhat of an oddity in the eyes of many businessmen and that, as a consequence, forward markets are still less developed than spot markets. There is no reason at all why forward transactions should, if these markets are normally developed, involve higher costs than spot-exchange deals.

The argument that it is not necessary for speculators to take over the exchange risk to make forward coverage by traders possible must not be misunderstood to mean that speculation (at a competitive average rate of return for the resources engaged in it) is unnecessary for smoothing out the random fluctuations of exchange rates *over time* that international trade may produce.[26] Such an assertion would obviously be wrong. While we have shown that, under conditions of full currency convertibility, no additional cost is involved in hedging by forward purchases or sales of foreign exchange, we cannot, of course, claim that such hedging would, when exchange rates are free to move, always be possible at reasonably stable forward rates without stabilizing speculation.

4.8. *Long-Run Forward Cover*

This is an appropriate place also to point out that it is entirely wrong to argue that forward cover is necessarily only available for relatively short time spans (say, up to six months), but not for the rather long periods often involved in commercial contracts. This view is undoubtedly again attributable to the belief that speculators are

[26] The main argument of the preceding pages, which was first sketched in my *Internationale Währungsprobleme* (Frankfurt: Knapp, 1964), pp. 99-101, was apparently interpreted in this way by H. Timm. See his survey article "Das Wechselkursproblem" in *Weltwirtschaftliche Probleme der Gegenwart.* Schriften des Vereins für Socialpolitik, Vol. 35 (Berlin: Duncker & Humblot, 1965), p. 138.

the only possible market partners of commercial hedgers in forward exchange markets. Speculation, most people are inclined to argue, is necessarily a short-run affair. Speculators cannot possibly be counted upon to assume forward commitments for more than six or nine months as a maximum.

Let us assume that the supply of two-year forward exchange by traders expecting payment in a certain currency in two years were to be only half the forward demand for this currency by other traders who have settled for payment in two years' time. Commercial transactions alone would therefore drive the currency to an excessive discount in the two-year forward market. The reader will have no difficulty in persuading himself that such a situation holds out the promise of huge profits to arbitrageurs who sell the currency in question on the spot market and buy it on the two-year forward market. Their activities will narrow the gap to the vicinity of the margin indicated by the interest differential. If forward markets of maturities of two years or more do not provide the possibility of coverage to commercial traders at the present time, this is largely due to the open or concealed discouragement of arbitrage by central banks and to the risk that exchange controls may become more stringent before the forward contract expires. These imperfections and uncertainties arise, in turn, only from the frequency of balance-of-payments difficulties in a system of pegged exchange rates in which the policies of the participating countries are not at all times guided exclusively by the demands of balance-of-payments equilibrium.

5. MONETARY POLICY

5.1. *The Balance of Payments as a Catalyst of Countercyclical Policy*

Whereas the average absolute level of spot and forward exchange rates between two currencies is, over the long run, primarily influenced by the price levels of exportable commodities in terms of each country's national currency,[27] the divergence between spot and forward rates is, as we have seen, determined by the difference between interest rates in the two economies. Given a certain term structure of interest rates in each country, the equilibrium term structure of forward rates will also be determined within narrow limits. If interest rates abroad are one per cent above domestic rates, for example, arbitrage equilibrium would dictate a three-month forward premium of about ¼ per cent for domestic currency, a six-month forward premium of approximately ½ per cent, a twelve-month forward premium of about one per cent, and so forth. With full currency convertibility and free spot and forward exchange markets, any change in monetary policy will, among other things, also change the term structure of forward exchange rates.

The changes in the term structure of forward rates that are prompted by adjustments of monetary policy will bring about rearrangements in the real sphere. To simplify the analysis, let us start out from a situation in which the same rate of change (which may be zero) of the prices of internationally tradable goods was anticipated at home and abroad and in which domestic and foreign interest rates are equal. The equilibrium levels of spot and forward rates must consequently have been approximately equal. Suppose that, by easing credit, the domestic central bank brings about a fall of domestic interest rates. Interest arbitrageurs will now find it profitable to transfer funds abroad. Their demand for spot exchange tends to make domestic currency depreciate on the spot market; their simultaneous

[27] This is not meant to assert the validity of a simple purchasing-power-parity theory, but only the rather plausible conjecture that an increase in one country's price level relative to that in another will, other things being given, generally tend to make the first country's currency depreciate with respect to that of the other. In practice, the prices of exports and import substitutes frequently diverge so much from the general trend of prices that the relative movements of aggregate price levels in different countries are inversely correlated to the evolution of equilibrium exchange rates.

sale of forward exchange will make it appreciate on the forward market that is chosen for the covering transaction.[28] This will favor exports and discourage imports of those commodities whose traders normally use the spot exchange market. Our previous considerations suggest that these are likely to be the commodities with the shortest delivery lags. It can be expected that the changes induced by the movement of the spot rate will be felt in the home economy with little delay. In our case, the balance on current account will show a larger surplus (or a smaller deficit). This cannot fail to stimulate business conditions.[29]

This foreign-trade effect of monetary policy can only take place, of course, if the spot exchange rate is free to adjust. If it is pegged by central-bank intervention, the outflow of funds cannot affect either the spot rate or the balance on current account. The capital outflow will merely cause a reduction of the currency reserves of the domestic central bank, and this will *counteract* the intention of the central bank to ease credit. Monetary policy can, as far as it is feasible at all under the constraint to keep exchange reserves from falling below zero, only operate through its customary effects on the *domestic* components of effective demand.

We have dealt with the case in which a central bank applies

[28] It is an elementary exercise to rephrase our conclusions for cases in which the initial conditions are different. The assumed change in monetary policy will always tend to make the currency depreciate and appreciate on the spot and forward markets, respectively, by comparison with the levels of exchange rates that would otherwise have come about.

[29] See my *Flexible Exchange Rates* (Chicago: University of Chicago Press, 1961) Chap. IV. The same point was made by R. Mundell in his papers "Flexible Exchange Rates and Employment Policy," *Canadian Journal of Economics and Political Science*, Vol. 27 (1961), pp. 513-514, and "Capital Mobility and Stabilization Policy Under Fixed and Flexible Exchange Rates," same *Journal*, Vol. 29 (1963), pp. 475-485. Mundell obtains his results under radically simplified assumptions (implicit in the first and explicitly pointed out in the second paper): spot and forward exchange rates as well as expected future spot rates are assumed to be identical, even though exchange rates may be perfectly free to find their momentary equilibrium levels at all times (*ibid.*, pp. 475-476). This eliminates all complications arising from the necessity to distinguish between movements of speculative and arbitrage capital in the real world. Mundell's assumptions also imply that domestic and foreign interest rates could never diverge in a frictionless model with perfect capital mobility. Under our assumptions, this would not have to occur even in this idealized case. *A fortiori*, Mundell's conclusion (in the second paper cited above) that fiscal policy would be inoperative as a tool of employment policy in a frictionless system of flexible exchange rates also does not follow.

expansionary monetary policy with the intention of stimulating business activity, but it is easily seen that the mechanism outlined here works as well in the opposite case, in which a policy of monetary restriction is pursued in order to restrain inflationary tendencies.

