PRINCETON STUDIES IN INTERNATIONAL FINANCE NO. 32

# International Money Markets and Flexible Exchange Rates

Stanley W. Black

INTERNATIONAL FINANCE SECTION
DEPARTMENT OF ECONOMICS
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## PRINCETON STUDIES
## IN INTERNATIONAL FINANCE

This is the thirty-second number in the series PRINCETON STUDIES IN INTERNATIONAL FINANCE, published from time to time by the International Finance Section of the Department of Economics at Princeton University.

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This series is intended to be restricted to meritorious research studies in the general field of international financial problems which are too technical, too specialized, or too long to qualify as ESSAYS. The Section welcomes the submission of manuscripts for this series.

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

PETER B. KENEN
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## ERRATA

The definition of the covered interest differential on page 36 as $z = NYB - LB + u$ should be corrected to $z = LB - NYB - u$.

In the Glossary of Symbols, $z$ should be defined as $R_f - R_d - u$ instead of $R_d - R_f + u$.

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# CONTENTS

## LIST OF TABLES



## LIST OF FIGURES

# I. INTRODUCTION

The international monetary crises of the 1960's and 1970's have raised hard questions concerning the inherent stability of the monetary system based on the Bretton Woods Agreement. Many economists now believe that the combination of independent national monetary policies, pegged exchange rates, and unrestricted international capital movements is unstable in principle.[1]

The instability principle can be stated for the "dilemma" case of a country with a balance-of-payments deficit and high unemployment. Low interest rates encourage short-term arbitrage funds to flow toward countries with high interest rates, with the arbitrageurs protecting themselves against exchange loss by selling foreign exchange forward at the same time they are buying it spot. Under flexible exchange rates, the resulting pattern of forward rates would approximate those indicated by the interest-parity theory: the currencies of countries with high interest rates would be at discounts forward and those of countries with low interest rates at a premium, and covered interest differentials would tend to disappear. The operation of interest arbitrage would be self-limiting. At the same time, speculators with diverse views on expected future spot exchange rates would tend to be long forward in the currencies of high-interest-rate countries and short forward in the low, engaging in stabilizing speculation. Under a regime of pegged exchange rates, by contrast, the loss of reserves implied by the flow of funds out of countries with low interest rates can instill doubts about the ability of the authorities to maintain the pegged rate. The famous "one-way bet" on devaluation replaces dispersed expectations with the politician's nightmare — a bear attack by speculators and businessmen seeking to avoid the effects of devaluation. The currency of the low-interest country can move to a discount forward, not a premium, providing an incentive to additional arbitrage flows toward high-interest countries and accelerating the loss of reserves.[2]

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Most of this study was written while the author was a member of the International Finance Section and Assistant Professor at Princeton University. Research support from the Section and Princeton University is gratefully acknowledged. The computations were ably performed by Pieter Brakel, and the typing by Linda Timmons.

[1]See, for example, Halm (1969). For an earlier statement, see Meade (1951, Chap. XVII).

[2]For a discussion of this case that omits forward exchange markets, see Halm (1969, pp. 12–15).

There are, broadly, three possible remedies for this kind of instability: (1) greater international coordination of monetary policies, tantamount to abandonment of independent national monetary policies; (2) controls on international money markets, tantamount to restrictions on convertibility; and (3) resort to flexible exchange rates, including such variations as wider bands and the crawling peg. Economists have a responsibility to bring all available evidence to bear on the crucial questions of this debate, especially the roles of arbitrage and speculation under fixed and flexible exchange rates.[3]

This study presents a theoretical and empirical analysis of a two-country model of international money markets with flexible spot and forward exchange rates. The theoretical model provides a framework for understanding the interrelationships among the many variables in the empirical data. There is an underlying symbiosis between the theoretical and empirical parts of the study: indeed, I can confidently state that neither part would have been completed without the stimulus of the other.

