International Short-Term Capital Movements: A Survey of Theory and Empirical Analysis

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COMPARED WITH THE TREATMENT of international trade, the analysis of international capital movements is still in a rudimentary stage of development. Over the past two decades, important advances have been made in both the theoretical and econometric studies of the trade balance, making possible a fairly rigorous statistical inquiry and quantitative projections on an individual country level and on a general equilibrium multicountry basis. Nothing comparable is as yet possible for the capital account.

However, recent years have seen some tangible progress in the theory and empirical analysis of short-term capital movements. Such progress reflects to some extent a fairly rich experience in coping, during the interwar period, with short-term capital movements of all kinds. However, the major influence has been the increasing attention paid, since the 1950s, to the role of short-term capital flows in the balance of payments adjustment process and to the effect of the increased capital mobility on domestic monetary and fiscal policies of industrial countries. Recent developments in monetary theory and in econometric techniques have contributed also to a more rigorous analysis of the role of short-term capital movements in the equilibrium on the foreign exchange market. Furthermore, these developments have permitted a more systematic quantitative analysis of the determinants of short-term capital movements.

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Short-term capital movements play a much more important role in the domestic and international adjustment processes of industrial countries, partly because these countries have highly developed foreign exchange and short-term capital markets and partly because they allow substantially greater freedom of short-term capital transactions than is true in many less developed countries. For this reason, this survey is limited to short-term capital movements among industrial countries. Furthermore, although international capital movements infringe on a vast area of domestic and international monetary policies, such policy issues as intervention by monetary authorities in the forward exchange markets, or such problems as the analysis of the functioning and the institutional developments of the Euro-currency markets, are outside the scope of this survey.

I. Theory

1. Short-term capital movements in the international adjustment mechanism

At the turn of the century, there was already some discussion of the role of short-term capital movements in the balance of payments adjustment mechanism and of their effect on the monetary policy of countries participating in trade. This discussion proceeded within the framework of the classical price specie-flow theory and of the more modern quantity theory of money applied to an open economy. Basic to the working of the price specie-flow theory was the assumption of a rather high flexibility of prices and production costs, which enabled them to respond to movements of gold and foreign exchange; the resulting adjustments in trade flows could thereby correct an initial balance of payments disequilibrium. The essential ingredients in such a process were (a) the effect of reserve movements (whether specie or foreign exchange) on the domestic money supply and (b) the resulting adjustment between relative interest rate changes, on the one hand, and prices and reserve movements, on the other hand.[1] Short-term capital movements in this system

[1] See Taussig (1927, Ch. 17), Angell (1926, pp. 402 ff.), Beach (1935, Chs. IV and IX), and Kindleberger (1937, Chs. II and III). Hawtrey (1950, pp. 108 ff.) presented a view that was more in accordance with the more recent intepretation of the adjustment mechanism. A balance of payments deficit, in his analysis, was caused by the expansion of domestic demand and price inflation in the late

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were determined essentially by international differences in yields. Flows responding to yield differentials played an important role in the classical adjustment mechanism because they were thought to *economize* international reserves, to provide a temporary relief to the current account adjustment process, and to facilitate the transfer of real resources that are associated with long-term capital movements.[2] Nurkse called such capital movements "equilibrating" because, in his opinion, they helped to restore a temporary equilibrium in the balance of payments.[3] However, under the gold exchange standard, short-term capital movements also responded to expectations of exchange rate adjustments. Such movements were defined by Nurkse as "disequilibrating" because they *generated* flows of gold and foreign exchange and tended to aggravate the balance of payments disequilibrium.[4]

The classical adjustment mechanism assumed that central banks would have a passive role; they were supposed to provide merely a clearing function between the domestic currency and desired foreign currencies or gold. In most countries, central banks were also supposed to follow the "rules of the game"; they were required to manage domestic money supply in accordance with the constraints imposed by a gold and/or foreign exchange reserve ratio as prescribed by their domestic legislation.

A major shortcoming in this rather incomplete view of the complexities in the international and domestic adjustment processes was that

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expansionary phase of the cycle. An increase in the demand for money, on the one hand, and a loss of foreign exchange, on the other hand, generated a credit stringency and caused an upward movement of interest rates. From this point, his analysis generally followed the line of the classical price specie-flow theory. See also Beach's criticism (1935, pp. 173 ff.).

[2] In the period when the income effect was not yet recognized in the international adjustment mechanism, classical economists were puzzled because the size of observed international gold flows was inadequate to explain fairly rapid and smooth adjustment of payment disequilibria during the period of the gold standard. (See, e.g., Viner (1924, pp. 177 ff.), Angell (1926, pp. 173 and 400), and Taussig (1927, p. 239).) Such behavior was explained mainly by equilibrating short-term capital movements, Angell (1926, pp. 410 ff.), Taussig (1927, pp. 215–20), League of Nations (1944, p. 100), and Bloomfield (1959, pp. 41–42).

[3] League of Nations (1944, pp. 15–16, and p. 72, footnote 1).

[4] More recent analysis has shown, however, that capital movements responding to differences in yield do not necessarily play an equilibrating role in the balance of payments and that disequilibrating speculative flows do not necessarily generate pressure on the balance of payments in the same direction as the trade balance. The higher the interest elasticity of a short-term capital movement, the greater is the probability that the effect of interest arbitrage may be disequilibrating on the balance of payments. For a discussion on this point, see Argy and Hodjera (1973, pp. 14–21) and Hodjera (1973).

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economies were exposed to severe fluctuations in domestic credit and employment in response to a change in the country's international reserves. Nevertheless, the classical adjustment mechanism provided a theoretical framework integrating the monetary and real sectors of national economies into an international equilibrium system that involved in a basic way both the current and capital accounts of the balance of payments. Furthermore, because of a fair amount of downward price flexibility in the period preceding World War I and a degree of flexibility in applying reserve requirements by central banks and the banking systems in most countries, the system had functioned fairly satisfactorily.

The flaws in the classical adjustment mechanism became particularly evident during the unsettled period of the gold exchange standard in the 1920s and during the severe balance of payments crises caused by the world depression in the 1930s. The monetary authorities of the major industrial countries attempted to protect their monetary sector and their domestic credit policies from erratic shifts in gold and foreign exchange induced by the effect of these disturbances on speculative behavior and on the balance of trade. Neutralization of the effects of international reserve movements on the domestic money supply permitted a degree of insulation of the domestic economy from the vagaries of gold flows, but it also perpetuated balance of payments disequilibria and further intensified destablizing speculative pressures. Substantial speculative short-term capital movements and capital flight, which were aggravated considerably by the lack of cooperation between major countries, forced monetary authorities to undertake severe protective measures that ended in competitive devaluations, in widespread controls that severely curtailed capital movements and foreign trade, and, finally, in the almost complete breakdown of the interwar system that was based on the gold exchange standard.

These experiences with speculative capital movements made free short-term capital movement suspect as an instrument in the adjustment process during the postwar reconstruction of the international monetary system.[5] As restrictions on exchange and trade transactions were lifted gradually in the 1950s, attempts were made again to integrate the short-term capital account as an operational part of the balance of pay-

[5] In 1947 (p. 289), Nurkse wrote: "There is now almost universal agreement that capital movements of the unbalancing kind—speculative transfers and capital flights—had better be subjected to control."

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ments theory.[6] Such efforts were directed toward two major areas of theoretical analysis. One involved attempts to define rigorously the mechanism of short-term financial flows as an integral part of the foreign exchange market and to specify the forces that determine such flows. This survey is concerned mainly with the discussion of developments in this area. The other area of analysis involved attempts to integrate national monetary sectors into a modern theory of the balance of payments adjustment. We shall briefly examine these attempts also, to the extent that they involve the theory of short-term capital movements.

2. Short-Term Capital Movements and the Foreign Exchange Market

In the gold standard period, which was characterized by a remarkable stablility in exchange rates, there was little interest in analyzing the mechanism of short-term capital movements beyond an a priori assumption that they responded to interest rate differentials.[7] However, unpredictable movements in exchange rates during the 1920s made it mandatory to acquire forward cover for international financial transactions. Keynes was the first to see the importance of a developed forward market under conditions of exchange rate uncertainty as (1) a facility that would eliminate exchange risk from foreign trade finance and thus stimulate trade and (2) an instrument that, to some extent, could insulate domestic interest rate policy from the vagaries of gold and speculative capital flows.[8] Keynes's interest in the forward market was basically pragmatic, and he did not enter into a more rigorous theoretical analysis of the problem.[9] Others provided institutional analysis of

[6] See Meade (1951, Part III and Ch. XXII), Spraos (1953), Bloomfield (1954), Bell (1956, Chs. IV, V, and XIII), Day (1957, Chs. 33 and 37), Scammell (1957, Ch. 4 and Part V), Trued (1957, pp. 403–11), Kenen (1960, Ch. V), Mundell (1962), and Fleming (1962). There was also a substantial discussion about the role of speculative capital movement in the adjustment mechanism under the flexible exchange rate system. For references, see Sohmen (1961, Ch. III).

[7] However, even then there was a practice of charging an implicit forward premium in short-term lending from a country with interest rates that were significantly lower than the rates in the country of the borrower. For specific instances involving forward market operations before 1914, see Einzig (1937, pp. 37 ff.).

[8] Keynes (1924, pp. 145–46) proposed that "State banks themselves . . . enter the forward market and offer to buy or sell forward exchange at a reasonable discount or premium on the spot quotation. . . . By varying these rates they would be able, in effect, to vary interest offered for *foreign* balances, as a policy distinct from whatever might be their bank-rate policy for the purpose of governing the interest obtainable on *home* balances."

[9] This pragmatic approach to the forward exchange market led some writers (Stoll (1968, pp. 58 and 63–64), Canterbery (1969, pp. 426–27)) to distinguish

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the market, stressing mainly the role of the arbitrage activity.[10] Although the role of speculators in absorbing undue fluctuations in the forward rate was sometimes recognized,[11] interest focused on the destabilizing effects of forward market speculation on short-term capital movements in the system of fixed parities. Such destabilizing speculation was viewed as causing substantial differences between two countries' interest parities and a forward discount or premium.

A more rigorous theoretical inquiry into the forces determining the working of the foreign exchange market, and into the implication of these forces for short-term capital movements, was stimulated by the post-World War II revival of limited forward exchange transactions in the early 1950s.[12] Tsiang (1959–60) pioneered a rigorous theoretical system that showed how hedging, speculation, and interest arbitrage, on the one hand, and activities on the spot exchange market, on the other hand, jointly played a role in an equilibrium determining both the spot and forward rates. This integration of the spot and forward exchange markets was a key to the explanation of international short-term capital movements.

Tsiang's treatment of hedging, speculation, and interest arbitrage as independent of one another permitted a lucid analysis of factors influencing demand and supply schedules of forward and spot exchanges. However, since most transactors who participate in these markets often perform more than one activity at the same time (in particular, trade-hedgers act as speculators as well as participants in covered interest arbitrage), some motives, such as risk that may affect all three activities, are not handled adequately.

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between Keynes's "traditional interest rate parity theory," on the one hand, in which arbitrageurs allegedly "determine the forward rate" (i.e., the arbitrageurs' demand schedule is infinitely elastic) while "speculators determine the quantity of forward commitments and the current capital flow" (Stoll (1968, p. 63)), and, on the other hand, the so-called modern theory in which both arbitrageurs' and speculators' schedules are less than infinitely elastic. However, Keynes (1924, p. 140) had seen the possibility for an upward sloping arbitrage schedule and had stated explicitly "that the floating capital normally available, and ready to move from center to center for the purpose of taking advantage of moderate arbitrage profits between spot and forward exchange, is by no means unlimited in amount, and is not always adequate to the market's requirements."

[10] Einzig (1937), Kindleberger (1937, pp. 194–210), Southard (1940, pp. 76–112).

[11] Keynes (1924, pp. 140–41), Einzig (1937, p. 143).

[12] Spraos (1953, 1959), Trued (1957), Jasay (1958 a, b), Jasay and Spraos (1958). Even these articles were oriented to a large extent toward issues of forward exchange policy, especially as regards government intervention in the forward market.

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It is useful, nevertheless, to review the forces affecting the equilibrium on the forward and spot exchange markets by using, as a starting point, Tsiang's methodology of three separate forward market activities.

