The Forward Market and Interest Rates in the Eurocurrency and National Money Markets

by

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Despite enormous shocks to the international monetary system during the past decade, forward exchange rates have remained at interest rate parity with respect to Eurocurrency interest rates.[1] In contrast, forward exchange rates have occasionally diverged quite markedly from interest rate parity with respect to national interest rates. Arbitrage is effective in holding forward rates at interest parity with respect to Eurocurrency rates primarily because (a) the Eurocurrency markets are largely free of the restrictions which inhibit arbitrage between national markets and because (b) the Eurocurrency markets share an equal vulnerability to future capital controls, and thus expectations of future controls do not inhibit arbitrage between Eurocurrencies.[2]

Knowing that interest parity holds for Eurocurrency interest rates, however, does not explain how transactions in the Eurocurrency markets and the forward exchange markets interact to determine Eurocurrency interest rates and forward exchange rates. While it is likely that increases in the demand for a particular Eurocurrency will affect the forward exchange rate, it seems equally likely that an increase in the speculative demand for a particular forward currency will affect Eurocurrency interest rates.[3] Unfortunately there is no standard framework for examining these interactions because most formal analyses of the forward exchange market have focused on the impact of interest rates on the forward rate while ignoring the impact which the forward rate itself may have on interest rates.[4]

In this study we reformulate the traditional analysis of the forward market to take into account the interaction among interest

rates and the forward rate.[5] Our model integrates an analysis of the Eurocurrency operations of banks with the traditional model of forward exchange transactions in order to explain why the forward rate and Eurocurrency interest rates are maintained at interest parity. The model is then extended to explain the joint determination of forward rates and national interest rates. The model is used to show how national and Eurocurrency interest rates each respond to speculation in the forward market, and how the forward rate responds to disturbances in the national and Eurocurrency money markets.

The analysis is developed in two stages. In Section I, we consider a case in which the national financial market in the foreign country is closed to all but trade transactions, and show how the forward rate and the non-dollar Eurocurrency rate are jointly determined. In Section II, the national market is then opened to international capital movements, and the interaction among the forward rate, the Eurocurrency rate, and the national interest rate are analyzed. We conclude with a brief summary of the analytic results. A statistical appendix reviews recent trends among interest rates and exchange rates in the D-mark and dollar markets.

I. Equilibrium in the Forward and Eurocurrency Markets

For simplicity we shall analyse a model in which there are only two countries, America and Germany, and only two currencies, the dollar and the D-mark. In this section we assume that the foreign market (Germany) is closed to all but trade transactions.[6] This assumption enables us to study the interaction between the Eurocurrency and for-

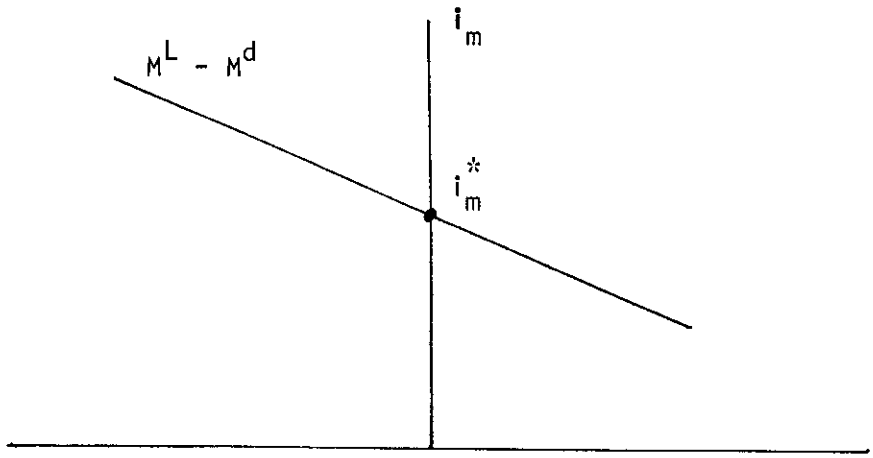
ward markets alone. The aim of the analysis is to explain the determination of the interest rate on Eurocurrencies denominated in D-marks (Euromarks) and the forward D-mark rate as functions of the Eurodollar rate (or U. S. interest rates) and non-interest rate factors. In order to focus upon the Euromark interest rate and the D-mark forward rate, we shall assume that the U. S. interest rate is controlled by Federal Reserve policy. Interest rates in the Eurodollar and U. S. markets, moreover, are assumed to be tightly linked by flows of funds between the two markets so that, in effect, the Eurodollar rate can be considered exogenous to the rest of the world.[7]

The Market for Euromarks

Eurocurrency banks are assumed to offer both Eurodollar and Euromark deposits and loans at interest rates $i_{\$}$ and i_m, respectively. The demand for Euromark deposits by nonbank investors is denoted by M^d, and the supply of Euromark loans by nonbank borrowers is denoted by M^L.[8] All assets and liabilities are assumed to be gross substitutes; for example, the nonbank demand for Euromark deposits is positively related to the covered $(i_m + fp)$ and uncovered $(i_m + sp)$ returns on Euromarks and negatively related to the Eurodollar rate, $i_{\$}$.[9]

If Eurobanks insisted on matching deposits and loans in each Eurocurrency market, then the Euromark interest rate, i_m, would be determined by the interaction of nonbank investors and borrowers in that market alone. Under this simplifying assumption,[10] the Euromark interest rate would be determined as in Figure 1 where the nonbank excess supply of Euromark loans, $M^L - M^d$, is zero.

Figure 1



Since Eurobanks generally operate in several Eurocurrency markets at the same time, the market for Euromarks is not independent of the other Eurocurrency markets. Eurobanks, in fact, often maintain a net loan position in one currency by converting funds obtained in another Eurocurrency market. For example, Eurobanks may convert an excess of Eurodollar deposits over loans into marks to increase their Euromark loans. The banks then end up with a net mark loan position, NMP.

With Eurobanks willing to convert dollar deposits into marks, mark loans can come from two sources:

(1) Euromark deposits, and

(2) marks converted from dollars by Eurobanks.