Our analysis is incomplete as yet in that only the effects of changes in monetary policy on the *spot* rate of exchange and on that part of international trade which is financed through the spot market have been discussed. While the creation of a negative interest differential tends to make domestic spot currency depreciate and thereby induces an additional commodity outflow, it must have the opposite effect on the forward market that is chosen for the covering transaction. In view of our general verdict that most "pure" traders deal not in the spot, but in the forward, exchange markets, one might at first sight be inclined to conclude that the foreign-trade effect of monetary policy on domestic business conditions under a system of flexible exchange rates might well work in a *perverse* way.

This impression can only arise, as will be seen in a moment, if one thinks in terms of only one single forward market. Even for this simple case, the first impact of a change in monetary policy on the foreign balance is likely to be as suggested above. The delivery of commodities whose traders use the spot market can be assumed to precede the delivery of commodities whose traders typically cover on the forward market.[30] In addition, it must be borne in mind that interest arbitrage is perpetuated as long as the interest differential persists. When the first forward contracts mature, there will, as long as the interest differential has not changed, be an undiminished inducement to undertake interest arbitrage by spot purchases and forward sales of foreign exchange. The delayed deflationary effect of the initial forward transactions of commercial traders (prompted by

[30] At first glance, it might appear as if a reduction of the spot rate of exchange relative to the forward rate in response to a change in the interest differential might induce many traders to shift from coverage (*for a given payment date*) on the forward market to coverage on the spot market, or vice versa. The change in the interest differential to which such an adjustment of spot relative to forward rates is due when all markets are in equilibrium will, however, make any apparent advantage of such substitution illusory. The changes in the "leads and lags" of traders' covering operations described by Spraos, "The Theory of Forward Exchange and Recent Practice," *Manchester School of Economics and Social Studies*, Vol. 21 (1953), pp. 87-117, are not of this type, but merely involve interest arbitrage in an environment in which exchange controls make outright arbitrage by means of purely financial transactions impossible.

the forward appreciation of domestic currency they induced) will, other things being unchanged, be approximately compensated for by the effects of the new purchases of spot exchange by interest arbitrageurs. In addition, the elasticity of supply of arbitrage funds is presumably higher in the long than in the short run. Immediately after a change of interest rates, funds that will eventually be used to take advantage of the newly opened arbitrage opportunities may be temporarily committed elsewhere. The full effect of the change in monetary policy will therefore be felt only after a certain time lag.

5.2. *The Adjustment of the Term Structure of Exchange Rates to Monetary Policy*

But the most important qualification of the argument presented thus far is recognized when the existence of more than one forward exchange market is taken into account. The creation of an interest differential by monetary expansion at home will make arbitrageurs produce a term structure of forward rates in which domestic currency depreciates on the spot market *as well as on the closer forward markets* and where it tends to appreciate only on the more distant forward markets (all exchange-rate adjustments being understood to be movements *relative to the previous equilibrium values* of spot and forward rates). It can easily be shown that this is indeed a necessary consequence of interest arbitrage. We still neglect the reactions of traders and speculators to changes of interest rates; as will be seen later, they only tend to reinforce our conclusions.

Figure 3 illustrates the following considerations. To avoid unnecessary complications in the wording of our conclusions, let us again assume that domestic and foreign interest rates are equal to begin with and that, while speculation is absent, excess demand from commercial sources $(M_t - X_t)$ is zero on the spot as well as on all forward markets at exchange rate $\bar{r}$, which will then be the initial equilibrium rate for all maturities. Let us first assume that the change in monetary policy does not at all affect commercial supply and demand functions. (This assumption is certainly most unrealistic and will be dropped in due course; let it only be pointed out here that its abandonment will strengthen our main result). Suppose that an easing of credit produces a new equilibrium in which the forward premium for domestic currency in the forward market with the longest maturity (the fifth forward market in Figure 3) is equal to the dis-

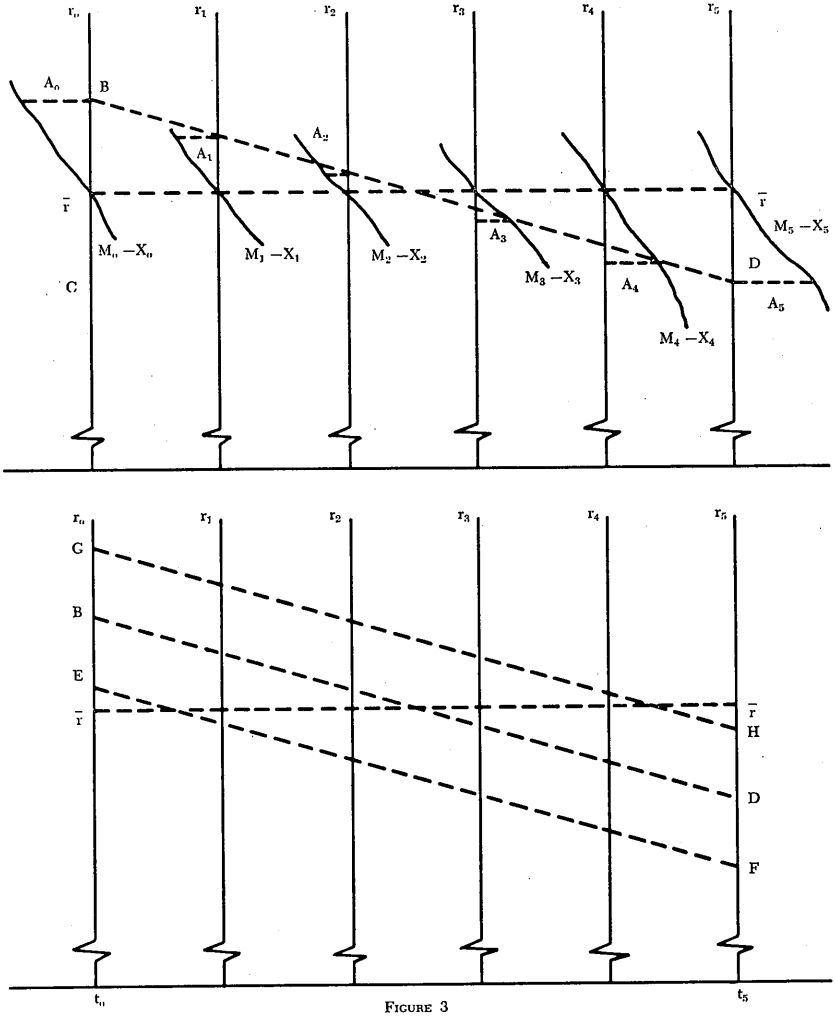

FIGURE 3

Arbitrage Equilibrium in the Spot and Five Forward Exchange Markets when Foreign Are Above Domestic Interest Rates