Arbitrage

Tsiang started with Keynes's proposition, which was developed formally by Spraos (1953, pp. 87–92), that there will be a net flow of short-term capital between two countries unless the forward premium (or discount) [13] on one of the two currencies is approximately equal to the difference in relevant short-term interest rates between the two countries. Tsiang, however, clarified a statement by Keynes that available arbitrage funds are limited at any point in time [14] by specifying that a marginal opportunity cost of funds available to an arbitrageur (in terms of alternative uses of his liquid assets)[15] is an increasing function of the size of his commitments in any one currency. Here a variant of a portfolio selection theory can already be found. Others have also advanced reasons for the upward slope of the opportunity-cost schedule of arbitrage funds. Stoll (1968, p. 58) considered that such a slope is caused by the relatively higher default risk on foreign assets because of "a . . . danger that the government concerned will freeze foreign balances." Klopstock (1965, p. 185) and Stein (1962, pp. 26–27) pointed out that, if a need arises to sell foreign assets prior to maturity, these assets, despite being covered forward, would be less liquid than comparable domestic assets. All these interpretations imply investment behavior under conditions of risk. However, risk here does not mean the exchange risk proper—since the latter is covered on the forward market—but risk related either to lack of information about the conditions in foreign financial markets [16] or to intervention by domestic or foreign governments in the freedom of short-term capital transactions.

[13] The forward premium is defined as a difference between the forward and spot rates, expressed as a percentage of the spot rate [i.e., $p=(FR-SR)/SR$].

[14] See footnote 9.

[15] "That is to say, spot liquid assets yield some intangible returns of convenience or liquidity in addition to their interest yields. Banks (and other financial institutions) would normally be expected to distribute their command over spot liquid assets in various financial centers in such a way that the marginal yields of interest *cum* liquidity (convenience) net of exchange risks of liquid assets would be approximately equal between different financial centers," Tsiang (1959–60, p. 81).

[16] In addition to administrative costs, this lack of information may be a major component of transaction costs on the forward exchange market that creates a discontinuity in the arbitrage function at the point of the current equilibrium position. For a discussion on this point, see Branson (1969).

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The existence of risk, other than the foreign exchange risk, is a major reason for the existence of a net demand for foreign exchange by arbitrageurs that is less than perfectly elastic. Other reasons are the budget constraint imposed by the total asset position of the arbitrageur and the portfolio balance constraint imposed by his existing unexpired commitments.[17] The greater an arbitrageur's risk and the higher his past commitments, the larger will be the difference between the forward premium and the interest rate differential needed to induce him to enter into new forward commitments.

For an individual arbitrageur, risk in different markets is determined by his own subjective valuation. All the other factors just mentioned are taken by the arbitrageur as either exogenous variables or parameters. However, when a market demand function is obtained by summing up functions of all individual arbitrageurs, risk represents the aggregate risk valuation on the arbitrageurs' side of the market. Total assets become an index of arbitrageurs' wealth, while past forward commitments acquire dynamic properties, since they not only provide a constraint on undertaking a new forward position but also generate a flow of spot foreign exchange at the moment when forward contracts mature.

Speculation

The treatment of speculation is quite a difficult problem, since the explanation of such activity is based on a still unresolved theory of expectations. Speculation on the foreign exchange market results from an open position in a foreign currency following either a spot transaction or a forward contract. It can be shown, however, that a speculative position on the spot market can be expressed without loss of generality as a combination of an open position on the forward market and a cov-

[17] An arbitrageur's net demand function for (90 days) forward foreign exchange can therefore be expressed as follows:

$$(1.1) \qquad Da_t = F\left[[P_t - (Id_t - If_t)], Vd_t, Vf_t, Aa_t, \sum_{i=t-1}^{t-89} Da_i\right]$$

$$\text{and } \partial F/\partial Vd, \partial F/\partial Aa > 0; \partial F/\partial[P - (Id - If)], \partial F/\partial Vf, \partial F/\partial \Sigma Da < 0$$

where P is the forward premium on the foreign currency, Id and If are domestic and foreign interest rates, Vd and Vf are the arbitrageur's subjective estimate of the risk on domestic and foreign exchange markets, Aa stands for the arbitrageur's total liquid assets, and the last term is the sum of his past commitments.

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ered interest arbitrage operation.[18] The most important motives influencing the behavior of an individual speculator in the forward exchange market are the difference between the expected spot rate at some future time and the current forward rate for a contract maturing at that same future time, and the speculator's estimate of risk attached to the realization of his expectations. Tsiang followed a generally accepted theory of choice in conditions of risk and expressed the expected rate as determined uniquely by the mean rate (i.e., the most likely future rate) and by the variance of the speculator's subjective probability distribution of expectations. The variance will reflect the speculator's estimate of the risk that the expected rate will not prove correct. In addition, the speculator's past forward commitments should also be taken into account.[19] Tsiang correctly pointed out that the time profile of past, although not yet matured, forward contracts will considerably influence the valuation of the risk of any new forward contracts.[20] The speculator's risk reflects mainly exchange rate risk, but it also incorporates risk of government intervention in the freedom of international capital transactions.

The basic weakness of Tsiang's treatment of speculation is that his demand function for forward exchange assumes expectations of future

[18] See Tsiang (1959–60, pp. 86–87 and 91–92) and Kenen (1965, p. 148). Therefore, an analysis of the speculative activity can be limited to the forward exchange market.

[19] Limited to 90-day contracts, the speculator's net demand function for forward foreign exchange is then as follows:

$$Ds_t = S\left[(ER_t - FR_t), r_t, As_t, \sum_{j=t-1}^{t-89} Ds_j\right] \tag{1.2}$$

$$\text{and } \partial S/\partial(ER - FR), \partial S/\partial As > 0; \partial S/\partial r, \partial S/\partial \Sigma Ds < 0$$

where ER is the expected foreign exchange rate in 90 days, FR is the 90-day forward rate, r is the speculator's subjective risk in undertaking forward contract, and As stands for his total liquid assets.

[20] In this influence, the most recent contract will have the largest weight and the one about to expire will have the smallest. Assuming that the effects of past commitments on the risk estimate diminish exponentially, Tsiang obtains the following linear expression:

$$r_t = \alpha D_t + \lambda r_{t-1}$$

where D is the current speculative foward position and λ should reflect the length of the effective time-horizon of the speculator's expectations, which horizon determines the diminishing influence of past commitments. However, Tsiang is not clear on that point.

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rates to be given exogenously.[21] Thus, without a theory that would provide a basis for the formation of exchange rate expectations, Tsiang's theoretical analysis of the forward and spot exchange markets is inoperative.

A number of efforts have been made to fill this gap and to provide some theoretical basis to link the formation process of expectations to observable variables. The major difficulty lies in the need to develop an expectations function (or a set of functions) that would explain, in the present system of pegged parities, both stabilizing and destabilizing speculative behavior and also the role of the intervention points in determining such behavior.

Among attempts to handle stabilizing speculation,[22] Arndt (1968, pp. 59–61) used a concept of adaptive exchange rate expectations based on Baumol's (1957) model of speculative behavior. Arndt assumed that a speculator's demand for foreign exchange was a function of deviations of the current observed rate from some "expected normal" rate. He then defined this expected rate as the previous period's expected normal rate, adjusted by a fraction of the difference between it and a current observed rate. The longer the speculator's time horizon, the smaller would be the revision of his expectations in response to temporary fluctuations in the spot rate. This approach leads to the familiar Koyck-type distributed lag model in which the demand for foreign exchange by speculators (i.e., a speculative capital flow) is a function of the change in the exchange rate and of the speculative demand from the preceding period. The size of the coefficient of the latter variable (which is a fraction) is related directly to the length of the adjustment period.[23] This theoretical approach to speculative behavior has acquired considerable currency in recent years.[24]

The weakness of such an approach to the formation of expectations is that it relies on a past performance of the dependent variable as the

[21] See Tsiang (1959–60, pp. 90–91). Stein (1965 a, pp. 48–49) and Sohmen (1966, pp. 15–16) also make the same assumption.

[22] For an earlier approach to stabilizing exchange rate expectations, see also Rhomberg (1959–60, pp. 441–44 and 1964, pp. 5 ff.).

[23] If factor λ is a coefficient of speculative demand for the period t-1, then it is indicative of the length of the adjustment period. Thus, the larger the λ, the longer the adjustment process. See also Tsiang's treatment in footnote 20.

[24] For uses of this approach in discussing short-term capital movements, see Stein (1965 a, p. 53), Hendershott (1967 b, pp. 460–61), Stoll (1968, pp. 64–65), and Miller and Whitman (1972, pp. 262 ff.). Since Tsiang's risk variable is also in the form of a Koyck lag (see footnote 20), he could also be included in this group.

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only explanatory factor. In speculation on the foreign exchange market, the past performance of the rate itself is only one among a number of variables in the minds of speculators, who try to predict the future exchange rate on the basis of a variety of indicators at hand. Furthermore, a rather rigid, exponentially decreasing path of past influences inherent in the Koyck distributed lag model is another unrealistic feature of the approach.

Other approaches relying on the band between intervention points have also been used. White (1963, pp. 487 ff.) has pointed out that in the Bretton Woods system of fixed intervention points the position of the spot rate within the band will determine expectations of the future rate. Branson (1968, Ch. 3) has used a more general form of lag distribution to approximate the stabilizing influence of the intervention points on the formation of future exchange rate expectations.

The attempts to handle destabilizing speculation in the fixed exchange rate system are much more complex and difficult. The main problem lies in the discontinuity that the existence of the band introduces into speculative behavior. A further difficulty is in the complexity of motives influencing speculative behavior under such conditions. Each country, each capital market, and each time period has specific features that are a major factor in the formation of expectations. If a country is a major participant in international trade with a low reserve position, its trade performance may be a major factor in influencing the expected exchange rate.[25] In other cases, exchange rate expectations can be influenced by the dynamics of relative rates of inflation between countries,[26] by substantial swings in short-term capital movements caused initially by changes in monetary policy, by an exchange rate crisis in a third country, etc. Thus, it appears that a more flexible methodology, which permits formulating a specific expectations function for a particular country or a particular period, would be more promising.

Trade-hedging

Credit arising from trade transactions contracted for future payments comprises an important proportion of short-term capital movements. In

[25] For the use of the lagged trade balance as a determinant of speculative flows in the United Kingdom, see Hodjera (1971, pp. 746 ff.).

[26] In their analysis of German capital movements, Kouri and Porter (1972 b) used a ratio of domestic to foreign cumulative rates of inflation to explain speculative behavior.

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a highly competitive international capital market, traders obtain finance from the source where interest rates, after allowing for the forward premium or discount, are the lowest. Thus, by hedging (i.e., covering forward their trade credit contracts), traders behave effectively as interest arbitrageurs. In line with his methodology of separating the analysis by activity, Tsiang assumed that all traders hedge, so that all trade that is not financed by long-term credit would generate capital movements. The direction of the movements would be determined by the condition for interest arbitrage. However, such an assumption is quite unrealistic, given that traders do tend to speculate, either through leaving trade credit contracts uncovered or through leads and lags. White (1963, pp. 487–93) has shown that whenever the cost of forward cover exceeds a properly estimated risk of loss from a change in the spot rate, the trader is induced to leave uncovered a certain proportion of his trade credit. Kenen (1965, pp. 145–49) also reached the same conclusion by a microeconomic analysis of the operation of an export-import firm. Branson (1968, Ch. 2) has formalized such a view in terms of the portfolio selection theory. He has obtained the usual utility maximization condition according to which the trader will stop expanding the uncovered portion of the value of his total trade credit when the ratio of the marginal gain in utility from a further reduction of forward cover payments to the marginal loss of utility from the additional risk equals the ratio of the risk estimate to the potential gain from the operation.

Therefore, it would follow that participation in the forward exchange market by traders as hedger-speculators is determined by the size of their short-term trade contracts and by a mean-variance analysis that would balance possible exchange gains from the risks of credit transactions not covered forward against the forward cover costs of risk minimization by hedging.[27] This speculation in uncovered credit transac-

[27] An individual importer's demand for forward foreign exchange, Dm, and an individual exporter's supply of forward foreign exchange, Sx, can be expressed as follows:

$$(1.3) \qquad Dm_t = N[M^*_t, [P_t - (Id_t - If_t)], Vd_t, Vf_t, (ER_t - FR_t), r_t]$$

and $\partial N/\partial M^*, \partial N/\partial Vf, \partial N/\partial(ER - FR), \partial N/\partial r > 0; \partial N/\partial[P - (Id - If)], \partial N/\partial Vd < 0$

$$(1.4) \qquad Sx_t = Y[X^*_t, [P - (If - Id)], Vf, Vd, (ER_t - FR_t), r_t]$$

and $\partial Y/\partial X^*, \partial Y/\partial[P - (Id - If)]\partial Y/\partial Vd, \partial Y/\partial r > 0; \partial Y/\partial Vf, \partial Y/\partial(ER - FR) < 0$

where, in addition to the variables already explained, M^* and X^* stand for imports and exports financed by short-term capital.