Hence in equilibrium, Euromark loans must now equal the sum of Euromark deposits and the net mark position of the Eurobanks:

$$(1) \quad M^L = M^d + NMP, \text{ where } M^L_{mf}, M^L_{ms}, M^d_{\$} < 0; \text{ and}$$
$$M^L_{\$}, M^d_{mf}, M^d_{ms} > 0.^{11}$$

As a result of the currency conversions by Eurobanks, the interest rate on Euromarks is closely tied to the interest rate on Eurodollars. To understand how these rates are related, consider the case where Eurobanks are induced to convert dollar funds into marks. In order for the banks to avoid the exchange risk associated with a net mark loan position, they will normally cover that position with an equivalent purchase of forward dollars. The whole transaction will be profitable as long as the interest rate on Euromark loans adjusted for the forward premium exceeds the interest rate paid on Eurodollar deposits. Ignoring transactions costs, the transaction thus will be profitable as long as

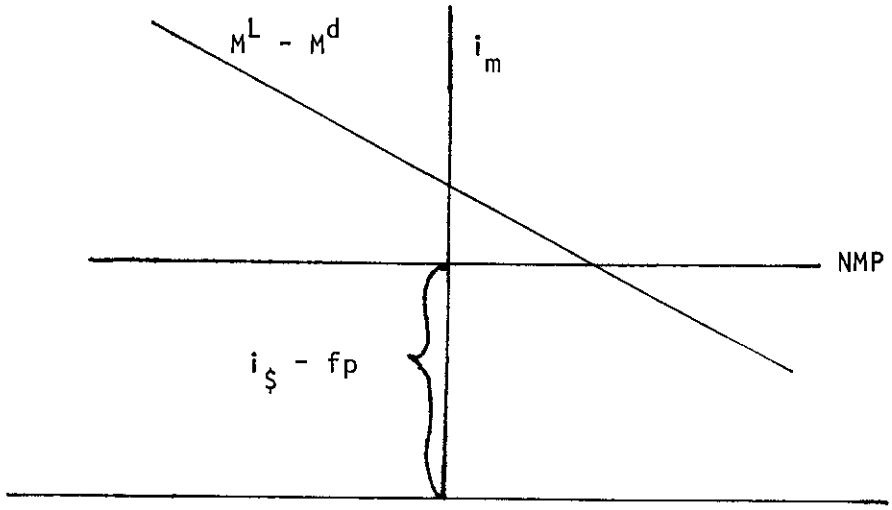
$$i_m + fp \geq i_\$,$$

where fp is the forward premium on marks.[12] Competition between Eurobanks, in fact, keeps the interest rate charged for Euromark loans at the interest parity level:[13/14]

$$i_m = i_\$ - fp.$$

If the Eurodollar rate and the forward premium are taken as given, then the Euromark rate offered by the Eurobanks is determined as well. Eurobanks stand ready to offer Euromark loans and deposits at an interest rate of $i_m = i_\$ - fp$, so the NMP schedule of the Eurobanks is horizontal at this rate. Equilibrium in the market for Euromarks, therefore, is achieved when the nonbank excess supply schedule intersects the NMP schedule at the interest parity rate.

Figure 2



Excess Supply of Euromark Loans by Nonbanks. Net Mark Loan Position of Eurobanks

Since the Euromark rate offered by the Eurobanks depends on the forward premium (as well as the exogenous Eurodollar rate), we must look at the forward market to understand how the Euromark rate is determined, and treat the markets for Euromarks and forward marks as two interdependent markets.

The Forward Exchange Market

The model of the forward market which we will introduce is a simple one which distinguishes between the excess demand for forward marks on the part of speculators and traders, and the excess supply provided by Eurobanks. The excess demand of speculators and traders (ST) is a function of orders for German exports (X^g) and German orders for imports from the rest of the world (I^g), as well as the forward and speculative premiums (fp and sp):

$ST = ST(X^g, I^g, fp, sp)$, where $ST_x, ST_s > 0$; $ST_I, ST_f < 0$.

Eurobanks supply forward marks in connection with their Eurocurrency operations.[15] Under the simplifying assumption that Eurobanks fully

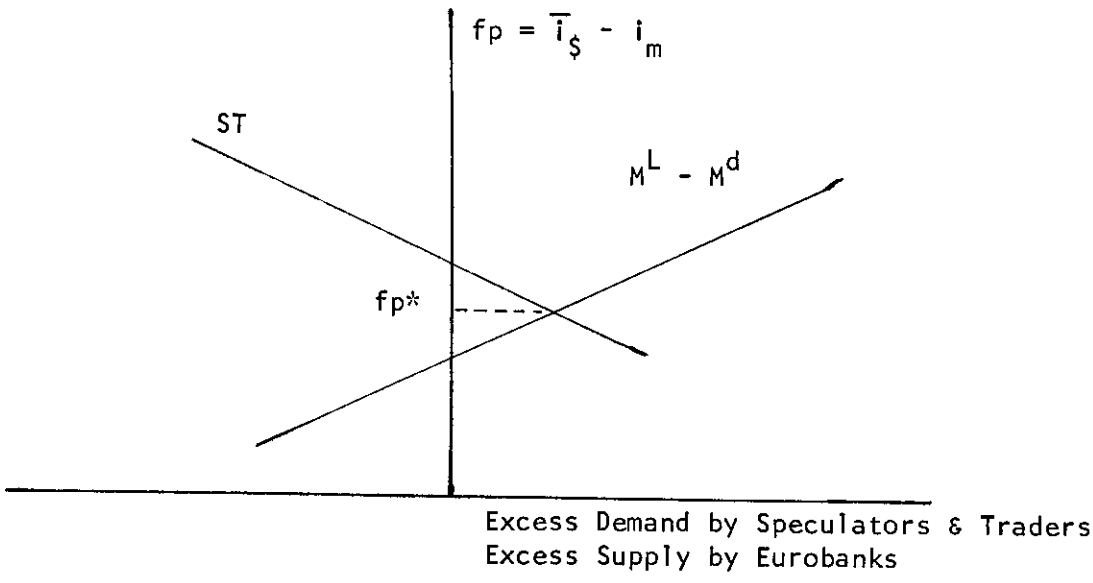
cover their net Eurocurrency positions, the excess supply of forward marks provided by Eurobanks is given by NMP, their net Euromark loan position. NMP, in turn, must equal the excess supply of Euromark loans by nonbanks, $M^L - M^d$. That is, since the Eurobanks are willing to accept whatever Euromark deposits or loans are offered at the prevailing interest parity rate, the excess supply of forward marks provided by the Eurobanks must reflect the underlying excess supply of Euromark loans ($M^L - M^d$) by nonbank borrowers and investors.[16]

In equilibrium, the excess demand by traders and speculators for forward marks must equal the excess supply by nonbanks for Euromarks (which generates an equivalent excess supply of forward marks by Eurobanks).[17]

$$(2.a) \quad ST = M^L - M^d.$$

The equilibrium in the forward market is illustrated in Figure 3.