tance *BC*. The change in monetary policy has certainly made it profitable for interest arbitrageurs to transfer funds abroad for this maximum period. If these were the only transactions being undertaken by arbitrageurs, only the spot rate r_o and the last forward rate (r_5 in Figure 3) would change until the commercial excess demand for forward exchange of the longest maturity became equal to the

excess supply of spot exchange by commercial traders *plus* the interest accrual, each of these being equal to the amounts of forward and spot exchange supplied and demanded, respectively, by interest arbitrageurs.

If nothing else had happened, the forward rates r_1, r_2, r_3 and r_4 would remain unchanged at $\bar{r}$; excess demand by commercial traders in these four forward markets would consequently remain zero. But this can obviously not be an equilibrium situation. The first forward rate, for instance, would be lower than the level indicated by the required term structure of exchange rates (shown by the line *BD* in Figure 3). It would consequently pay arbitrageurs to *buy* forward exchange of the first maturity and simultaneously *sell* it spot. This, let it be noted, is interest arbitrage in the *opposite* direction from that occurring between the spot market and the forward market of longest maturity. It tends to depress the spot rate and raise r_1 above $\bar{r}$. Similar readjustments will occur on all other forward markets. Equilibrium can only be maintained if arbitrageurs buy and sell spot and forward exchange for different maturities in such quantities that the forward rates swing into line with the term structure required by the prevailing interest differential. Perhaps paradoxically, the arbitrage funds between the spot rate and the closer forward rates flow "uphill" from the rest of the world to domestic banks where interest rates are *lower*. At the same time, interest arbitrage for longer maturities moves in the opposite direction, the one traditionally regarded as the only possible one.

The question may be asked whether it is really necessary for the new term structure of forward rates to center around the previous exchange rate $\bar{r}$. Why should it not be possible, say, for domestic currency to depreciate only on the spot market and appreciate in differing proportions on *all* forward exchange markets in such a way that the required term structure of forward rates is brought about (in the manner indicated by the line *EF*, parallel to *BD*, in the bottom half of Figure 3)? It would appear that the apparent paradox of capital flowing "uphill" to the country with lower interest rates would not arise in that case.

One can easily convince oneself, however, that a term structure of this kind is ruled out unless the excess-demand functions of commercial trade on spot and forward markets differ radically from each other in a most unusual way: for our case, the elasticity of excess demand for spot exchange from commercial sources would have to be

several times the average elasticity of commercial excess demand in forward markets. If these elasticities are not too different (or if the spot-market elasticities are even lower than the average of the forward elasticities, as they might well be), a term structure of forward rates of the type indicated by the line *EF* would conflict with condition (12) above, which requires that the algebraic sum of the discounted present values of the amounts of forward exchange offered by interest arbitrageurs has to equal their demand for spot exchange. If all arbitrageurs attempted to acquire spot exchange against their sales of forward exchange of different maturities, the spot rate would be driven up in much too high a proportion (that is, domestic currency would depreciate by far too much on the spot market) to agree with the required term structure. The difference between the spot and the closer forward rates would attain a level that would still leave possibilities of profitable arbitrage in the form of purchases of forward exchange of shorter maturities and sales of spot exchange.

We have established that, given a sufficient number of appropriately spaced forward markets, the closer forward rates will move in the same direction (by reference to the previous equilibrium) as the spot rate. It might be added that the required term structure of forward rates in the example we have discussed would not necessarily have to be brought about exclusively by arbitrage between spot and forward markets. There might conceivably also be arbitrage between different forward markets. The mechanics of such "differential forward arbitrage" have already been described in Section 4.4. They are so complicated, however, as to make it appear rather unlikely that such transactions will ever substitute for ordinary interest arbitrage which, as we have just seen, is perfectly adequate for the task of realizing the equilibrium conditions.

It is thus seen that the immediate countercyclical effect of monetary policy through the foreign-trade mechanism will not soon be counterbalanced by trade flows in the opposite direction. The improvement in the balance on current account that is prompted by monetary expansion in a system of flexible exchange rates is certain to be sustained over a fairly long period. It must also be borne in mind that the central bank is, when exchange rates are not pegged, perfectly free to apply easier credit conditions at any later time, in case the delayed foreign-trade effects eventually go too far in the opposite direction. The distinguishing feature of monetary policy in a regime

of flexible exchange rates is, to summarize our conclusions, that it becomes effective almost instantaneously as a consequence of the foreign-trade effect of the induced exchange-rate adjustments. Monetary policy can always be adjusted daily to changing conditions, with the assurance that its effects will be appropriate to the requirements of the day rather than being felt only with a delay of many months—a shortcoming often felt only too acutely by governments and central banks under the present system.

The issue analyzed above is, however, not to be confused with the question of the *feasibility* of a given change of interest rates. It is by now generally realized that the scope for independent monetary action in a system of pegged exchange rates and full currency convertibility is severely limited by the requirement that monetary reserves must not fall below zero. The present argument is not concerned with the question of whether or not a desired change in monetary policy is *permissible* at all in the light of a country's reserve position, but with the question of the *effectiveness* of a change of a certain magnitude on the level of aggregate demand. The question of feasibility of anticyclical monetary policy in a system of pegged exchange rates will be taken up in Chapter 6 below.

Our analysis must, on the other hand, not be misunderstood as attempting to assert that the foreign-trade effects of a given change in monetary policy will be felt for an indefinite future. Since covered interest arbitrage involves, by definition, a reversible capital movement, the foreign-trade effects we have described will, under otherwise stationary conditions, necessarily peter out. Capital outflows in search of higher interest earnings abroad will eventually be approximately cancelled by the return flows of previous arbitrage commitments. At that time, the traditional effects of interest-rate changes on domestic investment (and possibly consumption) will again dominate. With monetary policy capable of influencing business conditions so much faster when exchange rates are allowed to adjust freely to market conditions, however, these traditional effects on the domestic economy would, if an alert central bank always made full use of its enhanced powers, become considerably less important.