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tions by traders differs from the usual activity by speculators on the forward market only in the degree of risk aversion; for traders, gains from speculation on the exchange markets are less important than trading profits. On the other hand, Leamer and Stern (1970, p. 88) claim that arbitrage risk by traders will be quite small because the probability of the imposition of exchange controls on trade transactions is minimal.

Market equilibrium

The equilibrium on the forward exchange market is achieved at a forward rate at which that market is cleared. At that rate, the net supply (negative demand) of forward foreign exchange of the arbitrageurs is equal to the sum of the demand by speculators and traders.[28] In Figure 1, at the forward rate 0_2F, the distance AB, showing the net demand of forward exchange by speculators and traders (i.e., $\mathbf{D_S} - \mathbf{S_T}$), is equal to the net supply of the arbitrageurs, FC.

It is obvious from Figure 1 that the joint determination of the forward rate and the size of the forward exchange flow are influenced by the elasticity of the arbitrage and the speculators' demand functions along their relevant ranges. An infinitely elastic arbitrage schedule (i.e., the presumed Keynes's interest rate parity theory) would lead to a determination of the forward rate by arbitrage alone, while the speculators' function would determine the flow of forward exchange at that particular rate. On the other hand, if the speculators' schedule is infinitely elastic (when there is certainty about the future exchange rate) it will determine the forward rate and the latter will be independent of the interest rate differential.[29]

[28] In terms of equations (1.1) through (1.4) in preceding footnotes, equilibrium in the forward exchange market requires that net demand for forward exchange ($\mathbf{ND_F}$) equal zero, that is,

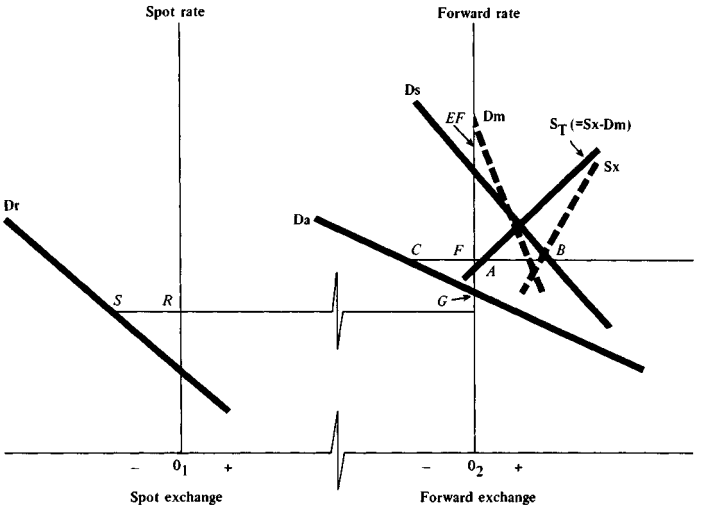
$$\mathbf{ND_{F_t}} = \mathbf{Da_t} - (\mathbf{Ds_t} + \mathbf{Dm_t} - \mathbf{Sx_t}) = 0 \tag{1.5}$$

where symbols in bold face type indicate *market* rather than individual demand and supply schedules.

[29] These conclusions follow from the assumption of an exogenously determined interest rate differential for the arbitrage schedule and a given exchange rate expectation for the speculative schedule. Furthermore, at this point the spot rate is still assumed to be determined exogenously. With these assumptions, it is obvious that no determinate equilibrium solution exists if both schedules are infinitely elastic. However, if any of the restrictive assumptions are relaxed and, in particular, if the interest rates and the expected exchange rate are taken to be endogenous variables, a more complex determinate equilibrium solution would exist. For a further discussion on these points, see Stoll (1968, pp. 62 ff.), Levin (1970, Ch. IV), and Argy and Hodjera (1973, pp. 38 ff.).

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FIGURE 1. EQUILIBRIUM IN THE FORWARD AND SPOT EXCHANGE MARKETS



Da = arbitrageurs' demand (supply) for forward exchange
Ds = speculators' demand (supply) for forward exchange
Dm = importers' demand for forward exchange
Sx = exporters' supply for forward exchange
Dr = exogenous demand (supply) for spot exchange
EF = expected future spot rate, assumed to be given
P = *Id* - *If* at 0_2G (see footnote 17); *Id* and *If* are assumed to be given.

An important point contributed by Tsiang was to clarify the essential role of arbitrageurs in creating the link between the spot and forward exchange markets. Since arbitrageurs always cover their forward commitments by reverse spot transactions, they will undertake new commitments only when the forward premium quoted on the market is at least equal to the interest rate adjusted for the difference in the marginal opportunity costs of funds.[30] An individual arbitrageur observes the existing spot and forward rates, on the one hand, and the interest differential, on the other hand, and adjusts his net forward and spot position in foreign exchange accordingly.

[30] More specifically, the forward rate that would satisfy the condition necessary for arbitrageurs to accept new forward commitments abroad is approximately as follows:

$$FR \geqslant SR(1 + Id - If + Vd - Vf) \tag{1.6}$$

where $Id - If$ is the interest rate differential and $Vd - Vf$ is the differential in the marginal opportunity costs of funds expressed in percentage terms.

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However, as is shown by Tsiang's analysis, in the process of achieving a full equilibrium on the exchange markets (when *market* behavior of arbitrageurs and speculators is considered), the forward exchange rate is an endogenous variable. This is also true for the spot rate when flexibility of the exchange rate parities (either within the band of intervention points or in the freely flexible exchange rate system) is allowed for.[31] Although individual participants in the exchange rate market take both spot and forward rates as data, the equilibrium can be achieved only when through the market mechanism the mutual adjustment of forward and spot rates is such as to satisfy the conditions just outlined. In Figure 1, the equilibrium condition is satisfied at the spot rate 0_1R, and at the forward rate 0_2F, at which rates $SR = CF = AB$. During this adjustment process, and depending on the behavior of exogenous variables, short-term capital flows will occur. These will be reflected in the spot exchange demanded (supplied) by arbitrageurs and traders, as a consequence of their activities on the forward market.

It can be seen that the model originated by Tsiang is, in a number of important aspects, a partial equilibrium model. Changes in some of the

[31] With a flexible spot rate the equilibrium on the forward exchange market, expressed by equation (1.5), can be sustained only if, at that spot rate, the net supply of foreign exchange on the spot exchange market, resulting from transactions that are independent of the current activity on the forward market, is equal to the demand for spot currency by arbitrageurs to cover forward commitments.

$$(1.7) \qquad \mathbf{LC}_t - (\mathbf{X}'_t - \mathbf{M}'_t) + \lambda(\mathbf{X}^*_{t-90} - \mathbf{M}^*_{t-90}) + \mathbf{G}_t + \mathbf{A}_{f(t-90)} = \mathbf{Da}_t$$

The left-hand side of the equation shows that net supply of spot foreign exchange consists of the following transactions: (a) net current long-term capital movements not used directly to finance current trade, $\mathbf{LC} - (\mathbf{X}' - \mathbf{M}')$; (b) payments on trade contracts coming due, which were financed by short-term capital (assumed to be uniformly on the 90-day basis) but not covered forward through the services of arbitrageurs, $\lambda\ (\mathbf{X}^*_{t-90} - \mathbf{M}^*_{t-90})$; the fraction λ, which is a function of the difference between the expected spot rate and the forward rate and of the speculative risk, shows the proportion of short-term trade finance that is not covered forward; (c) net sale of gold and foreign exchange by the monetary authorities, G; and (d) the net delivery of spot foreign exchange by arbitrageurs upon the expiration of their forward contracts, $\mathbf{A}_{f(t-90)}$. For the purpose of this analysis, only one additional specification of the system is necessary. If the arguments on the left-hand side of the equation (other than predetermined variables $(\mathbf{X}^*_{t-90} - \mathbf{M}^*_{t-90})$ and $\mathbf{A}_{f(t-90)}$, and λ determined on the forward market) are defined as a function of the spot exchange rate, the result is a positive slope of the net supply of (negative slope of the net demand for) spot foreign exchange (i.e., schedule **Dr** in Figure 1). When a fully developed model is considered, in equation (1.7), arguments other than those determining demand for arbitrage funds can be expressed as a function of other variables pertaining to the basic balance, in addition to the spot rate.

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exogenous variables, such as the expected exchange rate and interest rate differences, are most important in influencing short-term capital movements. However, these variables may, in turn, be influenced by the international readjustment of short-term capital assets. Furthermore, within this model the effect of the change in interest rates and in exchange rate expectations can be examined only by considering a shift in one of the schedules that determines the equilibrium of the model.[32] Since it has been shown that these schedules are interdependent, the proper analysis of a change in one of the exogenous variables becomes even more difficult.

Tsiang's analysis of the equilibrium in the forward and spot exchange markets was an important contribution in clarifying the relationship between forces that influence short-term capital movements. Further efforts were made to overcome the limitations of the model and, in particular, to make it operational for econometric analysis. Stein (1962) has considered a change in variables, still assumed to be exogenous, such as the interest rate in one of the two regions or an exogenous move in the spot rate. Although his analysis was institutional, it examined a dynamic process of adjustment in other variables as a result of an exogenous change in one variable. Stein differentiated between "normal" and "speculative" periods of adjustment on the basis of whether speculators expected no change or an adjustment in the exchange rate peg. In the normal period, the adjustment in both the interest rate differential and the spot rate within intervention points is such that the forward and spot rates would move in opposite directions. The comparative movement in these rates would thus affect the response of the flow of short-term capital by transferring the activity of speculators from the spot to the forward market or from the forward to the spot market. During the "speculative" period, however, an exogenous change in exchange rate expectations will tend to provoke a movement of both forward and spot rates in the *same* direction. Sohmen (1961, pp. 76–79; 1966, pp. 28–30), Auten (1963, pp. 13–16), and Argy and Hodjera (1973, pp. 41–43) have examined the implication of intervention points on the movement of the forward rate. Assuming no expectations of adjustment in the peg, the elasticity of supply of forward exchange

[32] Auten (1963, pp. 13–15) has diagrammatically examined a shift in the arbitrage schedule as a result of the change in the interest rate differential. However, he had to assume independence among various schedules shown in Figure 1. Furthermore, he could show only the effect of change in the interest rate differential on the forward exchange market.

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will increase considerably once the upper intervention point is reached, and the elasticity of demand for forward exchange will increase once the lower intervention point is reached. In the special case where the spot rate also approaches one of the intervention points—for example, during a protracted capital outflow from a strong-currency country or a protracted inflow into a weak-currency country—the forward rate may remain at the floor or at the ceiling for a considerable period of time. This would reflect an infinitely elastic speculative demand (supply) function, and during that period the forward premium will be independent of the movements in the interest rate differential. More generally, during the period of confidence in the band, exchange rate expectations will become inelastic when the spot rate approaches the intervention points, and the movement of the forward rate will be reversed. When, on the other hand, an adjustment in the peg is expected by speculators (i.e., the exchange rate expectations become elastic in the vicinity of the intervention points), the forward rate could considerably exceed the intervention points and could be driven to a large premium or discount.

3. Stocks versus flows and the portfolio selection approach

Another aspect of the theory of short-term capital movements was related closely to attempts to empirically investigate the response of financial flows to changes in interest rates and in foreign trade. The major question was whether financial flows in general, and short-term capital movements in particular, respond to absolute interest rate differentials or whether they respond to a *change* in these differentials.

Early students, such as Rhomberg (1959–60, 1964), Kenen (1963), and Black (1968), followed the classical view restated by Nurkse (1934), Ohlin (1933), and Iversen (1936) [33] that an arbitrageur's activity will generate financial flows whenever the gap between the interest

[33] However, these three writers have not considered interest rate changes as exogenous but have tried to explain the repercussions of an international interest rate differential on domestic adjustments and the effect of these adjustments on interest differences between countries. Although they proceeded along the line of the outmoded Austrian capital theory or the Heckscher-Ohlin approach based on the differential factor intensities of the production functions, the advantage of their analysis is that they basically followed a general equilibrium method. Examined within a general equilibrium adjustment in both domestic economies and their international interaction, the views of these authors can be consistent with a modern international capital stock-adjustment approach.

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rates exceeds the international differences in risk. Such a view also implied that once the monetary authorities were successful in preserving a favorable short-term interest differential they could then rely on short-term capital movements to finance a continuing deficit in the basic balance.