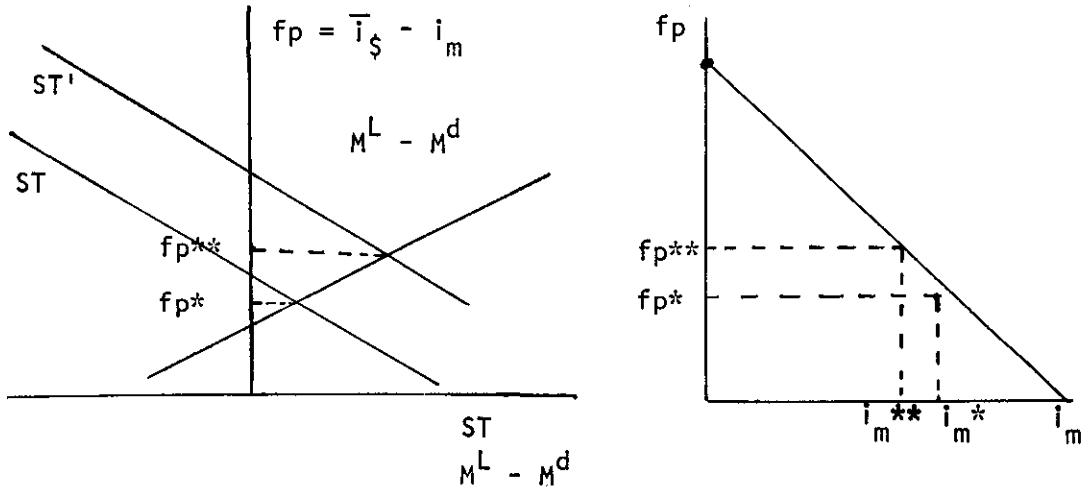
Figure 3



Given the level of the Eurodollar rate (and other exogenous variables), the forward market is in equilibrium at a forward premium of fp^*. Once the forward premium is determined, the Euromark rate is determined as well by the interest parity relationship.

Shifts in either curve, ST or $M^L - M^d$, lead to adjustments in the forward premium and corresponding adjustments in the Euromark rate. Thus an increase in orders for German exports leads to an upward shift in ST in Figure 4, raising the forward premium to fp^{**}. The Euromark rate then has to adjust downward to i_m^{**}, since Eurobanks maintain the Euromark rate at parity.

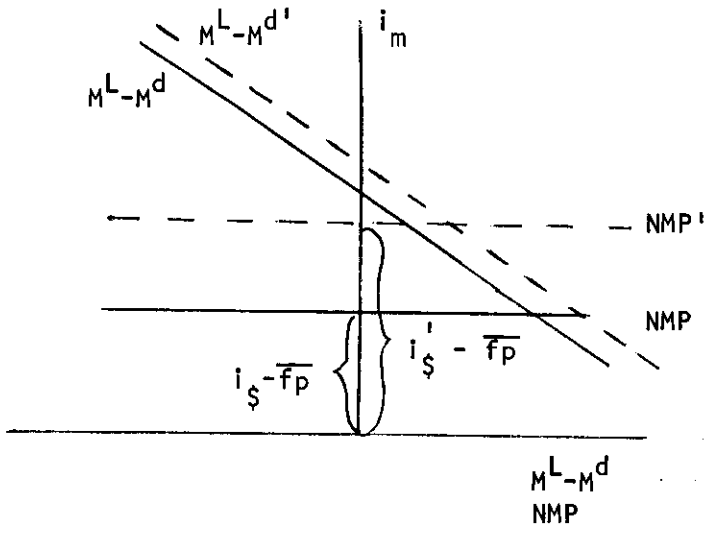
Figure 4



The effect of a change in the Eurodollar rate on the Euromark rate and forward premium is more complicated to analyse. First consider the adjustment of the Euromark rate alone under the assumption that the monetary authorities fix

the forward premium ($\overline{fp}$). An increase in the Eurodollar rate leads to an equivalent upward shift in the NMP schedule as the Eurobanks adjust the rate charged on Euromarks, and to a reduction in the nonbank excess supply of Euromark loans. In addition, nonbanks respond directly to the increase in the Eurodollar rate by increasing their net borrowing of Euromarks (a rightward shift of $M^L - M^d$ in Figure 5).

Figure 5



The result is an increase in the Euromark rate equal to the exogenous increase in the Eurodollar rate, and a net decrease in the nonbank excess supply of Euromark loans.[18] If the forward premium is also allowed to vary, then the Euromark rate will adjust by less than the Eurodollar rate. The net decrease in Euromark loans will cause Eurobanks to reduce their supply of forward marks. As a result, the forward premium will rise, reducing the necessary adjustment of the Euromark rate.[19]

As the analysis indicates, the traditional view of the forward market, where changes in interest rates caused changes in the forward premium, has to be amended once the Eurocurrency markets are introduced. In place of the traditional view we have presented an integrated analysis of the forward and Eurocurrency markets which recognizes that the forward premium and the Euromark rate are jointly determined.[20] In the next section, we introduce a further modification of the traditional model of the forward market which allows national interest rates to be simultaneously determined with the Eurocurrency and forward exchange rates.

II. The German Bond Market, the Euromark Market and the Forward Market

In order to focus on the interaction between the Eurocurrency markets and the forward market, we assumed in Section I that capital controls separate the German market from external financial markets. By assumption, the forward premium and the Euromark rate have been determined independently from the interest rate in Germany. If we now relax this assumption by permitting foreign holdings of German securities, we can investigate how the forward premium will be affected.[21]

The German Bond Market

To consider these questions, we shall incorporate a simple

model of the German monetary sector in our analysis. In this model, private German nonbanks hold assets consisting of demand deposits at German banks, DD^g, and bonds issued in the German market, G^{pd}. They may borrow by issuing bonds in the German market, G^{ps}. Their total wealth, $\bar{W}^g$, is assumed to be determined by factors exogenous to the model (although it may, of course, be augmented by a favorable trade balance).

Private German Nonbanks		German Banks		German Monetary Authority	
DD^g	G^{ps}	R^g	DD^g	SDR^g	R^g
G^{pd}	$\bar{W}^g$	G^{bd}		G^{md}	

German banks have liabilities consisting of demand deposits, DD^g, and assets consisting of bonds issued in the German market, G^{bd}, and reserves at the Central Bank, R^g, which are determined by the volume of demand deposits and the official required reserve ratio, q, $R^g = q^* DD^g$.[22]

The German monetary authority has liabilities consisting of the reserves of the banking system, R^g, and assets consisting of foreign exchange reserves, SDR^g, and bonds issued in the domestic market, G^{md}.