In our analysis of monetary policy up to this point, it was assumed that the excess-demand functions of non-arbitrageurs were unaffected by a change of interest rates. It followed that a change in monetary policy made the spot rate and the closer forward rates move in

a direction opposite to that of the forward rates for the longer maturities. This is not necessarily bound to happen, however. Especially on the more distant forward markets, on which foreign trade in capital goods is likely to be covered to a large extent, the dependence indicated by conditions (10b on page 21 above) will make itself felt. While arbitrage tends to cause *appreciation* of domestic currency on the more distant forward markets when domestic interest rates are lowered, commercial and speculative operations will have the opposite effect. If these latter forces are sufficiently strong, they may cause *depreciation* of domestic currency even on the more distant forward markets; at the very least, they will weaken the tendency toward forward appreciation that is caused by interest arbitrage. Arbitrage will, in turn, cause depreciation of domestic currency on the spot and the closer forward markets by more than the percentage indicated by our earlier analysis. The response of non-arbitrageurs strongly reinforces our previous conclusions concerning the effect of monetary policy on business activity in a system of flexible exchange rates. In Figure 3, the term structure of spot and forward rates might correspond to a line such as *GH*. It will, in any case, lie above the line *BD*.

The view is widely held that banks and foreign-exchange brokers immediately adjust their forward quotations when interest rates change, so that there is no need for movements of arbitrage funds to bring this about. This can surely not describe an equilibrium situation when the exchange markets are reasonably competitive, unless commercial supply and demand for forward and spot exchange show the most peculiar patterns.[31] In our example, in which domestic interest rates were lowered, a reduction of the forward quotations of foreign currencies by brokers without any prior arbitrage would result in excess forward demand for these currencies by commercial traders. This excess demand could not be satisfied by other market participants, for the anticipatory adjustment of forward rates by brokers would remove all profit incentives to arbitrage.

5.3. *The Responsiveness of Capital Flows to Interest-Rate Changes*

An oversight that is not merely of theoretical interest underlies an argument that has recently been forcefully expressed by Sir Roy

[31] This has already been emphasized by Einzig in his *Theory of Forward Exchange* (London: Macmillan, 1937), Chap. XIX, esp. pp. 170-171.

Harrod. "With fixed rates," Sir Roy argues, "seasonal or random deficits, or those due to divergent business cycle trends, can largely be covered by the private movement of short term funds, actuated by the movements in the exchange rates themselves, or by interest rate differentials as between countries. . . . But under the flexible system the risk of exchange fluctuations is too great to allow an uncovered movement of funds under the influence of interest rate differentials; but a covered movement of funds does not operate to fill a gap and therefore gives no help to the authorities. Thus, to maintain order in flexible exchange markets in the short term, it seems certain that the authorities would require larger funds than they do to maintain fixed rates."[32] Sir Roy apparently believes that covered arbitrage, because it involves simultaneous purchases and sales of the same currency, does not constitute a net movement of capital even in the short run. If this were true, it would indeed follow that covered arbitrage cannot compensate for temporary disequilibria in the other components of the balance of payments.

As has been emphasized at length in the preceding sections, all exporters and importers whose contracts do not call for immediate payment would in effect be speculating if they did not cover their future receipts or commitments in forward markets. These traders must necessarily respond to changes of forward rates that are brought about by arbitrage. Even in the absence of speculative activity in forward markets, arbitrageurs will therefore always be able to find partners in those markets. The new equilibrium after a change of the interest differential vis-à-vis the rest of the world will consequently have to come about through an adjustment of *both* spot and forward exchange rates. Contrary to Sir Roy's stated view, covered movements of funds will assuredly serve to fill seasonal and random gaps in a country's foreign accounts if adjustments of interest rates by the country's central bank provide the necessary incentives for them.

[32] R. F. Harrod, "World Reserves," in Francois Bochud and Edgar Salin (eds.), *Fundamentale Fragen künftiger Währungspolitik* (Tübingen: J. C. B. Mohr [Paul Siebeck], 1965), p. 129. See also his recent book *Reforming the World's Money* (London: Macmillan, 1965), Chap. 2.

Sir Roy is here not thinking of a "pure" system of flexible rates, but a hybrid one in which there is some exchange-market intervention by the authorities. Also, he is obviously not comparing this latter system with the one we now have, but an imaginary system in which all speculators have unshakeable faith in the continuity of the established parities at all times.

The impact of the covering forward transactions by arbitrageurs on the balance of payments will only make itself felt at a later date.[33]

The objection might be raised that the elasticities of excess demand by non-arbitrageurs on a particular forward market on which arbitrageurs wish to deal might be very low in the short run. In that case, one might argue, arbitrage movements in response to changes of interest rates would be negligible, since small amounts purchased or sold by interest arbitrageurs would already produce appreciable movements in forward rates. As has been pointed out on earlier occasions, this is not a real danger if several active forward markets are in operation. If large purchases or sales of a particular currency suddenly occurred on one of the forward markets, a tendency of the forward rate in question to move too far would immediately provoke arbitrage operations tending to resist that movement and to distribute its impact over all the other forward markets.

The considerations outlined above should not be misinterpreted as attempting to deny that changes of interest rates will generally have a weaker effect on international short-term capital movements in a system of adjustable exchange rates compared with the classical gold standard or any other arrangement in which currency parities are universally believed to be eternally immutable (this description obviously does not apply to the Bretton Woods system). The margin of error being much smaller in such a system, speculation will be much more willingly forthcoming when an exchange rate is at or close to one of the limits of fluctuation. In a system of pegged exchange rates that are universally believed never to move beyond the established margins of fluctuation, the supply of speculative funds can, in fact, be assumed to be almost perfectly elastic at these margins. This explains the swift response of short-term capital flows to interest-rate changes under the classical gold standard. Though less than infinite, the interest elasticity of arbitrage flows will assuredly not be zero when currency parities are not immutably fixed. This is borne out well by the Canadian experience.[34]

[33] The view expressed by Harrod was earlier stated by Keynes and Kindleberger, among others. See *Tract on Monetary Reform* (London: Macmillan, 1923), pp. 137-138; and C. P. Kindleberger, "Speculation and Forward Exchange," *Journal of Political Economy*, Vol. 47 (1939), pp. 163-181.