A coexisting view was that capital movements were influenced by a change in the international interest differentials.[34] This would have meant that in an equilibrium situation stocks of domestic capital abroad and of foreign capital at home were determined by the existing interest differentials, while international flows would occur if these equilibrium differentials were disturbed. Originally, attempts were made to test the validity of the flow or stock approaches by econometric techniques. However, it was soon realized that the stock approach is consistent with the Tobin-Markowitz theory of portfolio selection. Grubel (1966, pp. 12 ff., and 1968) and Willett (1967) have suggested that applying the portfolio selection theory to international capital movements can explain the international distribution of assets and also international flows of capital. Asset distribution will depend on a given set of interest rates in different countries, reflecting the expected returns to asset holders, and on risk estimates of holding these assets in the portfolio.[35] Any *change* in interest rates or in the degree of risk of some of these

[34] In his pioneering attempt to estimate determinants of U. S. capital movements, Bell (1962) has related capital stocks to interest differentials. He, however, does not provide theoretical reasons for selecting such an approach.

[35] The expected return, R^e, on total assets of an asset holder can be expressed as follows:

$$R^e = \frac{A_f}{A} R_f^e + \frac{A_d}{A} R_d^e \tag{1.8}$$

where A, A_f, and A_d are total, foreign, and domestic assets, respectively (so that $A = A_d + A_f$, or $A_d/A = 1 - A_f/A$); and R_f^e and R_d^e are expected returns on foreign and domestic assets—they can be seen as foreign and relevant domestic interest rates. The risk, σ_{R^e}, associated with holding of these assets is as follows:

$$\sigma_{R^e} = \left[\left(\frac{A_f}{A} \right)^2 \sigma^2{}_{R_f^e} + \left(\frac{A_d}{A} \right)^2 \sigma^2{}_{R_d^e} + 2 \frac{A_f A_d}{A} \operatorname{cov} (R_f^e, R_d^e) \right]^{1/2} \tag{1.9}$$

where $\sigma_{R_f^e}$ and $\sigma_{R_d^e}$ are variances of subjective distribution of returns on foreign and domestic assets. It is clear that risk associated with the total portfolio will vary in direct proportion to the covariance of expected returns on foreign and domestic assets (which is also equal to $r \cdot \sigma_{R_f^e} \cdot \sigma_{R_d^e}$, where r is a correlation coefficient between R_f^e and R_d^e). Only if these two kinds of asset are perfect substitutes will diversification not decrease risk. Granted the assumptions of (a) either a normal subjective probability distribution of returns or a quadratic utility function of the investor and (b) the existence of riskless

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assets will generate international *flows* of capital, until the reallocation of capital induced by these changes results in a new international distribution of assets. As already pointed out, Tsiang's analysis of the equilibrium in the forward and spot exchange markets has many features of the portfolio selection theory, and thus it is basically a stock approach.

A more rigorous application of the portfolio selection theory to the foreign exchange market was provided by Branson (1968, Ch. 2). He examined the case where traders were assumed to operate simultaneously as arbitrageurs, hedgers, and speculators.[36] Branson applied a quadratic form of the expected utility function, as had been done by Tobin and Markowitz, in order to formalize the profit-maximizing behavior of such risk-averse traders. In this way he obtained a familiar equilibrium condition for interest arbitrage on spot and forward markets, derived by Spraos (1953), Tsiang (1959–60), and Sohmen (1961), but he was also able to obtain a more specific formulation of the speculative behavior.[37] In analyzing the behavior of a trader as a speculator, Branson concluded that an upward shift in the expected foreign exchange rate would cause an upward shift in both forward and spot foreign exchange rates. In the process it would also generate an excess demand for foreign exchange on both spot and forward exchange markets, thus causing a short-term capital outflow. On the other hand, an increase in risk associated with given expectations of the future foreign exchange rate [38] would generate, other things being equal, a decrease in capital flows (with transactors increasing their borrowing at home) and an increase in the demand for forward cover by transactors in both countries.

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domestic assets, the optimal composition of an investor's international portfolio is determined on the basis of the two parameters expressed in equations (1.8) and (1.9). Any change in either R_i^e or $\sigma_{R_i}^e$ $(i = f, d)$ will cause a reallocation of the portfolio and an international flow of funds.

For a discussion of the portfolio selection theory, see Tobin (1958 and 1965), Markowitz (1959), Sharpe (1964), and Fama (1968). A summary of the theory is given in Moore (1968, Ch. 2) and in Grubel (1968, pp. 1299–1303).

[36] In addition to their usual hedging activities, traders behave as arbitrageurs through selecting a more favorable capital market for necessary trade finance, and they behave as speculators through leaving a certain proportion of their trade uncovered forward.

[37] See the section, *Trade-hedging*.

[38] More specifically, in variances of the speculators' subjective distributions of the expected foreign exchange rates.

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However, Branson's analysis of the effect of changes in the interest rate differential on capital movements is more ambiguous. He concluded that an increase in the foreign interest rate (generating a shift in the arbitrage schedule) would cause a decrease in the forward foreign exchange rate but that the direction of induced capital movements could not be determined. This unusual result is contradicted by the empirical work, which clearly supports the conventional view that an increase in a given country's interest rate will have a positive effect on the short-term capital inflow.

All these results are obtained by using a quadratic utility function. When, however, Branson uses the more general form of the utility function, the effects on capital movements of both a change in the interest rate and a change in exchange rate expectations become uncertain. These theoretical findings are confirmed by Feldstein (1968, pp. 187–90), who concluded that, under these assumptions and granted multiple currencies, only an increase in risk to speculators will have an expected discouraging effect on speculative flows. In a more general criticism of the Tobin-Markowitz portfolio selection theory, Feldstein (1969) pointed out that the portfolio selection analysis can generate determinate results only if the utility functions of risk-averse investors are quadratic or if their subjective distributions of expected returns can be assumed to be normal. Thus, for any other utility function and probability distribution, a two-parameter Tobin-Markowitz analysis would be inadequate. Although Tobin (1969), one of the pioneers of the portfolio theory, appears to have conceded the validity of this view, Tsiang has recently shown that it is too restrictive. The sufficient condition, according to Tsiang (1972, pp. 355–61), for a unique solution in a portfolio selection model, which is based on a mean of expected returns and on the variance of their subjective distribution, is that the risk (i.e., variance) assumed by the investor is fairly small relative to his total wealth.[39] However, when the analysis is based on such a set of more general utility functions, it is not clear what theoretical conclusion one

[39] While Branson was using a normal distribution as an alternative to the quadratic utility function, Feldstein has used a log-normal distribution. For a further analysis of portfolio selection based on a log-utility function, see Samuelson (1967, 1970). Tsiang (1972) has shown that if risk is small relative to an investor's total wealth, determinate results are obtained with all these utility functions and some others in terms of the mean-variance analysis as an approximate method. Under these conditions, a determinate solution can be obtained without need for recourse to higher moments in the distribution than the first two.

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could draw regarding the effects of changes in interest rates and exchange rate expectations on international capital movements. More work is required on this issue. As Tobin (1969) pointed out in a somewhat different context, the economic significance of "perverse" solutions should be explored. Solutions in which changes in interest differential and in exchange rate expectations cause "uphill flows" in terms of the conventional theory may be even less important than the "Giffen paradox" in the consumer demand theory.

An obvious advantage of using the portfolio selection theory in analyzing short-term capital movements is that such a theory can explain simultaneous two-way international short-term capital movements between two regions. A demand for foreign assets is viewed as a component of the total assets demand function by a given region of asset holders under conditions of risk. The supply of foreign assets is determined within a framework of the total assets demand function by asset holders abroad. This provides a theoretical basis for the separate estimation of foreign assets and foreign liabilities of a given country, since these are determined by different functions.

The original treatment, particularly in empirical studies, was to define demand and supply functions for short-term foreign assets of a representative investor on the basis of portfolio selection theory without distinguishing between arbitrage, speculative, and trade-hedging activities.[40] Levin (1970), Leamer and Stern (1970, and Basevi (1973) have treated each of these activities separately. However, when solved in terms of observable independent variables, the portfolio selection approach effectively evolves into the approach based on Tsiang's original methodology.[41]

The rearrangement of investors' portfolios in response to changes in exogenous variables occurs over a certain period of time. On the aggregate level, this leads to an adjustment in stocks of short-term assets among the two or more countries, which adjustment will also be com-

[40] For such treatment, see Bryant and Hendershott (1970, 1972), Branson and Hill (1971 b), Branson and Willett (1972), and Miller and Whitman (1972).

[41] Leamer and Stern (1970, pp. 82–89) and Levin (1970, Chs. II and III) assume that arbitrageurs, speculators, and trade-hedgers participate simultaneously in both arbitrage and speculation on the forward market. If one disregards these secondary activities of arbitrageurs as speculators and of speculators as arbitrageurs, which is quite a realistic view, the treatment of these three authors becomes quite similar to that shown in equations (1.1) through (1.5) in preceding footnotes. There is one rather significant difference (a possibility also pointed out by Tsiang, 1959), which is that each of these activities has two foreign assets demand functions—one by domestic and one by foreign asset holders.

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pleted (if not disturbed by other preceding or succeeding changes) over a period of time. Thus, a portfolio selection theory provides an explanation of adjustments in stocks in the form of a distributed lag model. However, depending on the nature of the distributed lag model used, considerable difficulty may occur in distinguishing a stock adjustment from a flow process. Hendershott (1967 a) and Leamer and Stern (1970, pp. 80–81) have shown that if the adjustment process is spread evenly over a large number of periods, a statistical estimation may make a stock adjustment phenomenon appear as a continuous flow.

Another important aspect of the portfolio selection theory as applied to international capital movements, raised by Floyd (1969 a, pp. 484–90) and Willett and Forte (1969, pp. 246–52), consists in the role played by a comparative growth of total assets as variables influencing asset reallocation among countries.[42] In a growing economy, a continuous flow of short-term capital may result from a difference among countries in one or more of these parameters: (a) the growth rate of each country's total assets; (b) the absolute size of their total assets at the beginning of the period; and (c) the proportion of each country's assets held abroad. These flows will thus occur even if the existing interest rate configuration among countries remains constant, and they can be thought of as being induced by differences in wealth effects. Furthermore, a change in the interest rate in one of the countries will not only generate a reallocation of a stock of assets in the portfolios of each country's investors but also cause a change in the continuous flows induced by a comparative wealth effect. This will be so because (as indicated in (c)) the proportion of each country's assets held abroad will be modified as a result of the change in international interest rate differentials. Thus, a change in the interest rate differential among growing economies generates a stock adjustment effect and a flow adjustment effect on capital movements. While the former effect is temporary and, *ceteris paribus,* is completed after a given period of time, the latter effect causes a smaller, but more sustained, adjustment in the flow of capital.[43]

[42] Grubel also (1968, pp. 1309–13) raises the same problem. However, his treatment of the interaction between the effect of interest rate changes and of growth of wealth is incomplete.

[43] Taking demand functions for short-term foreign assets by two countries, A and B (functions that do not distinguish specifically between arbitrage, speculation, and hedging—a procedure that is used by a number of writers), stock equations, S_i $(i = A, B)$, are as follows:

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The treatment of international short-term capital movements within the framework of the growing economy is a major improvement over Tsiang's analysis, which, in this respect, was essentially static. This improvement was made possible by applying the portfolio selection theory. Also, asset diversification, on which the portfolio selection approach is based, can successfully explain simultaneous cross flows of short-term assets and liabilities among countries.

However, there are also serious weaknesses in this approach as a basis for developing a theory of a foreign exchange market in general and of short-term capital movements in particular. Some weaknesses are inherent in the portfolio selection theory itself, while others result from its application to the process of international short-term capital movements.

A. As Malinvaud (in Hahn and Brechling, 1965, p. 287) pointed

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(1.10) $K_i/W_i = f_i(I_A, I_B, SR, ER, M_i)$ or

(1.10a) $K_i = f_i(\quad)W_i = S_i; \qquad (i = A, B)$

where K_i are foreign assets and the other symbols are explained in the preceding footnotes. The functions f_i are assumed to be linearly homogeneous in wealth, W_i.

The assumption that in each country total assets are increasing over time leads to flow equations, F_i, caused by a wealth effect.

(1.11) $dK_i/dt = f_i(\partial W_i/\partial t) = F_i; \qquad (i = A, B)$

The effect of a change in the interest rate of country A, I_A, on stocks of foreign assets is as follows:

(1.12) $dK_i/dI_A = (\partial f_i/\partial I_A)W_i$, which is a stock adjustment, dS_i/dI_A.

The effect of the interest change on flows, in relation to the growing wealth in both countries, is as follows:

(1.13) $d^2K_i/dtdI_A = (\partial f_i/\partial I_A)\,(\partial W_i/\partial t)$, which is a flow adjustment, dF_i/dI_A.