As in the preceding section, all assets are assumed to be gross substitutes; private holdings of German securities, G^{pd}, for example, are assumed to be positively related to the return on German securities, i_g, and negatively related to the volume of transactions, y^g (the principal determinant of the imputed

return on holdings of demand deposits). Because foreigners can hold both German securities and foreign securities, the foreign demand for German bonds (G^{ad}) depends positively on the covered and uncovered German rates, $i_g + fp$ and $i_g + sp$, negatively on the uncovered Euromark rate, $i_m + sp$,[23] and negatively on the Eurodollar rate, $i_\$$.

Equilibrium in the German securities market is established when the policy-determined net government supply of securities (the supply offered by the treasury, $\overline{G}$, net of the demand by the monetary authority, $\overline{G}^{md}$) is equal to the net private demand:[24]

$$\overline{G} - \overline{G}^{md} = G^{pd} - G^{ps} + G^{bd} + G^{ad} .$$

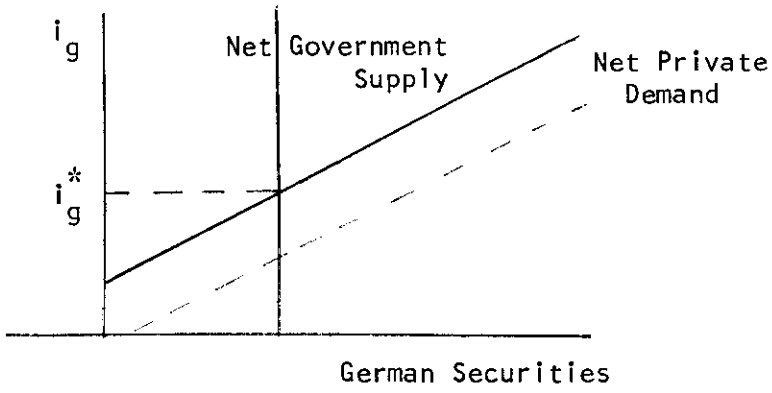
By making use of the balance sheet identities for the German private sector and the required reserve identity, we may rewrite the equilibrium condition in terms of demand deposits, the stock of wealth, and the foreign demand for bonds:

$$(3) \quad \overline{G} - \overline{G}^{md} = \overline{W}^g - q\, DD^g + G^{ad}, \text{ where}$$

$$DD^g_g < 0;\ G^{ad}_{gf},\ G^{ad}_{gs} > 0;\ G^{ad}_{mf},\ G^{ad}_{ms},\ G^{ad}_{\$} < 0.$$

The equilibrium is illustrated in Figure 6:

Figure 6



With external interest rates and the forward premium given, the net government supply and the net private demand for German securities together determine the level of the German rate (i_g^*). An increase in the forward premium[25] will, in the first instance,[26] lead to a decline in the German rate as foreigners increase their demand for covered holdings of German securities. Thus a higher forward premium is associated with a lower German interest rate. In the footnote below,[27] we show that the decrease in the German interest rate is always less than (or equal to) the increase in the forward premium.

The Forward Market

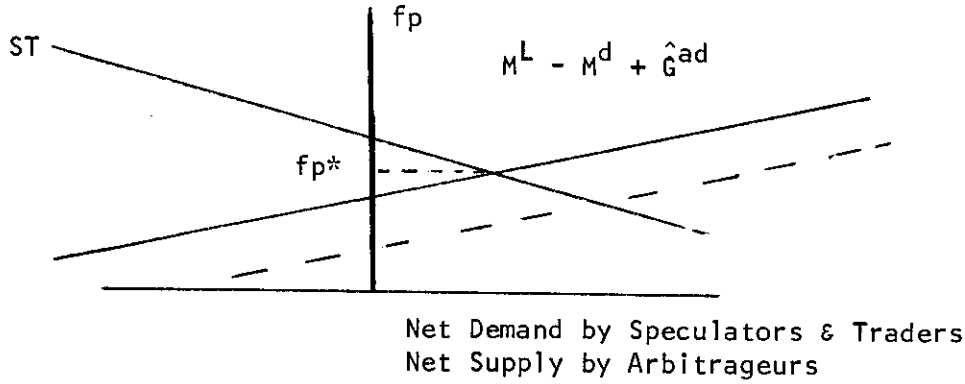
Covered purchases of German bonds give rise to an additional supply of forward D-marks which must be represented in the equilibrium condition for the forward market. At equilibrium the excess demand for forward D-marks by speculators and traders, ST, must now be equal to the excess supply of

forward D-marks by arbitrageurs--i.e., by Eurobanks, $M^L - M^d$, and by investors who have made covered purchases of German securities, $\hat{G}^{ad}$:

$$(2.b) \quad ST = M^L - M^d + \hat{G}^{ad}.$$

The equilibrium in the forward market is illustrated in Figure 7:

Figure 7

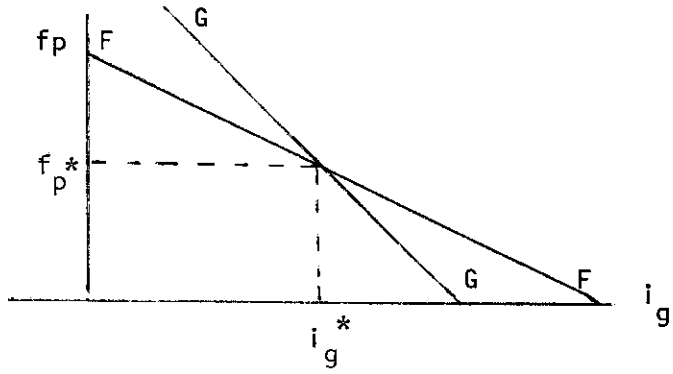


Given the level of the Eurodollar and German rates, the forward market is in equilibrium at the forward premium fp*. An <u>increase</u> in the German interest rate will lead to an increase in covered holdings of German bonds (a rightward shift in the arbitrage supply curve)[28] and a <u>decrease</u> in the forward premium. In the footnote below,[29] we show that the decrease in the forward premium is always greater than (or equal to) the increase in the German rate.

In Figure 8, we show the relationship between the German interest rate and the forward premium implicit in the equilibrium

conditions for the German bond market (3) and forward market (2.b). As we have demonstrated above, the forward market curve, FF, has a negative slope of absolute value less than unity, while the German bond market curve, GG, has a negative slope of absolute value greater than unity.[30] GG is the locus of all combinations of i_g and fp that will clear the German bond market. FF is the locus of all combinations of i_g and fp which will clear the forward market.

Figure 8



Together the two curves determine the German interest rate and the forward premium (given the Eurodollar rate and values of other exogenous variables). The level of the Euromark rate is also implicitly determined since Eurobanks will maintain this rate at interest parity with respect to the Eurodollar rate.