[34] See R. R. Rhomberg, "A Model of the Canadian Economy under Fixed and Fluctuating Exchange Rates," *Journal of Political Economy*, Vol. 72 (1964), pp. 1-31.

6. CENTRAL-BANK INTERVENTIONS ON SPOT AND FORWARD MARKETS

6.1. *Proposals for Forward-Market Intervention*

It is an elementary exercise to deduce the effect of a sale or purchase of foreign exchange by the monetary authorities on either the spot market or any one of the forward markets. An additional offer of foreign exchange on any market tends to depress the rating of the foreign currency and leads to readjustments of all economic variables that depend on the exchange rate in question. Other things being equal, the cheapening of imports tends to increase the country's net demand for those commodities whose traders customarily use this particular market. The realization that foreign currencies have become cheaper than they otherwise would have been will also encourage rather than discourage speculators to increase their foreign-exchange position for this maturity. The demand by interest arbitrageurs on the market in question will, with interest rates being unchanged, increase as well. The simultaneous sale of foreign exchange of other maturities by these arbitrageurs will depress the rating of foreign currencies on all other forward markets as well as the spot market.

The *Articles of Agreement* of the International Monetary Fund specify an obligation of each member country to hold spot exchange rates within a margin of one per cent to both sides of the established parity, but do not stipulate any limits of variation for forward exchange rates (Art. IV, sec. 3). Proposals have been made over the years, for a number of different reasons, to extend central-bank intervention also to forward markets.

Among economists, Keynes was probably the earliest advocate of forward intervention. He proposed management of forward exchange rates by central banks so as to create a spread between the effective interest rates for short-term investment in the domestic and foreign money markets whenever this appears desirable.[35] Keynes was primarily concerned with the objective of preserving an adequate international-liquidity position without the painful constraints that

[35] *Treatise on Money* (London: Macmillan, 1930), Vol. 2, pp. 325-327. This proposal is hinted at in the *Tract on Monetary Reform* (London: Macmillan, 1923), pp. 135 and 192.

may have to be imposed on an economy if monetary policy is used exclusively toward the equilibration of a country's international accounts. By appropriate interventions in forward markets, the central bank may gain greater freedom for its countercyclical policies.

In the late 1950's, Keynes's early proposals were taken up by a number of British authors. Jasay and Spraos, in particular, have criticized the policy of letting the forward rate fluctuate freely while pegging the spot rate.[36] They pointed out correctly that it was primarily nonspeculative interest arbitrage and not, as most observers were prone to believe, speculation that led to the rapid depletion of British gold and foreign-exchange reserves on several occasions. If the spot rate of exchange is held within narrow limits while the forward rate is free to move, the hedging operations of commercial traders in forward markets may at certain times produce a degree of depreciation of a currency on all forward markets that exceeds the prevailing interest differential. It will then become profitable to buy foreign currency spot and sell it forward. Given the negligible cost of arbitrage operations, even a relatively small increase in the forward discount of domestic currency beyond the margin set by interest differentials may produce a huge volume of arbitrage transactions that will melt away a country's international reserves at frightening speed. By forward sales of foreign exchange, the domestic central bank could reduce the forward discount for domestic currency sufficiently to make such arbitrage operations unprofitable. In this manner, the central bank could avoid a run on its reserves. It would be able to do this only by assuming an equal obligation to deliver foreign

[36] "Exchange Policy in the Forward Market," contributions by A. E. Jasay, J. Spraos, and Anonymous, *The Banker*, Vol. 108 (1958); A. E. Jasay, "Making Currency Reserves 'Go Round,'" *Journal of Political Economy*, Vol. 66 (1958), pp. 353-356 and "Bank Rate or Forward Exchange Policy," *Banca Nazionale del Lavoro Quarterly Review* (March 1958), pp. 56-73; J. Spraos, "Speculation, Arbitrage and Sterling," *Economic Journal*, Vol. 69 (1959), pp. 1-21. See also S. C. Tsiang, "The Theory of Forward Exchange and Effects of Government Intervention on the Forward Exchange Market," *International Monetary Fund Staff Papers*, Vol. 7 (1959), pp. 99-106; B. Hansen, "Interest Policy and Foreign Exchange Policy" and "Interest Policy, Foreign Exchange Policy and Foreign-Exchange Control," *Skandinaviska Banken Quarterly Review* (1958), pp. 114-122, and (1959), pp. 15-28; *Report of the Committee on the Working of the Monetary System* (Radcliffe Committee), London: H.M. Stationery Office, 1959, pp. 254-257, and its *Principal Memoranda of Evidence*, Vols. I and III. These ideas were revived in the United States as the American balance-of-payments difficulties developed. See especially J. H. Auten, "Counter-Speculation and the Forward Exchange Market," *Journal of Political Economy*, Vol. 69 (1961), pp. 49-55.

exchange at a later date, but this is at least no worse than an immediate exhaustion of reserves.

As long as the preservation of a given currency parity is regarded as a desirable policy objective, and as long as a central bank is determined to defend this parity at all costs, there is no convincing reason for limiting official stabilizing interventions to spot exchange rates. Under these conditions, pressure on the currency would only be a temporary matter. Periods of excess demand for foreign exchange would alternate with periods of excess supply. Balance-of-payments disturbances being only transitory affairs, the central bank would never have any difficulty in honoring its forward commitments. If it is official policy to keep exchange rates truly and permanently stable, it might be preferable, in fact, to stabilize only *forward* rather than spot rates. This follows from the fact that, for most commercial traders, absence of exchange risks would require the stability of *forward* rather than spot exchange rates (see Chapter I above).

It could be argued, of course, that stabilization of spot exchange rates alone ought to be quite sufficient to guarantee a high degree of stability of all forward rates as well, because interest arbitrage will never permit deviations of forward from spot rates by more than the rather minor premia or discounts due to interest differentials. This would be true if central banks could always be counted upon to permit unrestricted movement of arbitrage funds. This is patently not the case under present conditions, however. Precisely at times when a currency is under pressure and when the risk of a parity change is consequently greatest, central banks usually do everything in their power to discourage all forward transactions that are not directly related to commercial trade. This is done in order to prevent too rapid a depletion of foreign-exchange reserves, and it is usually done all the more readily because it is widely believed that every forward transaction unrelated to trade must necessarily be prompted by speculative motives that do not deserve official approval. The inevitable consequence of this policy is that forward markets dry up and allow commercial traders to cover forward only at prohibitive cost.[37]

[37] In recent years, some central banks appear to have become much more open-minded in this respect. Especially the American and German monetary authorities have occasionally been quite active in the forward exchange markets. See P. Einzig, "Some Recent Developments in Official Forward Exchange Operations," *Economic Journal*, Vol. 73 (1963), pp. 241-253; C. A. Coombs, "Treasury and Federal Reserve Foreign Exchange Operations," *Federal Reserve Bulletin*, Vols.