The empirical portion of this study uses the only body of data that gives commitments in *both* spot and forward exchange markets for a period of flexible exchange rates — the U.S. Treasury Department's *Statistics of Capital Movements between the United States and Foreign Countries* for the late 1930's. These data are used to test hypotheses that are the basis of the properties of the theoretical model. Other hypotheses tested relate to the extent of covering in forward markets and the stabilizing or destabilizing nature of speculation. The results should help to resolve conflicting assertions made about the forward exchange market and flexible exchange rates. In the absence of direct empirical evidence, such assertions have run all the way from Sohmen's (1969) belief that the forward market removes all uncertainty caused by flexible exchange rates[4]

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[3]For a general discussion of the dilemma and its possible resolutions, see Cooper (1968). The flexible-exchange-rate alternative is discussed by Lanyi (1969).

[4]Sohmen believes that, because the volume of purchases equals the volume of sales in any market (spot or forward), the average price agreed on in forward contracts is the same as the average spot price that would occur on the given day without forward dealings. Thus insurance against exchange risk is provided free, on average, by the forward market. The argument assumes that traders know perfectly in advance the dates at which they will need domestic or foreign currency. In actual fact, they will undoubtedly have unexpected needs arising from time to time and so will not be able to anticipate fully their exchange requirements. This uncertainty leads traders to hold transactions and precautionary balances of foreign exchange that cannot be perfectly covered because the date of their future use is not known. Thus forward markets are only a partial answer to the problem of exchange risk.

to Kindleberger's (1970, pp. 93–108) view that the forward market can be ignored.

The study is organized in the following way. Chapter II develops a two-country model in which the money markets and spot and forward foreign-exchange markets determine interest rates and spot and forward exchange rates. This model is a substantial generalization of my previous (1968) model[5] in the following respects: (1) interest rates in both countries are endogenous; (2) the trichotomy of speculators, arbitrageurs, and hedgers has been dropped, in response to criticism by Kenen (1965) and Leamer and Stern (1972); (3) speculation is allowed in both spot and forward exchange markets; (4) *stock* equilibrium conditions determine the various rates, instead of flow conditions; (5) the monetary sector of one country is developed fully. The complete comparative static properties of the model are derived in the Appendix and presented in Chapter III, including the effects of monetary policies under conditions of pegged and flexible exchange rates, the mechanics of pegging and of sterilizing capital flows, and government intervention in the forward exchange market.

Chapter IV extends the theory of rational expectations to a model with both spot and forward exchange markets. The response of the model to exogenous shocks affecting expectations suggests a way to specify dummy variables used in the empirical work. These are needed to represent expectations concerning the exchange rates. After a discussion of sources of data and methods of estimation in Chapter V, Chapter VI turns to empirical equations based on the theoretical model and using data on the short-term claims and liabilities of the United States vis-à-vis the United Kingdom for the period January 1936 to September 1939. Equations are also presented — for the first time, as far as I know — relating bank and nonbank positions in the forward market, as shown in *Statistics of Capital Movements*, to spot foreign-exchange holdings and trade commitments. The results show that forward covering was widely practiced.

Chapter VII presents equations for spot and forward commitments using dummy variables to represent expected future spot exchange rates based on the rational-expectations hypothesis. These variables allow tests of hypotheses that certain claims or liabilities were covered sufficiently in the forward market so that changes in expected future spot exchange rates did not significantly affect them. The findings corroborate the results obtained from direct estimates of equations for the forward market.

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[5]That model was an extension of Tsiang's well-known work (1959). For a different extension, see Sohmen (1969).

Chapter VIII examines numerous hypotheses concerning the specific events represented by the dummy variables and draws conclusions on the stabilizing or destabilizing nature of speculation and on the division of speculative activity between spot and forward markets. (Stabilizing behavior is defined here as behavior tending to reduce the variance of exchange rates around their equilibrium levels.)[6]

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[6]The reader of Chapter VIII will have to decide for himself whether my use of the equilibrium concept is acceptable (for guidance, see Machlup, 1958).