If equilibrium is disturbed in either of the two markets, in D-mark denominated assets or in the forward exchange market, both interest rates and the forward premium, in general, will change. If the German monetary authority, for example, institutes

a tighter monetary policy by selling bonds to the public, there will be adjustments in all three markets. This change in policy may be represented by a rightward shift in GG; given the level of fp, i_g must be higher to induce German and foreign residents to hold the increased supply of bonds. The tightening of monetary policy will lead to a higher equilibrium level of i_g, and a lower level of fp.[31] From this example, it is evident that events in the German financial market can influence the forward premium even though it is maintained at parity with respect to the Eurocurrency rates. Moreover, the shift in German monetary policy which led to a fall in the forward premium will automatically lead to a rise in the Euromark rate as Eurobanks arbitrage between the Eurodollar and the Euromark markets. Through this channel, movements in the German rate can influence the Euromark rate even if there are no direct flows between the two markets in D-mark denominated assets.

An increase in orders for German exports (or an increase in the expected return on speculative purchases of forward marks) will lead to an upward shift in FF. Once equilibrium is reestablished, the forward premium will be higher and the German and Euromark interest rates will be lower than previously. In the case where capital controls limit the flow of funds to

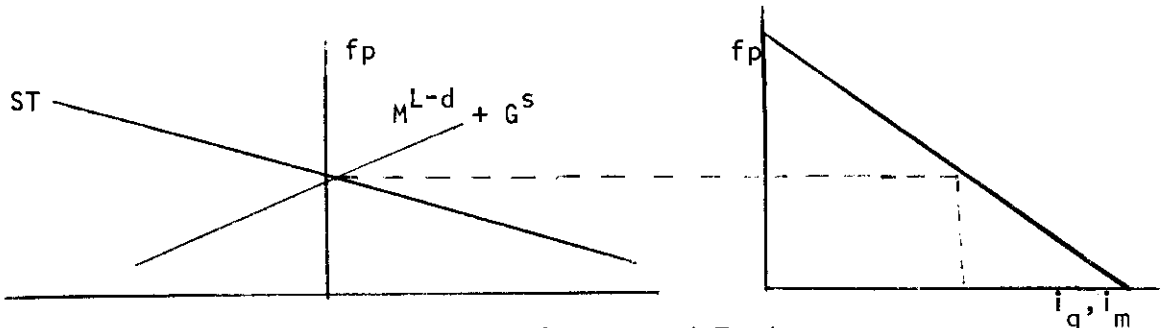
and from the German market, the FF schedule will be relatively horizontal and the GG schedule relatively vertical. Shifts in FF then will induce relatively large adjustments in fp while leaving i_g virtually unchanged. Under such conditions, a German export boom (or speculation in favor of the mark) could lead to a large increase in the forward premium combined with a large decline in the Euromark interest rate even though the German interest rate remains relatively constant. This may, in fact, illustrate what happened in February and March 1973, when the DM forward premium rose sharply, the Euromark rate fell to a very low, occasionally negative, level, and the German interest rate remained at a high level.[32]

On the other hand, a complete relaxation of capital controls is likely to enhance the importance of arbitrage flows in determining the German interest rate. If external flows are quite sensitive to the covered differential between dollar securities and German securities, then fp and i_g are likely to adjust to parity with respect to the Eurodollar rate. GG and FF will nearly converge at a slope of negative one. This convergence is even more likely if there is also a high degree of substitutibility between Euromarks and German securities.[33] If FF and GG do converge at a slope of negative one, the Euromark and German rates will be identical. Both

will be jointly determined with the forward premium; each interest rate and the forward premium will be maintained at interest parity with respect to the Eurodollar rate. This seems to characterize the period following the relaxation of German capital controls early in 1974,when the covered Eurodollar rate, the German rate and the Euromark rate converged.[34]

Finally, it should be noted that the fact that D-mark interest rates are maintained at interest parity with respect to the Eurodollar rate does not imply that the interest arbitrage schedule is perfectly elastic at the interest parity forward rate.[35] Given $i_{\$}$, the forward premium may vary so long as the D-mark interest rates vary inversely to fp. For example note that in Figure 9,[36] a change in the speculative

Figure 9



Net Demand by Speculators and Traders
Net Supply by Arbitrageurs

demand for forward D-marks, or an exogenous change in the supply of Euromark loans or in the supply of German bonds to arbitrageurs, can influence fp and hence i_g and i_m as well. The

arbitrage schedule becomes infinitely elastic only when the German government fixes i_g by offering an infinite supply of bonds. In this case, we return to the traditional analysis of the forward market in which, given the exogenously determined interest rate, an infinitely elastic arbitrage schedule determines the forward exchange rate.[37]

III. Conclusion

In this study we have reformulated the traditional analysis of the forward market to take into account the interaction among interest rates and the forward premium. The model which we have developed integrates an analysis of the Eurocurrency operations of banks with the traditional model of forward exchange transactions. A key element in the analysis is the competitive behavior of Eurobanks which ensures that each non-dollar Eurocurrency rate and the corresponding forward premium are maintained at interest parity with respect to the Eurodollar rate. With the Eurodollar rate given, Eurobank behavior fixes each non-dollar Eurocurrency rate relative to the forward premium, and Eurocurrency and forward market transactions by nonbanks together determine the forward premium.

Once arbitrage involving a national market is introduced, the analysis is broadened to include the simultaneous determination of the national interest rate as well as the Eurocurrency rate and forward premium. Shifts in either the excess demand for forward exchange or the excess demand for national

securities induce adjustments in all three markets. One implication of the analysis is that forward premiums and national interest rates can adjust to interest parity as a result of two different forms of arbitrage. Traditional covered arbitrage involving movements of funds between national markets exclusively may bring about the necessary adjustment of forward premiums and national rates. Alternatively, arbitrage between Eurocurrency and national markets offering securities in the same currency may also bring about interest parity between national rates even if there are no direct flows between national markets. In the latter case, adjustments occur in all three markets, with adjustments in the forward premium relative to Eurocurrency rates ensuring that the interest parity relation now holds for both the Eurocurrency and national markets.

Appendix I

Symbols used in more than one section of the text are defined below for quick reference.

$\hat{}$: a covered holding: for example, $\hat{M}^d$ denotes covered Euromark deposits.

DD^g: demand deposits at German banks held by German residents.

fp: the forward premium defined as (F-S)/S where "F" is the forward rate and "S" is the spot rate. Both exchange rates are expressed in \$/DM.

$\overline{G}$: the supply of bonds by the German treasury.

G^{ad}: the foreign demand for bonds issued in the German market.

G^{bd}: German bank holdings of bonds issued in the German market.

G^{md}: the German monetary authority's holdings of bonds issued in the German market.

G^{pd}: holdings of bonds issued in the German market by German nonbanks.