In a simple two-country model, the total effect of the interest change in country A on net short-term capital movements, C, that is, the induced change in foreign assets of country B (in liabilities to foreigners of country A) minus the induced change in foreign assets of country A, can be expressed as follows:

(1.14) $$C = [(\partial f_B/\partial I_A)W_B - (\partial f_A/\partial I_A)W_A] + [(\partial f_B/\partial I_A)(\partial W_B/\partial t) - (\partial f_A/\partial I_A)(\partial W_A/\partial t)]$$

While the expression in the first set of brackets is a differential stock adjustment between the two countries and it is completed over a given period of time (assumed here to equal one period), the expression in the second set of brackets is a differential flow adjustment that—on the assumption of a continued growth of total assets in both countries—continues indefinitely.

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out, Tobin-Markowitz's theory is concerned with individual financial behavior. The behavior of institutional investors creates a real difficulty in defining a collective utility function that should explain behavior of an aggregative portfolio selection. Baret (in Borch and Mossin, 1968, pp. 117–18) also suggested that the portfolio behavior of a proprietor who is investing his own funds is difficult to determine, since characteristics other than a possible monetary payoff enter into his utility function. Tsiang (1972, p. 368) has further pointed out that while the two-parameter portfolio selection analysis may be adequate for risk-averse portfolio investors (since they assume relatively small risk relative to their wealth), such analysis is not appropriate to handle entrepreneurs who regularly risk a major proportion of their total wealth.

In all such cases a two-parameter, mean variance analysis is clearly inadequate. The difficulties just mentioned are particularly relevant when international short-term capital movements are concerned, since portfolio behavior of a trader is typically that of a proprietor, while speculators often risk a substantial proportion of their wealth on the foreign exchange market. Also, institutional investors and banks are important participants in the foreign exchange market's speculative and arbitrage activities. Because of such a diversity of participants, a portfolio selection approach based on aggregate behavior, or on behavior separated by activities without regard to the nature of transactors, is not sufficiently defined. Leamer and Stern (1972, pp. 176–79) advanced a proposition that portfolio selection analysis based on a somewhat more homogeneous transactor group would be more satisfactory. However, such an approach faces important difficulties because of the lack of international comparability among transactors and because many of these transactors (such as traders) do not participate directly on the foreign exchange market but through various banking or brokerage institutions.

B. The portfolio selection theory, as developed by Tobin, did not involve diversification of assets on a geographical basis but endeavored to explain the behavior of a risk-averse investor by a diversification of his assets with respect to a degree of their liquidity, that is, with respect to the assets' maturity structure or the degree of risk. The nature of risk being what it is, it is reasonable to assume that an investor, operating on an international level, will also minimize risk by diversifying geographically. However, as pointed out by Rhomberg (1972, p. 317), an

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application of the portfolio selection theory limited only to one end of the maturity structure [44] violates the basic proposition of the theory. It is not possible to explain changes in short-term capital movements without considering (a) the effect of independent variables on the country's total capital assets; and (b) the risk-induced substitution of various subportfolios along the maturity scale resulting from a change in one or more of the independent variables.

C. The treatment of international capital movements in general and short-term capital movements in particular within the framework of a growing economy is still too pedestrian.[45] Still, even this simple approach faces difficulties. As has been pointed out by a number of critics of the portfolio theory (e.g., Liutner, in Hahn and Brechling (1965), pp. 18 ff., and Freimer and Gordon (1968), pp. 103 ff.), most utility functions upon which the theory is based imply a change in the degree of risk aversion associated with a change in wealth. Therefore a difference in the functional relationship between the growth of wealth and risk aversion in the two countries may generate flows, even if all other conditions indicate an equilibrium growth without international capital movements. This would mean that in such a case there would be an additional flow-adjustment effect as a result of a once-and-for-all change in the international interest rate differential. It has just been pointed out that the functional relationship between the growth of wealth and risk aversion is one of the difficult issues facing any application of the portfolio selection theory. While in a closed economy model such an issue may be considered less damaging to the theory, differences in this functional relationship between countries may generate international flows of capital whose direction cannot be deter-

[44] Studies, such as those by Branson and Willett (1972) and Miller and Whitman (1972), that apply the portfolio selection theory to international short-term capital movements consider only a country's total short-term assets as the wealth variable.

[45] It is well known that in a developed model of a growing economy a change in the interest rate will affect both savings and investment activity and thus will influence the growth rate of assets. The approaches used by Willett-Forte, Branson, and Miller-Whitman assume that a growth rate of assets is independent of the level of and the change in interest rates. More recently, Johnson (1972) developed several variants of a monetary growth model of the balance of payments; although his is not truly a portfolio selection model, it does treat capital movements in a proper setting of a growing economy.

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mined on the basis of the present state of the portfolio selection theory.[46]

D. Finally, the existence of international capital markets, such as those in London and New York, should also be considered. The gross asset position of institutions forming a part of these markets reflects the growth of wealth in other countries, which are using such institutions as intermediaries in their investment policies, rather than the growth of wealth in countries in which these markets are situated. In the portfolio selection theory, as applied to international finance, gross flows are essential to explain asset diversification. However, foreign wealth-induced aggregate increases in both assets and liabilities of institutions forming such an international capital market may be consistent with unchanged or even declining domestic assets of a country to which this market belongs, although neither international interest differentials nor a risk factor has changed in any way. Thus, a considerably more complex portfolio selection model is necessary to explain the geographical distribution (and, to some extent, also a maturity distribution) of assets in a country that has a major international capital market.

Despite all these criticisms, recent applications of the portfolio selection approach to Tsiang's theoretical framework represent a significant step forward in a development of the theory of international short-term capital movements. In particular, it has helped to resolve the controversy surrounding stocks and flows. While it led to the widespread adoption of stock adjustment models (or, more recently, of stock-flow adjustment models), it does not reject the arguments of those who insist that an arbitrageur's activity would generate international flows of short-term capital whenever covered interest differentials between countries exceed transactions costs.

4. General equilibrium analysis of capital movements

Much of the literature discussed thus far, in both the flow and stock versions, has treated short-term capital flows in isolation and not as part of an integrated macroeconomic system. Domestic interest rates, in particular, in these approaches have been viewed as entirely exogenous.

[46] This problem may be less damaging to short-term than to long-term capital movements. However, when a flow-adjustment effect resulting from a change in interest differentials is considered, such an effect can be estimated only if one can exclude flows induced by a comparative marginal wealth effect on risk aversion.

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An important development has been to incorporate financial flows into a more complete macroeconomic model of an open economy. We shall briefly mention the way in which international capital movements have been accommodated in these models. This brief survey is relevant because such a model was used recently as a framework for the empirical analysis of capital movements and of their effect on monetary policy of several industrial countries.

The early model of an open economy developed by Polak used a quantity theory framework, where capital flows were treated as entirely exogenous but the money supply was allowed to respond to the balance of payments.[47] The main interest of the model was to examine the relationship between changes in the credit creation of the banking system and the balance of payments. In this model, Polak has shown how an exogenous change in capital movements has an impact on the domestic money supply, which in turn influences both income and imports until equilibrium in the balance of payments is restored again.

Later models based on the Keynesian open economy framework were used in analyzing macroeconomic policies oriented toward the simultaneous maintenance of domestic full employment and balance of payments equilibrium.[48] Flow models developed by Mundell (1964), Johnson (1966), Argy (1969, pp. 267–78), Helliwell (1969 b), Baguley,[49] Courbis (1971), Basevi (1973), and others assumed capital movements to be endogenous, being sensitive to relative interest rates, but either the money supply or interest rates were taken to be exogenous variables. International capital movements played an important role in this analysis because the degree to which a country's capital flows were sensitive to interest rates was one of the key elements in determining a feasible policy mix for the internal-external balance.

Taking interest rates as exogenous variables in these models implied that, while the domestic interest rate was allowed to influence capital

[47] See Polak (1957–58) and Polak and Boissonneault (1959–60). A later paper by Polak and Argy (1971) suggested that while it may be appropriate to treat capital movements as exogeneous in less developed countries, this assumption is unrealistic for industrial countries; therefore, they developed a different model for the industrial countries.

[48] Pioneering work in this area on a less formal level was done by Mundell (1962) and Fleming (1962), who built upon the target-instrument framework of economic policy developed by Meade (1951) and Tinbergen (1952). A good review of models that analyze policies of internal and external balance is provided by Whitman (1970).

[49] In Caves and Reuber (1971, Appendix A); see also his doctoral dissertation (1969).

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movements, capital movements themselves did not influence interest rates. An implicit assumption was that monetary authorities adopt sterilization policies so as to counteract the effect of balance of payments developments on the domestic money supply or interest rates. Other flow models by Argy (1969, pp. 279 ff.), Swoboda (1972), and Aghevli and Borts (1973) used a Keynesian framework but treated the money supply as endogenous; they assumed that the monetary authorities either did not use sterilization policies or adopted a partial sterilization.

The appropriateness and relevance of these alternative Keynesian models are quite dependent on the extent or degree of sterilization by monetary authorities. Some attempts at econometric analysis of sterilization by Argy and Kouri (1972) suggest that in fact there may be only partial sterilization, but, as the authors show, the issues are complicated and not easily amenable to empirical testing. More important, the feasibilty of sterilization depends largely on the degree of capital market integration. The more financially integrated an economy, the larger the reserve volatility that is associated with a given dose of monetary independence. At the limit, where capital mobility is perfect, the domestic interest rate, and hence the domestic money supply, is completely at the mercy of developments in allied foreign markets.

At this point a distinction should be made between a "short-term" and a "long-term" equilibrium condition in these macro-models. Short-term equilibrium can be interpreted as an "impact effect" of the change in an independent variable in which behavioral relations in the model are satisfied but the balance of payments is not necessarily in equilibrium; the actual surplus or deficit caused by such a change in an independent variable is equal to the *ex ante* surplus or deficit. Long-term, or "full," equilibrium implies that the adjustment process in the model has worked itself out in such a way as to eliminate any payments imbalance. The analysis of a majority of the models just discussed is limited to a short-term equilibrium. Since these are flow models, in which a one-time change in the interest rate generates a continuous flow of capital, a long-term equilibrium would imply that the interest rate reverts to its original level.[50] Argy (1969), Polak and Argy (1971), and Swoboda (1972) have explored the long-term equilibrium condition by examining implications of monetary and fiscal policies on income and

[50] See Argy (1969, p. 274, footnote 8). This problem may create a difficulty in models in which interest rates are taken to be exogenous variables.

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international reserves, given the long-run constraint that the balance of payments must be restored to equilibrium.

A further development consisted in the use of a portfolio balance approach within a macroeconomic framework. Basically, it meant adding to the usual Keynesian open economy model an additional behavioral equation defining the equilibrium in the asset market [51] and including wealth as an explanatory variable in the expenditure, money, and asset demand functions. The portfolio approach permitted a treatment of capital movements as a stock adjustment phenomenon in the model. As indicated in Section 3, under such conditions the effect of a one-time change in the interest rate is seen as a transitory phenomenon causing a once-and-for-all change in a country's reserves but generating no continuous effect on the balance of payments.

Early, simplified, portfolio balance models of an open economy assumed either perfect immobility or perfect mobility of capital. A model by McKinnon (in Mundell and Swoboda, 1969) is based on complete international immobility of capital and does not concern us here. On the other hand, models by McKinnon and Oates (1966), Oates (1966), Levin (1970), and Whitman (1970) assume perfect capital mobility by considering that asset holdings by the private sector consist of both domestic and foreign bonds, which are treated as perfect substitutes. In these models, money supply is determined exogenously, implying that the monetary authorities sterilize the effect of disequilibrium in the balance of payments. Consequently, the equilibrium in this kind of model is satisfied when a surplus or deficit on the current account is offset by a deficit or surplus in the asset market.[52]

All these portfolio models consider the case of a single small country that is unable to influence variables in the rest of the world, such as foreign interest rates and the asset position abroad. When one considers the portfolio balance in the rest of the world, a long-term stationary equilibrium in models based on Oates's framework is inconsistent with continuing capital movements. Formal two-country macro-models taking up this problem are developed by Floyd (1969 a, b and 1972) and Allen (1973). In both models, a neutralization of the effect of capital

[51] However, Argy (1969, pp. 272–76) incorporated the asset market into a Keynesian flow model, but he did not introduce wealth as a variable influencing portfolio balance.

[52] Since in these models a disequilibrium in the assets (i.e., bond) market is generated by the surplus or deficit in the budget, this surplus or deficit must be equal to the surplus or deficit on the current account.