6.2. *Forward-Market Intervention and International Liquidity*

A voluminous literature has developed over the past decade on the question of whether or not there is an adequate supply of "international liquidity." Our analysis of forward exchange markets should have shown that it is entirely wrong to regard the available gold and foreign-exchange reserves (together with immediate drawing rights at the International Monetary Fund and other international agencies) as appropriate indicators of the "international liquidity" at a country's disposal at any given time. Even when stabilization of *spot* rates of exchange is the main objective of central banks, they can achieve this objective by exclusive intervention in *forward* rather than spot exchange markets. A central bank need not hold any gold or foreign exchange for this purpose.[38]

The only reason why one might be skeptical about the wisdom of central-bank activity in forward markets is that a central bank (and hence, one step removed, the country's taxpayers) might incur huge losses if it assumes large forward commitments and nevertheless finds out in the end that it is unable to preserve the established parity. If a country resorts to official sales of forward exchange in order to fight a tendency for its currency to depreciate, this cannot fail to encourage imports and discourage exports, as compared with what would have happened if forward rates had been free to find their equilibrium levels. If the currency is devalued eventually, the central bank will have to honor its commitments to deliver foreign exchange at lower prices than the ones it will itself have to pay after the parity change.[39]

If this is regarded as a convincing argument against official intervention in forward markets, it is equally compelling as an argument

---

48, 49, 50, and 51 (March and September issues); E. Brehmer, "Official Forward Exchange Operations. The German Experience," *International Monetary Fund Staff Papers*, Vol. 11 (1964), pp. 389-411; and various recent issues of *Monatsberichte der Deutschen Bundesbank*.

[38] As emphasized before, forward interventions by central banks should never be more than a means of correcting temporary disturbances. But spot-market interventions, the only *raison d'être* for holding international reserves, are equally out of place if they are designed to correct anything but disturbances of a merely temporary nature.

[39] This has often been emphasized as an argument against forward intervention. In particular, see S. C. Tsiang, "The Theory of Forward Exchange and Effects of Government Intervention on the Forward Exchange Market," *International Monetary Fund Staff Papers*, Vol. 7 (1959), pp. 102-106; and O. Braun, "Zur Theorie des Devisenterminmarktes," *Jahrbücher für Nationalökonomie und Statistik*, Vol. 177 (1965), pp. 149-152.

against the pegging of spot exchange rates. The reestablishment of the previous level of international reserves after the drain which usually occurs before a government decides to devalue involves the same loss to taxpayers per dollar of exchange reserves as the percentage that is lost on the central bank's forward commitments. The only consideration that is possibly relevant is that the opportunity to postpone devaluation that is provided by forward as compared to spot market intervention might induce some central banks to commit themselves to a much larger extent than they would be able to as long as interventions are limited to the level of exchange reserves and immediate drawing rights at international institutions. Every form of increasing international liquidity is open to precisely the same objections, however.

It might be added, in conclusion, that all pronouncements of governments and central bankers that currency parities will be maintained, come what may, will necessarily be met with disbelief if they refuse at the same time to stabilize forward exchange rates not only for short, but also for medium and long maturities, by official market intervention. As long as currency parities are maintained, support operations on forward markets at the officially established limits of fluctuation would not only cost the central bank nothing, but would usually even be profitable, for the spot price of foreign currencies at any time would never be higher than the rate at which it has committed itself to deliver it. An analogy is often drawn between a system of fixed exchange rates and a single-currency area, and certain advantages of the latter are then also claimed for the former. It is almost always forgotten that a single-currency area is characterized not only by constant spot "exchange rates," but also by constant "forward rates" for any desired maturity. Without a binding obligation to hold not only spot, but also forward exchange rates for many years ahead rigidly constant (with an assurance of unlimited currency convertibility), a system of pegged spot rates may develop characteristics that are much further removed from those found within a single-currency area than almost any other imaginable form of international monetary management.

APPENDIX

STABILITY AND UNIQUENESS OF EXCHANGE-MARKET EQUILIBRIUM

Assuming again that domestic and foreign interest rates for all maturities are given and that the monetary authorities abstain from intervention in the exchange markets, writing E_j for the excess supply functions of non-arbitrageurs, $X_j - M_j + S_j$, and B_j for $A_j e^{-i_{ft_j} t_j}$, the discounted present values of the net supply by arbitrageurs in each market, we can substitute (12) in the first equation of (11) on page 21 to obtain the system.

$$\begin{aligned} E_o(r_o) &- B_1(r_1 - r_o) - \ldots - B_n(r_n - r_o) = 0 \\ E_1(r_1) &+ A_1(r_1 - r_o) = 0 \\ E_n(r_n) &+ A_n(r_n - r_o) = 0 \end{aligned}$$

Gale and Nikaidô have shown that such a system of $(n+1)$ equations is uniquely solvable for the $(n+1)$ unknowns ($r_o, r_1, \ldots r_n$ in our case) if all the principal minors of its Jacobian matrix are positive for all possible values of the unknowns.[40] In our case, the Jacobian is

$$\begin{bmatrix} \left(E'_o + \sum_{j=1}^{n} B'_j\right) & -B'_1 & -B'_2 & \ldots & -B'_n \\ -A'_1 & (E'_1 + A'_1) & 0 & \ldots & 0 \\ -A'_2 & 0 & (E'_2 + A'_2) & \ldots & 0 \\ \vdots & \vdots & \vdots & & \vdots \\ -A'_n & 0 & 0 & \ldots & (E'_n + A'_n) \end{bmatrix}$$

where $E'_j = \dfrac{\partial E_j}{\partial r_j}$, $A'_j = \dfrac{\partial A_j}{\partial (r_j - r_o)}$ and $B'_j = \dfrac{\partial B_j}{\partial (r_j - r_o)}$.

[40] D. Gale and H. Nikaidô, "The Jacobian Matrix and Global Univalence of Mappings," *Mathematische Annalen*, vol. 159 (1965), pp. 81-93. This article corrects an earlier conjecture by Samuelson that the nonvanishing of the left-hand principal minors of the Jacobian guarantees uniqueness. See P. A. Samuelson, "Prices of Factors and Goods in General Equilibrium," *Review of Economic Studies*, vol. 21 (1953-54), pp. 16-17.