G^{ps}: issues of bonds in the German market by German nonbanks.

I^g: German orders for imports from the rest of the world.

i_g: the interest rate on bonds issued in the German market.

i_m: the Euromark rate.

$i_\$$: the Eurodollar rate.

M^d: the nonbank demand for Euromark deposits.

M^L: the nonbank supply of Euromark loans, i.e., desired borrowing in Euromarks from Eurobanks.

NMP: the net mark loan position of Eurobanks.

q: the official required reserve ratio.

R^g: required reserves.

SDR^g: Official German foreign exchange reserves.

sp: the speculative premium, the expected return from holding a spot position in D-marks. $sp = ((S^e-S)/S)$ where S^e is the expected future spot rate.

ST: the excess demand for forward marks by speculators and traders.

$\overline{W}^g$: wealth of German nonbanks.

X^g: orders for German exports.

Y^g: the volume of transactions in Germany.

Appendix II

In this appendix we present a brief graphical analysis of recent interest rate trends in the U.S. and Eurodollar markets and in the German and Euromark markets.

Interest Rate Relationships between Eurodollar and U.S. Markets

From the accompanying graphs (A.1, A.2 and A.3), it is apparent that Eurodollar rates and comparable New York interest rates have moved almost in tandem over the last three years. The close correspondence between external and domestic dollar interest rates is particularly striking in the very short-term end of the market. Graph A.1 displays movements in the overnight Eurodollar and Federal Funds rates over the period from January 1971 through July 1974. Discrepancies between the two rates are slight, as one would expect from the fact that large U.S. banks are continually dealing in both markets.

A comparison of three month rates reveals a looser correlation, although the covariation is still quite impressive. Graph A.2 charts movements in the Treasury Bill rate, the Eurodollar and U.S. Certificate of Deposit rates. Both of the latter two interest rates are adjusted for marginal reserve requirements to reflect the effective cost of each source of funds to large U.S. banks. The Treasury Bill rate is included to illustrate that changes in lender preferences can lead to widening spreads between interest rates even within the U.S.

market where barriers to arbitrage are minimal. In contrast to the pattern during 1971, toward the end of the period the two bank deposit rates are more tightly linked than the CD and Treasury Bill rates.

Because nonbank lender arbitrage may also have an important influence on the relationship between the internal and external deposit rates, Graph A.3 displays movements in the unadjusted Eurodollar and Certificate of Deposit rates (and the Treasury Bill rate). In the period preceding June 1973, the pattern of covariation is even stronger than for the adjusted deposit rates suggesting that lender arbitrage played a predominant role.[38]

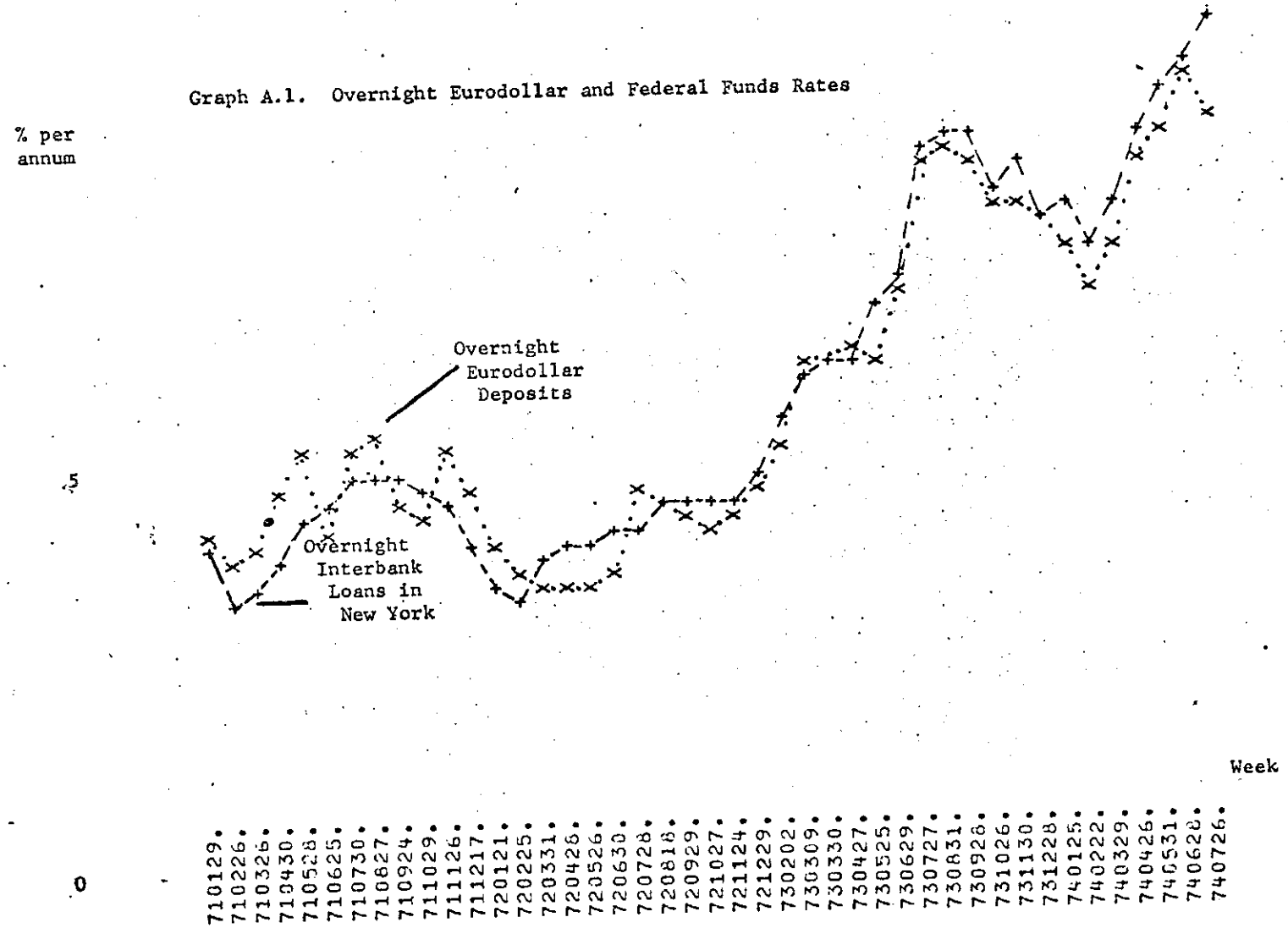
Comparisons of rates charged nonbank borrowers are more difficult because of the difference in pricing practices in the internal and external dollar markets. However, most analysts have concluded that, when average compensating balances in the U.S. and the typical mark-up over the London Interbank rate are taken into account, borrowing costs in New York and in the Eurodollar market have been quite similar.[39]