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movements on domestic money supply is assumed, but while Allen assumes a single type of asset in both countries and thus perfect capital mobility, Floyd considers the case of imperfect capital mobility with different interest rates in the two countries. Floyd's Keynesian model is addressed to a comparative static analysis of effects of changes in the money stock and output in one country on international capital movements and the balance of payments. Allen's model exhibits dynamic properties that enable her to distinguish between a short-run market equilibrium, when all markets are cleared, and a long-run portfolio equilibrium reached gradually through a sequence of short-run equilibria, when the additional condition of unchanged desired holdings of assets by participants is also met. On the basis of her model, Allen reaches an interesting conclusion that a change in one country's liquidity preference or in money supply will have no long-run effect on the balance of payments. The distribution of assets between countries achieved during this process depends on which country had a temporary balance of payments surplus; the surplus country will gain wealth. Finally, whether these disturbances in the liquidity preference or money supply are expansionary or contractionary in both countries will depend on their relative wealth effects on the demand for assets.

A distinctive feature of a model by Kouri and Porter (1972 a, b) is that, on the one hand, it treats the money supply as endogenous but, on the other hand, it treats the real sector as exogenous to the model. By specifying demand and supply functions for money and domestic and foreign bonds, Kouri and Porter are able to solve the model for changes in the domestic interest rate and net capital flows as a function of the same set of exogenous variables. In particular, the capital flow equation that they obtain enables them to directly estimate the effect of changes in domestic monetary policy on capital movements, under the assumption that the monetary authorities do not sterilize the effects of payment imbalances. Girton and Henderson (1973) have also developed a two-country financial portfolio model; however, the advantage of the Kouri-Porter approach is in the ability to use their reduced forms for quantitative analysis.

However, the macroeconomic portfolio balance approach has a number of unresolved problems. It is still limited to a one-country or a two-country analysis. In a multicountry approach the complexity of a disturbance-induced adjustment in asset holdings of various countries, which is consistent with the additional constraint of a portfolio balance

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in all countries, is still to be examined. Moreover, there is still no satisfactory treatment of the problem of growth of wealth at home and abroad, although recent monetary models by Johnson (1972), which relate growth of the overall balance of payments to growth in income, domestic credit, and international reserves, provide a basis for further analysis. Finally, the proper treatment of short-term capital movements requires integrating into a portfolio balance the macro-model forces that determine equilibrium on the forward exchange market.[53] Future developments in the analysis of short-term capital movements will no doubt attempt to fill the gap in these areas.

II. Empirical Analysis

Attempts to subject various hypotheses about the determinants of short-term capital movements to statistical tests are quite recent. Initially, these tests were limited to capital flows of the United States and Canada. Only since the beginning of the 1970s has econometric analysis been applied to the capital account of some developed countries outside North America. However, the methodology has not advanced beyond the estimation of either short-term capital flows of a single country or bilateral flows between two industrial countries. Finally, several attempts were made to estimate capital flow equations as a part of large econometric models of the Canadian and U. S. economies.

This part is divided into two sections: (1) a survey of the major methodological approaches that are structured within Tsiang's theoretical framework; and (2) a description of the more recent attempts to reformulate econometric analysis within the framework of the portfolio selection theory and to apply this analysis to capital movements of a number of industrial countries.

1. Early attempts and the "conventional" approach

The complexities of the forces influencing short-term capital movements are such that the first attempts at empirical analysis were necessarily limited. In his structural model of the Canadian economy and of its foreign exchange market, Rhomberg (1959–60, p. 450, and 1964, pp. 9–12) estimated Canadian short-term capital movements with the

[53] Attempts on this point were made by Levin (1970, pp. 83–90), Kouri and Porter (1972 b), and Basevi (1973).

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U. S.-Canadian interest differential, the forward premium, and the change in the Canadian floating rate as independent variables. Studies by Bell (1962) and Kenen (1963) consisted of simple or multiple regressions that used a selected number of independent variables. The use of a stock model by Bell and of a flow model by Rhomberg and Kenen was also on an ad hoc basis, since no theoretical reasons were provided. While Bell found little evidence that either movements of short-term U. S. claims on foreigners and of U. S. short-term liabilities to foreigners or their components were very sensitive to *changes* in international interest rate differentials (1962, pp. 440–47), he found a close log-linear relationship between U. S. claims outstanding and exports (1962, pp. 428–29 and 462). Kenen (1963, pp. 155–59 and *passim*), on the other hand, found a significant, but rather weak, relation between the various components of U. S. short-term capital flows and the *levels* of covered interest rate differentials; but he found no significant relation between exports and the component flows generally associated with export finance. Neither of the two studies found a significant relationship between short-term capital movements and uncovered interest rate differentials.[54] The more complex analysis by Rhomberg suggested that short-term capital movements played a stabilizing role in the Canadian foreign exchange market. They appeared to have offset large swings in Canada's basic balance without subjecting the exchange rate to substantial fluctuations.

Powrie (1964) also tested a flow version of Canadian short-term capital movements during the floating exchange rate period (1953–61). He used, in the same equation, both covered and uncovered interest differentials as regressors. He also tried to allow for speculation on exchange rate fluctuations by using as regressors the differences between the current and the future, as well as the current and the past, exchange rates. The explanatory power of his regression equations was not good.

The main difficulties in all these studies were as follows: (a) the lack of a rigorous theoretical framework relating short-term capital movements and the independent variables used in the equations tested;[55] (b) the use of disaggregated short-term capital flows by Kenen and Bell without taking into account the substitution effects

[54] Cohen (1963, pp. 196 ff.) attempted to reconcile the results of these two studies.

[55] However, Rhomberg's studies are pioneering because short-term capital movements were treated in a more systematic way, by a simultaneous estimation of the whole structural system through the limited information method.

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between various subflows; (c) a bias introduced by using interest differentials covered forward as independent variables; and (d) multicollinearity among the independent variables in the equations.

More rigorous approaches

By the mid-1960s it had been recognized (Stein, 1965 a, pp. 42–45; Heckerman, 1967, pp. 555–56; Laffer, 1967, p. 58; Stoll, 1968, pp. 49 ff.) that the use of a covered interest rate differential as an explanatory variable for short-term capital movements (whether expressed in the form of stocks or of flows) results in biased and inconsistent estimates. This is caused by the fact that the disturbance that affects short-term capital movements also affects the forward cover, so that there exists a substantial simultaneous relationship between the independent and dependent variables in the regression equation.

Stein attempted to construct a testable model that would, on the one hand, provide a theoretical framework for an empirical analysis of short-term capital movements and, on the other hand, permit a separation of the effects of the speculative activity from the effects of international interest rate changes. He attempted to explain the determinants of the speculative activity in order to avoid using the covered interest differential as an independent variable in the regression equation. The regression equation used was a linearized reduced form of a simplified equilibrium system for the spot and forward exchange markets based on Tsiang's approach. However, Stein thought that he could use as an estimate of speculation the residual between the actual and computed values obtained by regressing the pound sterling forward premium on the U. S.-U. K. interest differential.[56] Both the theoretical model [57] and the econometric methodology were questioned. Heckerman (1967) showed that Stein's "proxy" for speculation was derived in a way that was inconsistent on econometric grounds. Since the equations defining the demand and supply functions for spot dollars and the net demand function for forward dollars include a lagged adjustment variable, the error

[56] In other words, Stein thought that such a residual would capture the effect of the speculative activity that is not "explained" by regressing the forward premium on the interest differential. The same method was used by Prachowny (1969) in estimating determinants of short-term capital movements in his structural model of the U. S. balance of payments.

[57] Stein's expressing the U. S. basic balance as a function of the foreign exchange rate alone was critized by Branson (1968, p. 5), because in the Bretton Woods system of fixed parities the basic balance is insensitive to spot rate fluctuations between narrow intervention points.

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terms are serially correlated in the reduced form regression equation. This, of course, leads to biased and inconsistent estimates of the determinants of short-term capital movements. Stein used his structural equation, which basically expressed short-term capital movements as a function of the interest rate differential and of the residual as a proxy for speculation, to empirically test the validity of a stock and a pure flow model in the analysis of short-term capital movements. Despite the fact that he favored the flow model, his quantitative results were such that no distinction could be made between the two models.[58]

A more rigorous application of Tsiang's theoretical model for estimating short-term capital movements between the United States and Canada was attempted by Black (1968). He carefully specified a structural system for the spot and forward exchange markets and developed a system of two testable regression equations with short-term capital movements and the change in the forward exchange rate as dependent

[58] Stein's regression analysis is interesting because it illustrates pitfalls of econometric techniques incorporating lagged adjustment. His "stock" and pure flow versions of the regression equations were as follows:

(2.1) $S_t = a_0 + a_1 S_{t-1} + a_2 Id_t + a_3 R_t$ a "stock" version

(2.2) $\Delta S_t = b_0 + b_1 Id_t + b_2 R_t$ a flow version

where S was the stock of shortterm U. S. banking liabilities abroad or of short-term U. S. banking foreign assets; Id was the U. K.–U. S. 90-day treasury bill differential; and R was the "proxy" for speculation. The proxy stood for the following expression in the structural equation:

(2.3) $$R_t = c_1 r_t^e - c_2(T_t - w_t)$$

where r^e was the expected foreign exchange rate, T was foreign net official (positive or negative) sales of dollars during the period tested, and w was the error term in the equation for supply of spot dollars.

Although equation (2.1) appeared to be a stock adjustment equation, the fact that in Stein's regression equations the estimate of coefficient a_1 was not significantly different from unity (Stein, 1965 a, pp. 60–62) made stock and flow equations identical; that is, from equations (2.1) and (2.2):

(2.4) $$\Delta S_t = S_t - S_{t-1} = a_0 + a_2 Id_t + a_3 R_t = b_0 + b_1 Id_t + b_2 R_t$$

Actually, equation (2.1) is a Koyck-Nerlove type of stock-adjustment equation in which $a_1 = \lambda$. Since Stein estimated a_1 to equal unity, $1 - \lambda = 0$; hence, equation (2.1) becomes a continuous flow equation.

In most cases in which the flow version was used in the regression analysis, the lagged value of the dependent variable was by far the most significant variable and the interest rate was not significant. As Bryant and Hendershott (1970 b) have pointed out, this may have been the major reason why the value of a_1 was spuriously close to unity.

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variables. Black eliminated the problem of endogenicity of the spot and forward exchange rates in the regression equation by using the two-stage least-squares estimation. He further introduced the use of a distributed lag function of the observed foreign exchange rates as an estimate of the expected exchange rate, a key variable in defining speculative activity.

Black also formalized a stock and a flow model of short-term capital movements and used the regression analysis to test the validity of these two alternative concepts. Although he favored the flow concept, his "hybrid" model, combining a stock and a flow concept, yielded the best empirical results; this should have indicated that the time adjustment process was more complex than the one expressed by either a pure stock or a pure flow model. The explanatory power of Black's regression analysis was not very high, probably as a result, in part, of using a simple exchange rate expectations function. Black found a significant, but quite low, interest sensitivity in U. S.-Canadian short-term capital movements. In a somewhat simpler regression analysis of short-term capital movements between the same two countries, based on a more general structural model of the capital accounts, Caves and Reuber (1971, pp. 70–87) obtained somewhat better results. They sided with a flow concept and used forward exchange rate as an exogenous variable.

The exchange between Stein and his critics and Black's efforts contributed greatly toward clarifying many of the issues that face one who attempts to empirically estimate the determinants of short-term capital movements in a way that is consistent with a theoretical framework. Insofar as the structure of the model is concerned, it became obvious that any choice between stock and flow approaches on the basis of the empirical evidence alone was a fruitless exercise; such a selection can be meaningful only if it is consistent with a clearly formulated theoretical hypothesis. It also became obvious that quantitative estimates of speculative activity cannot be made unless a satisfactory function explaining exchange rate expectations can be introduced into the econometric model. Finally, it became more and more apparent that the adjustment process either in exchange rate expectations or in the short-term capital flows may be spread over a period of time. Thus, some form of lagged adjustment of dependent variables to changes in independent variables should have been considered.