## II. A TWO-COUNTRY MODEL

The model is designed to explain the behavior of domestic and foreign interest rates and spot and forward exchange rates. The domestic economy is disaggregated into a banking sector, a monetary authority, and a private nonbank sector, while the foreign economy remains aggregated. Eight assets are introduced: high-powered money, dollar (domestic-currency) deposits, dollar loans, domestic government securities, sterling (foreign-currency) deposits, sterling loans, gold, and sterling deposits for future delivery. As deLeeuw (1965, p. 482) explains in a similar context, "It is convenient to begin a verbal description of this model by comparing it with a simpler hypothetical model. In this simpler model, one demand and one supply function for each market would determine the amount outstanding and the interest rate in that market." In a model with N markets, the wealth identity (analogous to Walras's Law) shows that one of the markets is redundant, so that only N-1 interest rates could be determined, and one would be set at zero. DeLeeuw continues, "In some cases a supply relationship could be replaced by defining a supply or interest rate as exogenous." In the model developed in this paper, the rate of interest on high-powered money is arbitrarily set at zero. In addition, yields on three other assets are taken as fixed: gold, dollar deposits, and dollar loans. The fixed yields imply an infinitely elastic demand for dollar loans and an infinitely elastic supply of dollar deposits by banks, as well as an infinitely elastic demand for gold by the monetary authority as a consequence of a pegged gold price. The remaining five markets will generate five excess-demand functions, only four of which will be independent because of the wealth identity. The four independent excess-demand functions will suffice to determine two interest rates and the spot and forward exchange rates. With this preview, the model will now be set out.

The model consists of four sectors — three domestic and one foreign. The sectors, with their symbols following in parentheses, are: the domestic monetary authority ($m$), the domestic banking system ($b$), the domestic nonbank private sector ($p$), and the foreign sector ($f$). The United States and the United Kingdom are identified with the domestic and foreign

countries, respectively. The foreign sector includes the gold and sterling assets of the British Exchange Equalization Account ($e$).[1]

There are four domestic financial instruments, with their symbols following in parentheses: U.S. short-term government securities ($S$); bank dollar deposits, both demand and time ($DD$); high-powered money, consisting of total bank reserves ($TR$) and domestic currency ($C$); and, finally, bank dollar loans and acceptances ($DL$).

There are two foreign financial instruments: sterling bank deposits and other liabilities of British banks ($SD$) and sterling loans and acceptances ($SL$).

There are also an international asset, gold ($G$), and a contingent asset, the volume of outstanding contracts for the forward sale ($FS$) or purchase ($FP$) of foreign currency. Nonbanks or foreigners are on the selling side of forward sales, and domestic banks on the buying side; nonbanks or foreigners are on the buying side of purchases, and domestic banks on the selling side.[2] Since nothing is known about the maturity structure of these contracts, the three-month forward contract is taken to be representative. The quantities of *all* these financial instruments are measured *in dollars* at the *end of a specific period*, the *week*, for this model is to be applied to weekly data. The spot exchange rate, $x$ dollars per pound, is used to convert sterling assets to dollars. Time subscripts are omitted when all variables relate to the same period. Thus a three-month forward contract calls for the delivery of a specified quantity of sterling on a date three months from the week in which the contract is concluded at a price agreed upon at the time it is concluded. This price is the forward exchange rate ($y$ dollars per pound for delivery in thirteen weeks).

The resulting structure can best be illustrated by displaying the T-accounts of the sectors and the banks' foreign-exchange position sheet. Exogenous variables are shown with a bar on top (for example, $\bar{S}$, the total stock of domestic government securities). Where it is necessary to identify the sector owning a claim or owing a liability, that is shown by a subscript (for example, $S_p$, the private sector's holdings of government

[1]The Account's operations are represented by exchange of sterling for gold. Prior to the collapse of the gold bloc in September 1936, many day-to-day operations were in French francs. The francs were always immediately exchanged for gold with the Bank of France, since the Account's charter did not allow the holding of positions in foreign currencies. After the conclusion of the Tripartite Monetary Agreement and its Protocol, dealings in dollars were frequent, but again positions were not maintained. Many dealings were directly in gold, since the fixed dollar price of gold provided an indirect influence on the dollar-sterling exchange rate via the gold price (see Waight, 1939).