The Covered Eurodollar, Euromark, and German Interest Rates

In Graph A.4 the relationship among Eurodollar, Euromark, and German interest rates is shown for the recent period. The Eurodollar interest rate is adjusted for forward cover by

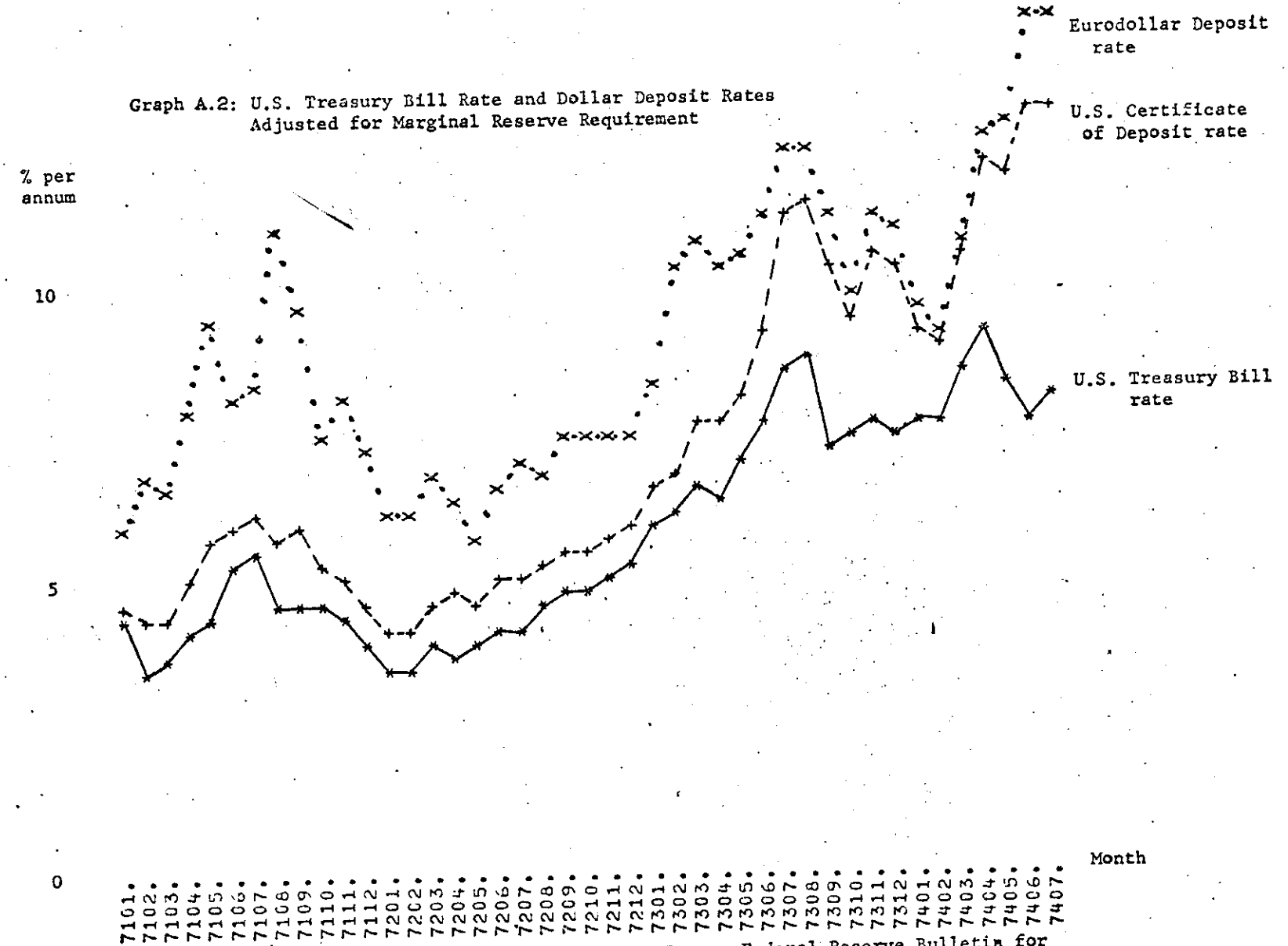
subtracting the forward premium (fp in the text). As is evident from the figure, the covered Eurodollar rate and the Euromark rate follow closely together through time with only minor discrepancies between the rates. German interest rates, in contrast, are at markedly higher levels than the Euromark rate or covered Eurodollar rate through most of 1973. But with the relaxation of German controls on capital inflows in early 1974,[40] German interest rates move into line with Euromark rates. German and Euromark rates both remain close to interest parity with respect to the Eurodollar rate through the rest of the period. Graph A.5 suggests that the Euromark rate and forward premium often respond to exogenous forces other than the Eurodollar rate, even though the three rates adhere closely to the parity relationships.