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Estimating effects of speculation

Since the late 1960s, several attempts have been made to provide a more rigorous explanation of the effect of speculation on short-term capital movements. In particular, a number of ways have been tried to formulate an estimating equation capable of explaining the exchange rate expectations that are the key instrumental variable in expressing speculative activity. Stoll (1968) and Arndt (1968) drew on the Koyck-Nerlove concept of adaptive expectations in expressing the expected exchange rate as a geometrically declining weighted average of past spot rate. It is well known, however, that when the Koyck distributed lag model is used to express a lag adjustment process, the estimates are subject to serious serial correlation in the disturbances and are beset with problems of specification that are likely to lead to inconsistent estimates.[59] Furthermore, if serial correlation is positive, which it is most often, a substantive upward bias may be introduced into the estimated average lag.[60] Arndt used the "three pass least squares" method as an alternative procedure to eliminate the problem of serial correlation. However, this procedure resulted in an even longer period of adjustment (Arndt, 1968, p. 63, and Table 1). Also, the length of the lag based on either of the two methods of estimation was not robust and changed substantially when the regression coefficient of the term in question was changed within the limit of one standard error.[61]

Econometric models using the geometric lag structure to express the process of formation of exchange rate expectations were criticized as inappropriate in the system of fixed parities, with a band within which the spot exchange rate tends to fluctuate in something of a sinusoid fashion. Branson (1968, pp. 43–66) approximated such a formation of expectations by a second-order difference equation of observed exchange rates, on which equation he imposed conditions reflecting dampened oscillatory movements. He used this model, in a study of U. S. financial capital flows, for estimating expected exchange rates of Canada

[59] See, on this, Griliches (1967, pp. 33–43). Bryant and Hendershott (1970, pp. 234–36) also pointed out that even though the regression equation may be seriously misspecified, the stock adjustment model based on the Koyck lag method can generate superficially plausible estimates.

[60] Several studies of short-term financial variables based on the Koyck distributed lag method have come up with estimates of a considerable length in the adjustment process, which casts doubt on their reliability (see, e.g., Hendershott, 1967 b, pp. 461–65).

[61] See, on this, Hodjera (1971, p. 748, including footnote 17).

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and of several European countries. However, his estimated coefficients of the regression equations did not generally satisfy stability conditions for dampened oscillatory movements.[62] Kesselman (1971) also tried to describe oscillatory movements of the exchange rate within the band by a so-called dual expectation model. He combined an adaptive expectation equation along the lines of a Koyck-Nerlove approach with an extrapolative expectation equation showing a movement away from some "normal" exchange rate.[63] However, Kesselman's complex structural equation was underdetermined, so that he could obtain only a range of solutions by considering one coefficient as a variable parameter and by calculating other coefficients over a range of values of that variable parameter. Furthermore, the regression result exhibited a high degree of positive serial correlation of residuals, strongly suggesting that one or more important variables had been omitted.[64]

More recently, in a study of Germany's capital movements, Kouri and Porter (1972 b) advanced a hypothesis that the determination of the forward rate is dominated by speculative activity and that speculators' exchange rate expectations are determined basically by the relative inflationary processes at home and abroad. In their study, they proceeded to explain the forward premium on the deutsche mark in terms of the ratio of the cumulative rates of inflation in Germany and in the United States. The regression analysis yielded reasonably good results. However, a closer examination of residuals suggests that the correlation coefficient was dominated by the substantial speculative pressures between late 1967 and 1970, while during the earlier period of the series tested (i.e., the first quarter of 1963 to the third quarter of 1967) the fit does not appear to be very good. Thus, the hypothesis by Kouri and Porter appears to be a quite useful approach in explaining longer-term speculative forces during the period of protracted destabilizing speculation and should be tested for other industrial countries. However, dur-

[62] In further estimations of capital movements of the United States and other European countries, Branson abandoned his model of exchange rate expectations. For most countries, he used only dummy variables for destabilizing speculative activity.

[63] The movement in the succeeding period is assumed to continue in the same direction, but the level of the exchange rate is only *fractionally* larger than that of the preceding period. This condition ensures stability for the extrapolative expectation model.

[64] Kesselman (1971) attempted to improve the fit by experimenting with a number of more or less ad hoc "real world" variables as additional independent variables in the equation. The results improved somewhat but at the expense of the theoretical consistency of the model.

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ing periods of confidence in the parity, exchange rate fluctuations are dominated by the intervention points of the band, and also in such conditions arbitrage activity cannot be ignored as a determinant of the forward rate. Finally, the Kouri-Porter hypothesis cannot explain sudden, large, international shifts in short-term assets generated by intensive speculative crises.

Black (1972, and 1973, pp. 22–27) used a more flexible approach in analyzing the effect of speculative stocks on short-term capital movements within a floating exchange rate system. He reformulated Muth's (1961) analysis of rational price expectations in order to construct a nonstochastic model of exchange rate expectations. This model enabled him to specify behavioral relations for different kinds of disturbance and to associate these with different time paths of exchange rate movements. Completely foreseen disturbances are distinguished by exchange rate changes originating ahead of the event, reaching a peak at the time of the event, and afterward returning progressively toward the original level. In unforeseen disturbances there is a sudden large exchange rate adjustment at the time of the event and then a slow adjustment toward the original level, while in partially foreseen disturbances a sudden change may occur some time ahead of the event. Black approximated the effect of these disturbances on exchange rates and capital movements by a series of exponential dummy variables of an appropriate form. Using his model for an econometric analysis of short-term capital movements between Great Britain and the United States in the latter half of the 1930s, Black has obtained results that are consistent with his expectations hypotheses and that suggest that the forward market has played an important role in determining equilibrium in the foreign exchange market.

It can be seen from all this that empirical studies of the possible determinants of speculation have not yet produced very encouraging results. Many problems raised by these efforts—in particular, the problem of the adjustment process involved—have provided thought for further theoretical analysis. However, despite progress achieved by Black (1973), the problem of explaining the formation of exchange rate expectations still remains basically unresolved. Without such an explanation, no satisfactory testable hypothesis can be advanced that could handle speculative behavior, especially the behavior within the system of pegged exchange parities. This difficulty is compounded by the fact that any empirical analysis of short-term capital movements in recent years

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should be able to properly incorporate both stabilizing and destabilizing speculation.

2. Tests of the Portfolio Selection Approach

Short-term capital movements of the United States

The application of the theory of portfolio selection to international capital movements provided a much more satisfactory framework for economic analysis than did the earlier "conventional" approach. However, adapting this theoretical framework to econometric analysis involved resolving a number of serious methodological and statistical difficulties, so that the progress was relatively slow. Thus, although Branson pioneered in developing the theory of portfolio selection in this area, his initial empirical investigation of U. S. financial flows (1968, Chs. 4 and 6) represented essentially a transition from the conventional approach to the portfolio selection approach. His selection of a stock adjustment structural model in relating independent variables to short-term foreign assets and short-term liabilities abroad was consistent with the portfolio selection theory, as was his testing of gross rather than net financial flows as dependent variables. On the other hand, the lack of wealth as an explanatory variable in his model, and no clear concept of risk, reflected conventional lines of analysis.

Branson's attempt to use a polynomial lag model to estimate the stock adjustment process in financial variables is of methodological interest. This method avoided problems of serial correlation and of possible inconsistency in estimates associated with the Koyck-Nerlove distributed lag technique,[65] as well as the awkwardness of a geometrically declining lag profile. However, the unusually flexible lag structure of the polynomial lag model, and the Almond technique of selecting a lag with the best fit, generates a lag adjustment process that is practically tailor-made for each series tested. The resulting lag profile is not based on any a priori hypothesis of what the adjustment process to that particular financial variable should look like. Furthermore, since the application of the polynomial lag technique for any one of the independent variables in the regression equation uses up a considerable number of degrees of freedom, extensive use of such techniques in Branson's econ-

[65] For the use of such a technique in portfolio models, see Bryant and Hendershott (1972, pp. 216–25 and 233–36) and Miller and Whitman (1972, pp. 262 ff.).

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ometric work raises the question of the appropriate level of significance for his coefficients.[66]

Branson's selection for the final regression equation of various industrial countries' interest rates and of instrumental variables standing for expected exchange rates appears arbitrary, since this selection was based on a trial-and-error technique. His method of truncating the lag adjustment process in order to select only those current or lagged variables that, based on his statistical exploration, appear to exert significant influence can also be questioned. Nevertheless, the results of his econometric estimation are interesting and suggestive.

Branson has estimated that an increase in the interest rate differential of 1 per cent in favor of the United States generates an inflow of short-term capital of $0.8–0.9 billion over the six-month period, which considerably exceeded all earlier estimates. However, he also uncovered an asymmetry in the sensitivity of short-term flows to changes in the U. S. interest rate compared with foreign rates. When tested separately as independent variables, the U. S. rate had a substantially smaller explanatory power than did most foreign rates. Branson suggested that rates in foreign national money markets adjust rapidly to changes in the U.S. rates, while, on the other hand, foreign monetary authorities could intervene in their domestic money markets without making an impact on the U. S. interest rate.[67]

A regression analysis, more consistent with the portfolio selection theory, was developed by Lee (1969), Bryant and Hendershott (1970,

[66] This problem becomes even more important in view of Branson's rather lax standards for determining the level of significance of his independent variables. He considered as sufficient that the estimated coefficient in the regression equations exceeded the size of its standard error, which reflects a level of significance of less than 70 per cent (instead of the usual 95 or 99 per cent). In his further econometric work on international financial flows, Branson abandoned the Almond polynomial lag technique and fell back on the use of simple, unconstrained lags of one or two periods. Such a technique has the advantage of simplicity and is particularly useful when the expected lag adjustment process is of a relatively short duration. The disadvantage is that the lag structure is even less defined. For the use of simple lags in the empirical analysis of short-term capital movements, see Branson (1970), Hodjera (1971), and Branson and Hill (1971 b).

[67] He confirmed this by finding that simple regression coefficients of changes in interest differentials on changes in corresponding foreign interest rates were in all cases considerably larger than the regression coefficient of the same changes in interest differentials on the change in the U. S. interest rate. However, since in Branson's analysis interest rates are taken to be exogenous variables, this evidence of a fairly rapid adjustment in foreign rates to changes in the U. S. interest rate points out a bias in the estimation of the interest elasticity of U. S. short-term capital movements.

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1972), Branson and Hill (1971 b), Branson and Willett (1972), and Miller and Whitman (1972). All these studies involved estimation of U.S. short-term capital movements, except that Bryant and Hendershott limited their analysis to bilateral flows between the United States and Japan.[68] The improvement on Branson's (1968) approach consisted in the introduction of wealth as a constraint and as a scale variable in the regression equations. This method permitted a more rigorous estimation of the effect of interest rate changes on the adjustment in the stock of foreign assets held. Furthermore, it permitted estimating the effect of interest rate changes on the continuous flow of short-term capital induced by a growth of wealth at home and abroad.

In most cases the method used consisted of a separate estimation of a stock adjustment and a flow adjustment process.[69] Miller and Whit-

[68] Lee also studied bilateral flows between the United States and Canada. However, his study is limited to flows of long-term securities and is here referred to for reasons of methodology. For the same reason, mention is made of a study of the U. S. portfolio investment by Miller and Whitman (1970), since the methodology developed in that study is applied to the two authors' analysis of U. S. short-term capital movements.

[69] A structural equation similar to equation (1.10a) can be used to illustrate the estimation procedure. The stock of foreign assets, K, held in one country is then expressed as the following function:

$$K = f(Id, If, \sigma, K, Z)W \tag{2.5}$$

where, in addition to variables already described, σ is the index for differential risk between domestic and foreign assets and Z is a vector of other noninterest-rate distribution variables (such as domestic credit controls and various controls of short-term capital movements).

The stock adjustment effect on a given country's holdings of foreign assets is tested by a regression equation, which is a linearized first-difference form of equation (2.5):

$$\Delta K = a_0 + a_1 W + a_2 \Delta(WId) + a_3 \Delta(WIf) + a_4 \Delta(W\sigma) + a_5(WX) + a_6 \Delta(WZ) + u \tag{2.6}$$

with $a_2, a_4 < 0$; $a_3, a_5 > 0$; and $a_1, a_6 \gtrless 0$

where u is the error term. If the adjustment process is expected to exceed one time period, lagged values of independent variables may be included in the equation.

The flow adjustment effect is calculated in various ways based on equation (1.13). The simplest way is indicated by Branson and Willett (1972, p. 293), who assumed a unitary wealth elasticity of the portfolio growth (i.e., other things being equal, foreign assets remain a constant proportion of the total portfolio). The ratio of the flow effect to the stock effect then becomes equal to the rate of growth of wealth. (If, e.g., wealth is growing at 5 per cent a year, then the initial annual flow effect of a given interest change will be 5 per cent of the initial stock effect induced by that change.)

Then, in a model of two countries, A and B, and assuming that a stock adjustment is completed within one period, a net short-term capital flow, C, induced during that period by a 1 per cent change in the interest rate of country A is as follows:

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man, Branson and Willett (1972), and Bryant and Hendershott estimated the determinants of U. S. short-term holdings of foreign assets only, using as a wealth variable several variants of total U. S. short-term assets.[70] Only Branson and Hill (1971 b) estimated all three major categories of U. S. short-term capital flows (i.e., foreign assets, liabilities to foreigners, and errors and omissions) by using as a proxy for foreign wealth variables a sum of the value of gross national product (GNP) of the six major industrial countries other than the United States.[71] The regression analysis by Miller and Whitman and by Bryant and Hendershott shows a greater degree of consistency with their theoretical framework than is true with others.[72] However, even these writers could not avoid using some ad hoc proxies for those variables in their theoretical framework that were unobservable or empirically untractable. Branson and his collaborators have shown more flexibility by taking into account institutional conditions in the U. S. money market, but their methodology suffers from the trial-and-error approach to selecting variables for the regression analysis.