[2]The data used in the empirical section are net of transactions among banks.

securities). The net worths of the private sector and the foreign sector are denoted as $\overline{P}$ and $\overline{B}$, respectively, while the banks' net foreign-exchange position is assumed to be zero.[3]

The banks hold reserves against a required ratio ($k$) applied to dollar and sterling liabilities, plus some excess reserves ($ER$). They supply loans ($DL$) and deposits ($DD$) in any amount demanded at a fixed interest rate (zero for demand deposits). The loan rate may be changed from time to time to regulate demand but is assumed to be fixed on a short-term (week-to-week) basis. The nonbank private sector borrows from the banks ($DL_p$) and invests its portfolio in accordance with considerations of diversification and yield. Exporters are likely to have sterling deposits ($SD_p$). Importers have sterling liabilities ($SL_p$), which may show up, however, as bank-acceptance liabilities ($SL_b$) offset on the balance sheet by a corresponding loan to the importer ($DL_p$). Exporters and importers are usually the main source of nonbank demand for purchase and sale of sterling forward.

(2.1) $$TR \equiv k(DD + SL_b) + ER$$

(2.2) *Domestic Banks* ($b$)

| | |
|---|---|
| $TR$ | $DD$ |
| $S_b$ | |
| $DL$ | $SL_b$ |
| $SD_b$ | |

(2.3) *Foreign* ($f$)

| | |
|---|---|
| $DD_f$ | $DL_f$ |
| $SL_f$ | $\overline{SD}$ |
| $S_f$ | $\overline{B}$ |
| $\overline{G}_e + G_f$ | |
| $\overline{SD}_e + SD_f$ | |

(2.4) *Nonbank Private* ($p$)

| | |
|---|---|
| $DD_p$ | $DL_p$ |
| $S_p$ | $SL_p$ |
| $C$ | $\overline{P}$ |
| $SD_p$ | |

[3]A less detailed model of this sort is given in Hendershott (1968). His model contains only one interest rate and no exchange rates.

(2.5)

*Banks' Position Sheet*

| | |
|---|---|
| $SD_b$ | $SL_b$ |
| | $BFP$ |

The foreign sector is consolidated, and the money supply is assumed for simplicity to be a fixed stock of sterling deposits ($\overline{SD}$).[4] Thus a substantial proportion is held by the foreign sector ($SD_f$). Foreign exporters and importers have dollar loans and deposits. Their covering of exchange risk is done in the London forward market, which of course affects the New York market through British banks' adjustment of their positions. The Banks' Position Sheet contains the domestic banks' spot and forward foreign-exchange commitments.

In addition to the four identities implied by the balance sheets given above, there are eight equations balancing supply and demand, one for each of the financial instruments in the model:

| | | *Instrument* | *Yield* |
|---|---|---|---|
| (2.6) | $TR + C = \overline{G_m + S_m}$ | High-powered money | 0 |
| (2.7) | $\bar{S} = S_b + S_p + S_f + \overline{S_m + G_m} - G_m$ | Government securities | $R_d$ |
| (2.8) | $DL = DL_p + DL_f$ | Dollar loans | fixed |
| (2.9) | $DD = DD_p + DD_f$ | Dollar deposits | fixed |
| (2.10) | $\overline{SD} = SD_p + SD_b + SD_f + \overline{SD_e}$ | Sterling deposits | $R_f$ |
| (2.11) | $SL_p + SL_b = SL_f$ | Sterling loans | $R_f$ |

[4]Polly Allen has pointed out that, for $\overline{SD}$ to be exogenous, the foreign government must fix the *dollar* value of sterling deposits. To avoid this assumption, the *foreign* demand and supply functions can be defined in terms of sterling. All the variables with suffix $e$ or $f$ in equations (2.7) to (2.12) would be preceded by $x$, to convert them from sterling into dollars. In (2.10) and (2.14) $\overline{SD}$ and $\bar{B}$ would likewise be preceded by $x$. The left-hand side of the balance-of-payments equation would become $x_{t-1}\Delta B_t$, since valuation effects are excluded from the balance-of-payments statistics. The same modifications would carry through to equations (2.33) to (2.38). See section 1 of the Appendix for the role of valuation effects in this case.