This determinant as well as its principal minors will be positive whenever all the $E'_j s$ and $A'_j s$ are always positive. This completes the proof of the statement on page 21 above. It is easily seen that positivity of the slopes of the excess-supply functions is not necessary for uniqueness of solution. Negativity of one or more of the $\frac{\partial E_j}{\partial r_j}$'s over certain ranges may be compensated for by sufficient responsiveness of arbitrage supply on the forward markets.

It is intuitively clear that a unique equilibrium will also be stable. This may be shown formally, along familiar lines, by dynamizing our system of equations above and retaining only linear terms. The matrix of coefficients of the resulting system of differential equations can be derived from the Jacobian matrix above by multiplying each of its rows by the (negative) speed of adjustment in the associated (spot or forward) exchange market. In the normal case, this matrix has negative entries in the main diagonal while all off-diagonal elements are nonnegative. It has been shown by Metzler that systems of this type are always stable if consecutive principal minors alternate in sign.[41] It is readily verified that our system also fulfills this latter condition.

[41] L. A. Metzler, "Stability of Multiple Markets: The Hicks Conditions," *Econometrica*, Vol. 13 (1945), pp. 285-290. The case treated by Metzler concerns matrices whose off-diagonal entries are strictly positive, but his proof is easily extended to matrices with nonnegative elements outside the principal diagonal.

In preparing this Appendix, I have benefited from discussions with my colleague, Hans Schneeweiss.

PUBLICATIONS OF THE INTERNATIONAL FINANCE SECTION

The International Finance Section publishes at irregular intervals papers in four series: ESSAYS IN INTERNATIONAL FINANCE, PRINCETON STUDIES IN INTERNATIONAL FINANCE, SPECIAL PAPERS IN INTERNATIONAL ECONOMICS and REPRINTS IN INTERNATIONAL FINANCE. All four of these may be ordered directly from the Section.

Single copies of the ESSAYS and REPRINTS are distributed without charge to all interested persons, both here and abroad. Additional copies of any one issue may be obtained from the Section at a charge of $0.25 a copy, payable in advance. This charge may be waived to foreign institutions of education or research.

For the STUDIES and SPECIAL PAPERS there will be a charge of $1.00 a copy. This charge will be waived on copies distributed to college and university libraries here and abroad. In addition, the charge is sometimes waived on single copies requested by persons residing abroad who find it difficult to make remittance.

For the convenience of our British customers, arrangements have been made for retail distribution of the STUDIES and SPECIAL PAPERS through the Economists' Bookshop, Portugal Street, London, W.C. 2; and Blackwells, Broad Street, Oxford. These booksellers will usually have our publications in stock.

A mailing list is maintained for the distribution of ESSAYS and REPRINTS as they are issued and of announcements of new issues in the series of STUDIES and SPECIAL PAPERS. Requests for inclusion in this list will be honored, except that students will not be placed on the permanent mailing list, because waste results from frequent changes of addresses.

The following is a complete list of the publications of the International Finance Section. The issues of the four series that are still available from the Section are marked by asterisks. Those marked by daggers are out of stock at the International Finance Section but may be obtained in xerographic reproductions (that is, looking like the originals) from University Microfilms, Inc., 313 N. First Street, Ann Arbor, Michigan 48107. (Most of the issues are priced at $3.00.)

†No. 1. Friedrich A. Lutz, International Monetary Mechanisms: The Keynes and White Proposals. (July 1943)
† 2. Frank D. Graham, Fundamentals of International Monetary Policy. (Autumn 1943)
† 3. Richard A. Lester, International Aspects of Wartime Monetary Experience. (Aug. 1944)
† 4. Ragnar Nurkse, Conditions of International Monetary Equilibrium. (Spring 1945)
† 5. Howard S. Ellis, Bilateralism and the Future of International Trade. (Summer 1945)
† 6. Arthur I. Bloomfield, The British Balance-of-Payments Problem. (Autumn 1945)
† 7. Frank A. Southard, Jr., Some European Currency and Exchange Experiences. (Summer 1946)
† 8. Miroslav A. Kriz, Postwar International Lending. (Spring 1947)
† 9. Friedrich A. Lutz, The Marshall Plan and European Economic Policy. (Spring 1948)
† 10. Frank D. Graham, The Cause and Cure of "Dollar Shortage." (Jan. 1949)
† 11. Horst Mendershausen, Dollar Shortage and Oil Surplus in 1949-1950. (Nov. 1950)
† 12. Sir Arthur Salter, Foreign Investment. (Feb. 1951)
† 13. Sir Roy Harrod, The Pound Sterling. (Feb. 1952)
† 14. S. Herbert Frankel, Some Conceptual Aspects of International Economic Development of Underdeveloped Territories. (May 1952)
† 15. Miroslav A. Kriz, The Price of Gold. (July 1952)
† 16. William Diebold, Jr., The End of the I.T.O. (Oct. 1952)
† 17. Sir Douglas Copland, Problems of the Sterling Area: With Special Reference to Australia. (Sept. 1953)
† 18. Raymond F. Mikesell, The Emerging Pattern of International Payments. (April 1954)
† 19. D. Gale Johnson, Agricultural Price Policy and International Trade. (June 1954)
† 20. Ida Greaves, "The Colonial Sterling Balances." (Sept. 1954)
† 21. Raymond Vernon, America's Foreign Trade Policy and the GATT. (Oct. 1954)
† 22. Roger Auboin, The Bank for International Settlements, 1930-1955. (May 1955)
† 23. Wytze Gorter, United States Merchant Marine Policies: Some International Implications. (June 1955)
† 24. Thomas C. Schelling, International Cost-Sharing Arrangements. (Sept. 1955)
† 25. James E. Meade, The Belgium-Luxembourg Economic Union, 1921-1939. (March 1956)
† 26. Samuel I. Katz, Two Approaches to the Exchange-Rate Problem: The United Kingdom and Canada. (Aug. 1956)
† 27. A. R. Conan, The Changing Pattern of International Investment in Selected Sterling Countries. (Dec. 1956)
† 28. Fred H. Klopstock, The International Status of the Dollar. (May 1957)
† 29. Raymond Vernon, Trade Policy in Crisis. (March 1958)
† 30. Sir Roy Harrod, The Pound Sterling, 1951-1958. (Aug. 1958)