Neither of these investigations was successful in handling the difficult problem of estimating risk. While Miller and Whitman attempted to use a proxy for the degree of risk attached to U. S. domestic assets, arbitrageurs' and exchange rate risks were altogether left out of the estimating equations. Bryant and Hendershott showed considerable ingenuity in estimating the effect of capital restrictions on lending to Japan by U. S. banks. They went beyond the usual way of using dummy variables for such a purpose and constructed variables that reflected a differential restrictive impact of the U. S. voluntary foreign credit restraint program,

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$$(2.7) \qquad C_A = \overset{+}{a_{3B}} W_B(1 - gw_B) - \left[\overset{-}{a_{2A}} W_A(1 + gw_A)\right]$$

where a_{ij} $(i = 2, 3;\ j = A, B)$ is coefficient i in the regression equation (2.6) for country j; W_j is the value of wealth in country j at the end of the period, as the scale variable; and gw_j is the growth rate of wealth in country j. Above the coefficients, a_{ij}, are the expected signs.

[70] Bryant and Hendershott used the net worth of U. S. banks as the wealth variable in analyzing U. S. bank lending to Japan. Furthermore, they estimated only a stock adjustment effect of interest rate changes.

[71] Their domestic wealth variable consisted of the net worth of U.S. consumers, which is more consistent with the theory of portfolio choice than a wealth subset, such as total short-term assets alone.

[72] However, the use of the Koyck distributed lag model in the Miller-Whitman regression equations appears to have generated an excessive length in the adjustment process and thus to have biased upward the estimated sensitiveness of short-term capital movements to changes in independent variables.

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of the increase in creditworthiness of Japanese borrowers, and of relaxations in Japanese capital restrictions.

Because of substantial differences in methodology, a comparative analysis of regression results obtained by these studies would not serve a useful purpose. However, on one point all studies appear consistent. In all studies, U. S. domestic and foreign interest rates are entered separately in regression equations, and the results indicate higher responsiveness of capital movements to changes in foreign interest rates than to changes in the U. S. rate. These results are consistent with Branson's (1968) suggestion that a change in the U. S. short-term interest rate is followed rapidly by adjustments in foreign interest rates, while foreign rates are freer to change without repercussions on the U. S. money market. Therefore, the estimated sensitivity of short-term capital movements to changes in U. S. short-term rates appears to be biased downward.

Capital movements of other industrial countries

Econometric analysis of capital movements of countries other than the United States and Canada is quite a recent phenomenon. The major stumbling block had been a lack of adequate data for the capital account. Up to now there have been studies of short-term capital movements for only three countries—the United Kingdom (Hodjera, 1971), Germany (Willms, 1971; Porter, 1972; Kouri and Porter, 1972 a, b; and Kouri, 1973), and, quite recently, France (Bourginat and others, 1973). The degree of financial integration for several European countries was studied indirectly by Argy and Hodjera (1973), who used a reduced form regression equation of the forward exchange market in which data on short-term capital movement were not necessary.[73] Total capital movements, which include both short-term and long-term capital, were examined for several industrial countries by Branson and Hill (1971 b) and Kouri and Porter (1972 a, b).

The approaches were based on an incomplete form of the portfolio selection theory, since—because of the lack of data—no wealth variable could be included. Also, *net* capital flows were used in all cases as dependent variables. Furthermore, with the exception of Hodjera and of

[73] The reduced form of the system including an arbitrageurs' supply function and a speculators' and traders' demand function was solved for the forward premium. The size of forward commitments, generating short-term capital movement, drops out in the solution.

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Kouri and Porter (1972 b), no attempt was made to include variables to represent exchange risk. The studies can be separated broadly into two categories: those assuming interest rates to be exogenous variables and those treating these rates as endogenous.

In analyzing U. K. short-term capital movements, Hodjera (1971) examined total short-term capital movement and its three major components. He found the U. K./Euro-dollar interest rate differential significant in influencing capital movements, particularly when net transactions in non-sterling area currencies are concerned. He also found that a lagged trade balance operates as a sensitive index of speculators' confidence in the parity of the pound and could be used as a variable for speculation during the period covering crises in the U. K. balance of payments between November 1964 and November 1967. In using the interest rate differential covered forward, he also found that in the period 1963–67, which was dominated by destabilizing speculation, use of the forward cover, which is an endogenous variable in the equation, introduces a large upward bias in the estimate of interest sensitivity of short-term capital flows.

Branson and Hill (1971 a, b) applied methods of analysis developed in earlier Branson studies of the U. S. financial capital account to six other major countries in the Organization for Economic Cooperation and Development. Because of the lack of data on capital movements in some of these countries, the authors had to use as capital flow series the balance of payment residuals between the official settlement position and the current account balance. Despite these difficulties, the results for Germany, Japan, and Italy were encouraging. The explanatory power of the regression equations for these countries is relatively high.[74] While in Germany and Japan assorted short-term and long-term domestic interest rates and foreign interest rates were significant explanatory variables, in Italy the most significant variables were the gap between potential and real GNP, and the Euro-dollar rate. In many aspects the study by Branson and Hill is pioneering, since it is the first attempt to estimate the determinants of the capital movements of major industrial countries in such a way as to achieve analytic comparability. However,

[74] However, for Japan, good explanatory power of the regression equation that does not include a variable for capital controls is surprising, when compared with tests of Japanese borrowing from the U. S. banking sector by Bryant and Hendershott (1972). The latter found that capital controls account for about 70 per cent of the variation in borrowing.

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before substantial progress can be achieved in this area, the question of the quality of data for capital flows and their components and for major domestic explanatory variables—including variables for differing institutional conditions—must be resolved.

Kouri and Porter (1972 a, b) [75] have developed an interesting method for empirical analysis of capital movements that was based on a model with domestic interest rates as endogenous variables. They were thus able to avoid the problem of biased estimates that are caused by a simultaneous relationship between capital movements and interest rates. Such a simultaneous relationship occurs when interest rates are treated as exogenously determined [76] and the monetary authorities are not sterilizing the effect of capital movements on domestic liquidity. The underlying model is based on the portfolio selection approach, but, as in all earlier models for countries other than the United States, the regression equations do not include wealth as a constraint and as a scale variable.

Kouri and Porter used a reduced form of their model and a limiting case of perfect capital mobility to obtain a regression equation for capital movements, in which changes in the Euro-dollar rate, in the domestic component of the monetary base (which is adjusted for the reserve requirements), and in domestic income, as well as in the level of the trade balance, are taken as independent variables.[77] The hypothesis is that the change in base money is used as an exogenous policy instrument by the monetary authorities but may be offset by induced capital movements. If the coefficient of the change in the domestic base money component is equal to unity, this component is perfectly offset by capital flows; if it is equal to zero, there is no offsetting, that is, the effect of capital movements on the money supply is completely sterilized by the authorities. An offset coefficient close to unity also implies a high degree of integration between the domestic and foreign capital markets. Financial integration that is so nearly perfect means that monetary authorities are powerless in their attempts to sterilize the effect of international capital movements on domestic money supply.

[75] See also Kouri (1973).

[76] For a discussion of a simultaneous equation bias in estimates of sensitivity of U.S. capital movements to changes in the U.S. interest rate, see Branson (1968, pp. 99–103). For earlier systematic treatment of the bias, see Black (1968) and Bryant and Hendershott (1970, Appendix A). Rigorous analysis is provided by Kouri and Porter (1972 a).

[77] The use of an instrumental variable for the forward rate in Germany (Kouri and Porter, 1972 b) has been discussed earlier.

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The regression equation is tested for four industrial countries. The results appear to be encouraging. It is interesting that the change in income (as an index of a change in the transactions demand for money) is significant in all cases tested. The "offset coefficient" for Germany is 0.7–0.8; it is about 0.6 for the Netherlands, 0.5 for Australia, and 0.4 for Italy. It appears that German monetary policy was not very effective during the 1960s, as it was largely offset by induced capital movements. On the other hand, in the other three countries there was apparently more scope for a partial neutralization of the liquidity effects of capital movements.

On closer examination, the regression results for Germany, Australia, and, to some extent, Italy appear to have been dominated by periods of substantial destabilizing speculation in the closing years of the 1960s. This is probably caused by an important simultaneous relationship exhibited in the regression equation between capital movements as a dependent variable and domestic money supply as an independent variable. Such a simultaneous relationship is expected to generate a substantial bias in the coefficients and in the level of significance when periods with large speculative flows are included in the series used. Also, lack of significance of any foreign interest rate in the regression equations for the Netherlands, Italy, and Australia is surprising. Nevertheless, Kouri and Porter have initiated an important econometric approach based on a general equilibrium analysis, which, on the one hand, avoids the bias occurring in models that assume interest rates to be exogenous and, on the other hand, facilitates statistical analysis by expressing the (often unavailable) appropriate domestic interest rate in terms of other monetary variables.

III. Conclusions

The theory of international short-term capital movements has experienced significant progress over the past 20 years. The integration of the spot and forward exchange markets within Tsiang's framework permitted a more rigorous explanation of the forces influencing short-term capital movements. The application of the theory of portfolio selection to international finance settled the stock-flow controversy, led to the development of theoretically more satisfactory stock adjustment models, and permitted the treatment of financial flows within the framework of

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a growing economy. A parallel development of macroeconomic models of an open economy allowed an analysis of capital movements within a general equilibrium framework and led to a more complete explanation of causal links between short-term capital flows and domestic monetary policies. However, although progress has been made in integrating some of these approaches into a unified framework, a number of serious problems have remained unresolved.

1. The formation of exchange rate expectations still needs to be explained before the forward exchange market can be incorporated into a theory of short-term capital movements. Furthermore, the problem of integrating the forward exchange market into portfolio selection models is still far from resolved. This is particularly so if the aim of the analysis is to facilitate econometric estimation in term of observable variables.

2. The problem of dynamic adjustments in models describing short-term capital movements is as yet barely outlined. These adjustments involve two separate issues. (a) The analysis of capital movements between growing economies is probably more germane to long-term portfolio investment. However, the inclusion of savings and investment functions into an open economy's interest determination process that would be consistent with some concept of equilibrium growth, as well as with international reallocation of assets, must be resolved if portfolio balance models are to be useful in analyzing international capital movements. (b) The process of adjustment of capital flows, as a dependent variable, to changes in one or more independent variables is more germane to the dynamics of short-term capital movements. Although some results have been achieved in the analysis of the distributed lags on the microeconomic level and in a closed economy, little is known about the appropriate lagged adjustment process when variables influencing international short-term capital movements are concerned.

3. Finally, the most difficult problem still to be faced in formulating a theory of short-term capital movements is the development of a framework covering more than one or two countries. The portfolio balance behavior should be mutually consistent in all countries covered. In a multicountry framework, simultaneous determination of variables hitherto assumed to be exogenous, such as the "foreign" interest rate, should also be attempted. Although the tremendous difficulties of such a task should not be underestimated, only in this way can a truly general equilibrium analysis of capital flows be achieved.

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The econometric analysis of short-term capital movements has also progressed in recent years. A better specification of structural relationships underlying the regression analysis of U.S. capital movements has resulted in considerably improved estimates of the effects of changes in some key financial variables, such as interest rates. The use of this improved methodology has provided the basis for a systematic comparative study of determinants of short-term capital movements in a number of other industrial countries. Econometric estimation based on general equilibrium macro-models, with the domestic interest rate treated as an endogenous variable, was a further step in this direction.

However, the progress in empirical work in recent years has been rather lopsided. One reason for this has been the inadequacy of data on financial variables in most countries. Another reason has been an increasing discrepancy between the rapid advance in econometric techniques and the rather slow development in the specification of a structural framework upon which the regression analysis of short-term capital movements is based. Often, methods from other areas of quantitative analysis are applied to international financial flows with rather dubious results. Instead of attempting to use new, powerful econometric tools in the analysis, perhaps the more modest goal of developing a carefully defined structural framework is currently appropriate. A useful development along these lines has consisted of estimating techniques that take careful account of various institutional rigidities, such as controls of capital movements or other forms of intervention in the foreign exchange market mechanism. Also, specifying a theoretically consistent framework based on independent variables for which data are readily available can be much more fruitful than applying advanced techniques to an ad hoc framework.

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