| | | *Instrument* | *Yield* |
|---|---|---|---|
| (2.12) | $\overline{G} = G_m + G_f + \overline{G}_e$ | Gold | 0 |
| (2.13) | $FS = FP + BFP + \overline{H}$ | Forward sterling | − |

Note that the domestic monetary authority is assumed to offset gold flows ($G_m$), so that its open-market portfolio ($S_m$) is an endogenous variable (equal to $\overline{S_m + G_m} - G_m$). In equilibrium the high-powered money stock is equal to the monetary authority's holdings of gold and government securities.[5] The market for forward sterling matches forward sales by nonbanks and foreigners ($FS$) with forward purchases by the same groups ($FP$) and with net forward purchases of the domestic banks ($BFP$) and the British Exchange Equalization Account ($\overline{H}$).

By substituting the three private balance-sheet identities into equation (2.7) and solving equations (2.7) through (2.12), one may verify that there is an additional dependent equation implied by the model, the wealth identity:

$$\overline{P} + \overline{B} \equiv \overline{G} + \overline{S} \ . \tag{2.14}$$

Since claims on real capital have been ignored in this model, world net *private* worth ($\overline{P} + \overline{B}$) is the sum of gold and claims on the domestic government.

The balance-of-payments equation (2.15) states that import deliveries ($IMD$) minus export deliveries ($EXD$) in period $t$ equals the increase in net worth of the foreign sector in period $t$:

$$\overline{B}_t - \overline{B}_{t-1} = IMD_t - EXD_t = IMO_{t-1} - EXO_{t-1} \ . \tag{2.15}$$

It is assumed that these deliveries are predetermined by *orders* for exports ($EXO$) and imports ($IMO$) in earlier periods.[6] *Current* orders for exports and imports are endogenous variables in the current week, however. The first difference of the foreign-sector balance sheet (2.3) shows that the trade deficit $\Delta\overline{B}$ is equal to the short-term capital inflow plus gold outflow from the domestic country.

Including orders for exports and imports and the variables in equations (2.1) to (2.14), twenty-six endogenous quantity variables have been introduced so far. There are four rate variables, measured as averages over the

[5]Therefore, equation (2.6) is *not* an identity. (For a similar approach, see Tobin, 1969, or deLeeuw, 1965.)

[6]For the dynamics of orders, deliveries, and payments in foreign trade, see Hansen (1961.)

week: the domestic short-term rate of interest ($R_d$), the foreign short-term rate of interest ($R_f$), the spot exchange rate expressed in dollars per pound ($x$), and the three-month forward exchange rate expressed in dollars per pound for delivery in thirteen weeks ($y$). These thirty variables are explained by five independent identities, eight balance equations, and seventeen behavior equations.

The behavior equations, with assumed signs, are provided in Table 2.1.[7] The basic assumption about behavior is that holdings of an asset depend positively on the asset's own yield and negatively on the yields of competing assets, as well as depending on certain quantity variables that measure the implicit services yielded by the asset.

TABLE 2.1

SIGNS OF PARTIAL DERIVATIVES OF BEHAVIOR EQUATIONS [a]