† 31. Randall Hinshaw, Toward European Convertibility. (Nov. 1958)
† 32. Francis H. Schott, The Evolution of Latin American Exchange-Rate Policies since World War II. (Jan. 1959)
† 33. Alec Cairncross, The International Bank for Reconstruction and Development. (March 1959)
† 34. Miroslav A. Kriz, Gold in World Monetary Affairs Today. (June 1959)
† 35. Sir Donald MacDougall, The Dollar Problem: A Reappraisal. (Nov. 1960)
† 36. Brian Tew, The International Monetary Fund: Its Present Role and Future Prospect. (March 1961)
† 37. Samuel I. Katz, Sterling Speculation and European Convertibility: 1955-1958. (Oct. 1961)
† 38. Boris C. Swerling, Current Issues in International Commodity Policy. (June 1962)
† 39. Pieter Lieftinck, Recent Trends in International Monetary Policies. (Sept. 1962)
† 40. Jerome L. Stein, The Nature and Efficiency of the Foreign Exchange Market. (Oct. 1962)
† 41. Friedrich A. Lutz, The Problem of International Liquidity and the Multiple-Currency Standard. (March 1963)
† 42. Sir Dennis Robertson, A Memorandum Submitted to the Canadian Royal Commission on Banking and Finance. (May 1963)
† 43. Marius W. Holtrop, Monetary Policy in an Open Economy: Its Objectives, Instruments, Limitations, and Dilemmas. (Sept. 1963)
† 44. Harry G. Johnson, Alternative Guiding Principles for the Use of Monetary Policy. (Nov. 1963)
† 45. Jacob Viner, Problems of Monetary Control. (May 1964)
† 46. Charles P. Kindleberger, Balance-of-Payments Deficits and the International Market for Liquidity. (May 1965)
* 47. Jacques Rueff and Fred Hirsch, The Role and the Rule of Gold: An Argument. (June 1965)
* 48. Sidney Weintraub, The Foreign-Exchange Gap of the Developing Countries. (Sept. 1965)
* 49. Tibor Scitovsky, Requirements of an International Reserve System. (Oct. 1965)
* 50. John H. Williamson, The Crawling Peg. (Dec. 1965)
* 51. Pieter Lieftinck, External Debt and Debt-Bearing Capacity of Developing Countries. (March 1966)
* 52. Raymond F. Mikesell, Public Foreign Capital for Private Enterprise in Developing Countries. (April 1966)
* 53. Milton Gilbert, Problems of the International Monetary System. (April 1966)
* 54. Robert V. Roosa and Fred Hirsch, Reserves, Reserve Currencies, and Vehicle Currencies: An Argument. (May 1966)

PRINCETON STUDIES IN INTERNATIONAL FINANCE

†No. 1. Friedrich A. and Vera C. Lutz, Monetary and Foreign Exchange Policy in Italy (Jan. 1950)
† 2. Eugene A. Schlesinger, Multiple Exchange Rates and Economic Development. (May 1952)
† 3. Arthur I. Bloomfield, Speculative and Flight Movements of Capital in Postwar International Finance. (Feb. 1954)

† 4. Merlyn N. Trued and Raymond F. Mikesell, Postwar Bilateral Payments Agreements. (April 1955)
† 5. Derek Curtis Bok, The First Three Years of the Schuman Plan. (Dec. 1955)
† 6. James E. Meade, Negotiations for Benelux: An Annotated Chronicle, 1943-1956. (March 1957)
† 7. H. H. Liesner, The Import Dependence of Britain and Western Germany: A Comparative Study. (Dec. 1957)
† 8. Raymond F. Mikesell and Jack N. Behrman, Financing Free World Trade with the Sino-Soviet Bloc. (Sept. 1958)
† 9. Marina von Neumann Whitman, The United States Investment Guaranty Program and Private Foreign Investment. (Dec. 1959)
† 10. Peter B. Kenen, Reserve-Asset Preferences of Central Banks and Stability of the Gold-Exchange Standard. (June 1963)
* 11. Arthur I. Bloomfield, Short-Term Capital Movements under the Pre-1914 Gold Standard. (July 1963)
* 12. Robert Triffin, The Evolution of the International Monetary System: Historical Reappraisal and Future Perspectives. (June 1964)
* 13. Robert Z. Aliber, The Management of the Dollar in International Finance. (June 1964)
* 14. Weir M. Brown, The External Liquidity of an Advanced Country. (Oct. 1964)
* 15. E. Ray Canterbery, Foreign Exchange, Capital Flows, and Monetary Policy. (June 1965)
* 16. Ronald I. McKinnon and Wallace E. Oates, The Implications of International Economic Integration for Monetary, Fiscal, and Exchange-Rate Policy. (March 1966)
* 17. Egon Sohmen, The Theory of Forward Exchange. (July 1966)

SPECIAL PAPERS IN INTERNATIONAL ECONOMICS

*No. 1. Gottfried Haberler, A Survey of International Trade Theory. (Sept. 1955; Revised edition, July 1961)
† 2. Oskar Morgenstern, The Validity of International Gold Movement Statistics. (Nov. 1955)
* 3. Fritz Machlup, Plans for Reform of the International Monetary System. (April 1962; Revised edition, March 1964)
† 4. Egon Sohmen, International Monetary Problems and the Foreign Exchanges. (April 1963)
† 5. Walther Lederer, The Balance on Foreign Transactions: Problems of Definition and Measurement. (Sept. 1963)
* 6. George N. Halm, The "Band" Proposal: The Limits of Permissible Exchange Rate Variations. (Feb. 1965)
* 7. W. M. Corden, Recent Developments in the Theory of International Trade. (March 1965)

REPRINTS IN INTERNATIONAL FINANCE

* 1. Fritz Machlup, The Cloakroom Rule of International Reserves: Reserve Creation and Resources Transfer. [Reprinted from *Quarterly Journal of Economics*, Vol. LXXIX (Aug. 1965)]
† 2. Fritz Machlup, Real Adjustment, Compensatory Corrections, and Foreign Financing of Imbalances in International Payments. [Reprinted from

Robert E. Baldwin *et al., Trade, Growth, and the Balance of Payments* (New York: Rand McNally and Amsterdam: North-Holland Publishing Co., 1965)]

* 3. Fritz Machlup, International Monetary Systems and the Free Market Economy. [Reprinted from *International Payments Problems: A Symposium* (Washington, D.C.: American Enterprise Institute, 1966)]

SEPARATE PUBLICATIONS

† (1) Klaus Knorr and Gardner Patterson (editors), A Critique of the Randall Commission Report. (1954)

† (2) Gardner Patterson and Edgar S. Furniss, Jr. (editors), NATO: A Critical Appraisal. (1957)

* (3) Fritz Machlup and Burton G. Malkiel (editors), International Monetary Arrangements: The Problem of Choice. Report on the Deliberations of an International Study Group of 32 Economists. (Aug. 1964)

$1.00