| | | *Independent Variables* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *Asset* | *Variable* | $R_d$ | $R_f$ | $x$ | $w(x)$ | $y$ | $EXD - IMD$ | $SL_p$ | $SD_p$ | |
| (2.16) Sterling deposits | $SD_b$ | − | + | − | + | + | | | | |
| (2.17) Sterling deposits | $SD_p$ | − | + | − | + | + | + | | | |
| (2.18) Sterling deposits | $SD_f$ | − | + | − | + | + | | | | |
| (2.19) Dollar loans | $DL_p$ | + | + | − | + | + | | | | |
| (2.20) Dollar loans | $DL_f$ | + | + | − | + | + | + | | | |
| (2.21) Dollar deposits | $DD_p$ | − | − | + | − | − | | | | |
| (2.22) Dollar deposits | $DD_f$ | − | − | + | − | − | − | | | |
| (2.23) Sterling loans | $SL_b$ | + | − | + | − | − | | | | |
| (2.24) Sterling loans | $SL_p$ | + | − | + | − | − | − | | | |
| (2.25) Domestic securities | $S_f$ | + | − | + | − | − | | | | |
| (2.26) Currency | $C$ | − | | | | | | | | |
| (2.27) Excess reserves | $ER$ | − | − | + | − | − | | | | |
| (2.28) Forward purchases[b] | $FP$ | | | | + | − | − | + | | |
| (2.29) Forward sales[b] | $FS$ | | | | − | + | + | | + | |
| (2.30) Gold | $G_f$ | − | − | − | | + | | | | |
| (2.31) Export orders | $EXO$ | | | | + | + | | | | |
| (2.32) Import orders | $IMO$ | | | | − | − | | | | |

[a]One equation has been left as a residual equation in each balance sheet, ensuring that the "adding-up" restrictions on each balance sheet are satisfied. This is equivalent theoretically to specifying all equations and then specifying the "adding-up" restrictions separately (see Brainard and Tobin, 1968). The residual variables, whose coefficients just balance out the coefficients in the nonresidual variables, are $S_b$, $SL_f$, $S_p$, and $BFP$.

[b]In these equations, the trade variable is $EXO - IMO$.

[7]All behavior equations are assumed to be continuous and differentiable functions of their arguments.

In the case of foreign assets, the yields to domestic residents must be corrected for changes in exchange rates. Suppose that holdings of foreign assets are covered through forward sale of foreign exchange. Under the simplifying assumption of zero transactions costs, a dollar is exchanged for $1/x$ units of sterling at the spot exchange rate and invested in the foreign asset to yield $R_f$ in three months. Covering the foreign-exchange position is accomplished by selling the anticipated foreign-exchange receipts forward, for delivery on maturity of the investment, obtaining in consequence $y$ dollars per pound. Thus covering converts a dollar today into $y/x$ dollars in the future at a cost of $400(x - y)/x$, measured in per cent at an annual rate. The covered foreign interest rate is then $R_f - 400(x - y)/x$.

If the foreign asset is *not* covered, the sterling will be repatriated at the spot rate ruling at maturity of the asset. The expected future spot rate is defined as $w(x)$, an increasing function of the current spot rate, with elasticity less than unity. The *expected* yield on the uncovered foreign asset is then $R_f - 400(x - w)/x$.

The general form of the demand equations in this model can now be expressed for any asset $A$ as $A = A(R_d, R_f - 400(x - y)/x, R_f - 400(x - w)/x, EX - IM)$. Holdings of sterling deposits, for example, respond negatively to the domestic interest rate and positively to the covered and uncovered foreign rates. An increase in the level of exports would increase desired holdings of sterling deposits. Dollar loans and deposits may appear from Table 2.1 to be exceptions to the rule that asset holdings respond positively (and liabilities negatively) to their own yields, but in fact the "own yields" on these instruments are fixed. The domestic interest rate is therefore the yield on a *substitute* asset, government securities, and has the usual negative effect on holdings of dollar deposits (positive effect on loans).

Note that dollar loans to foreigners should increase with an increase in exports. Increased imports are assumed to raise desired holdings of dollar deposits by foreigners and desired sterling loans to domestic residents.

Currency is assumed to be a substitute for domestic securities, and excess reserves are substitutes for either domestic or foreign securities. Foreign gold holdings are substitutes for foreign security holdings (uncovered) or domestic security holdings (covered).

In the forward market, the outstanding volume of nonbank and foreign contracts to *purchase* forward foreign exchange from banks ($FP$) is assumed to depend on the stock of sterling liabilities and the flow of import orders that is available to be covered through forward purchases. The speculative purchase of forward exchange is based on a profit calculation.