Graph A.1. Overnight Eurodollar and Federal Funds Rates



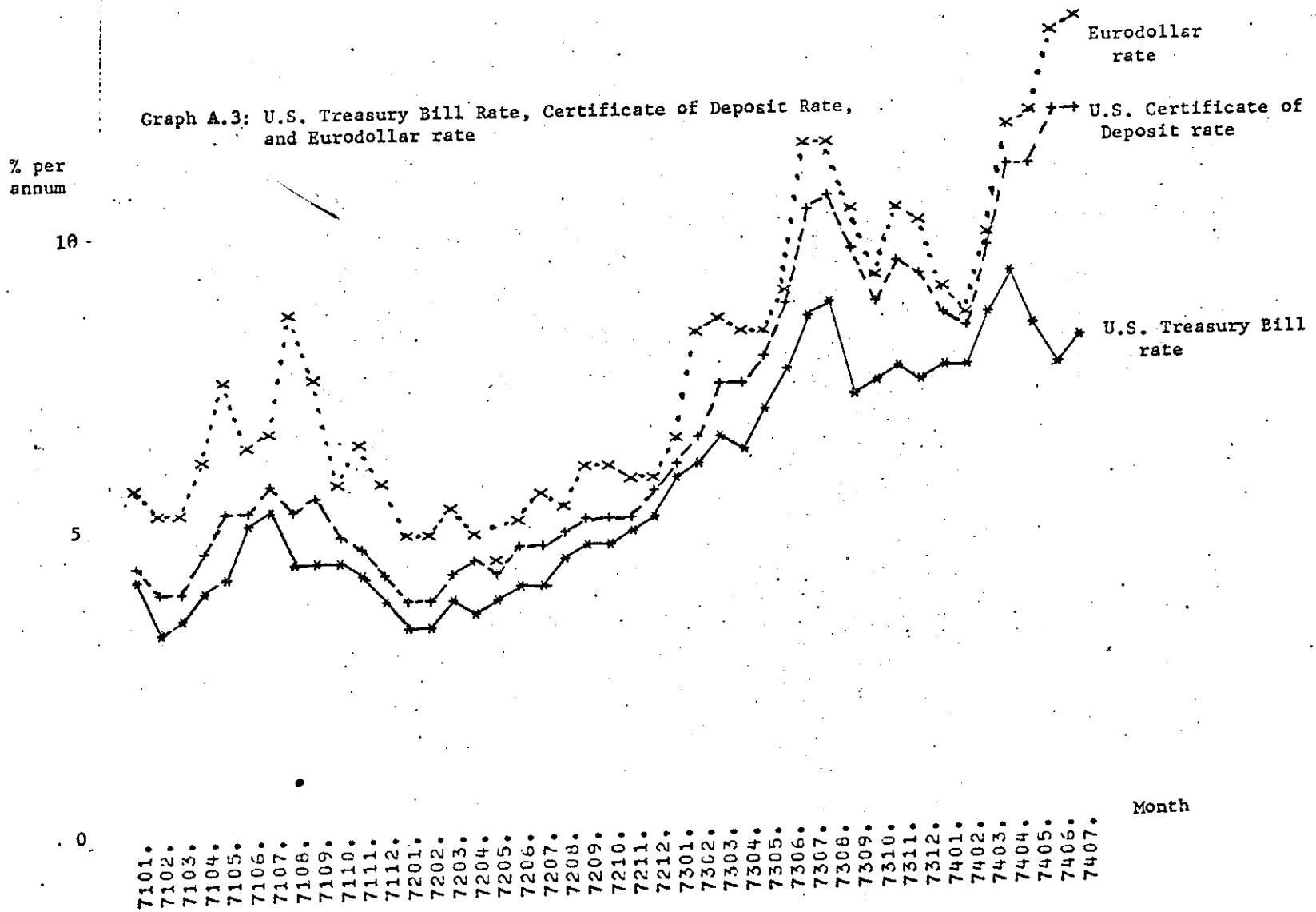
Source: Federal Reserve Board. Call Eurodollar Deposits: weekly averages (Thursday-Wednesday) of broker's bid rates in London through April 1971; Overnight Eurodollar Deposits: beginning May 1971, weekly averages (Thursday-Wednesday) of broker's bid rates in London; Federal Funds: weekly averages (Thursday-Wednesday) of overnight interbank loans in New York City.

Graph A.2: U.S. Treasury Bill Rate and Dollar Deposit Rates Adjusted for Marginal Reserve Requirement

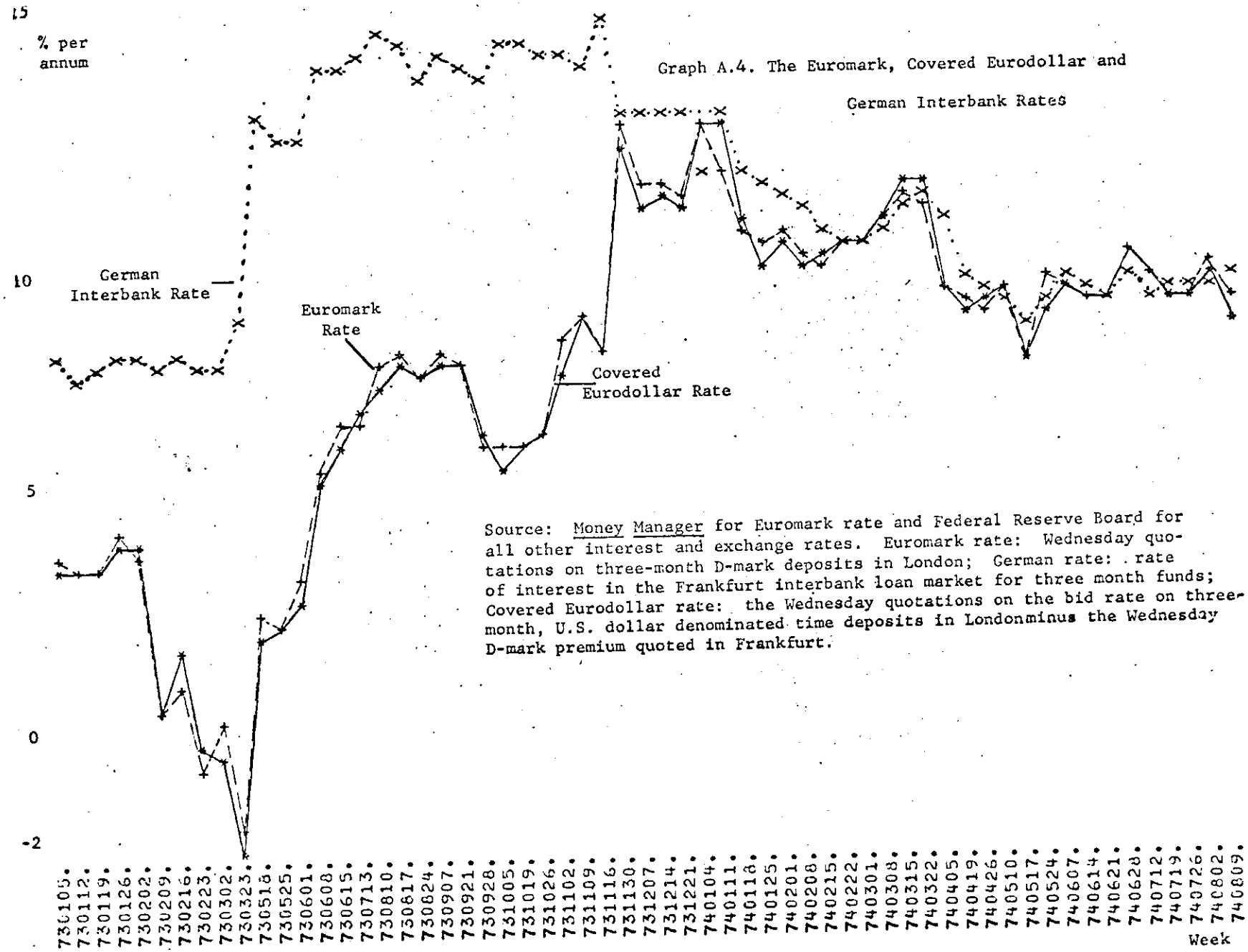


Source: World Financial Markets for the Interest Rates; Federal Reserve Bulletin for the Reserve Requirements.

Graph A.3: U.S. Treasury Bill Rate, Certificate of Deposit Rate, and Eurodollar rate



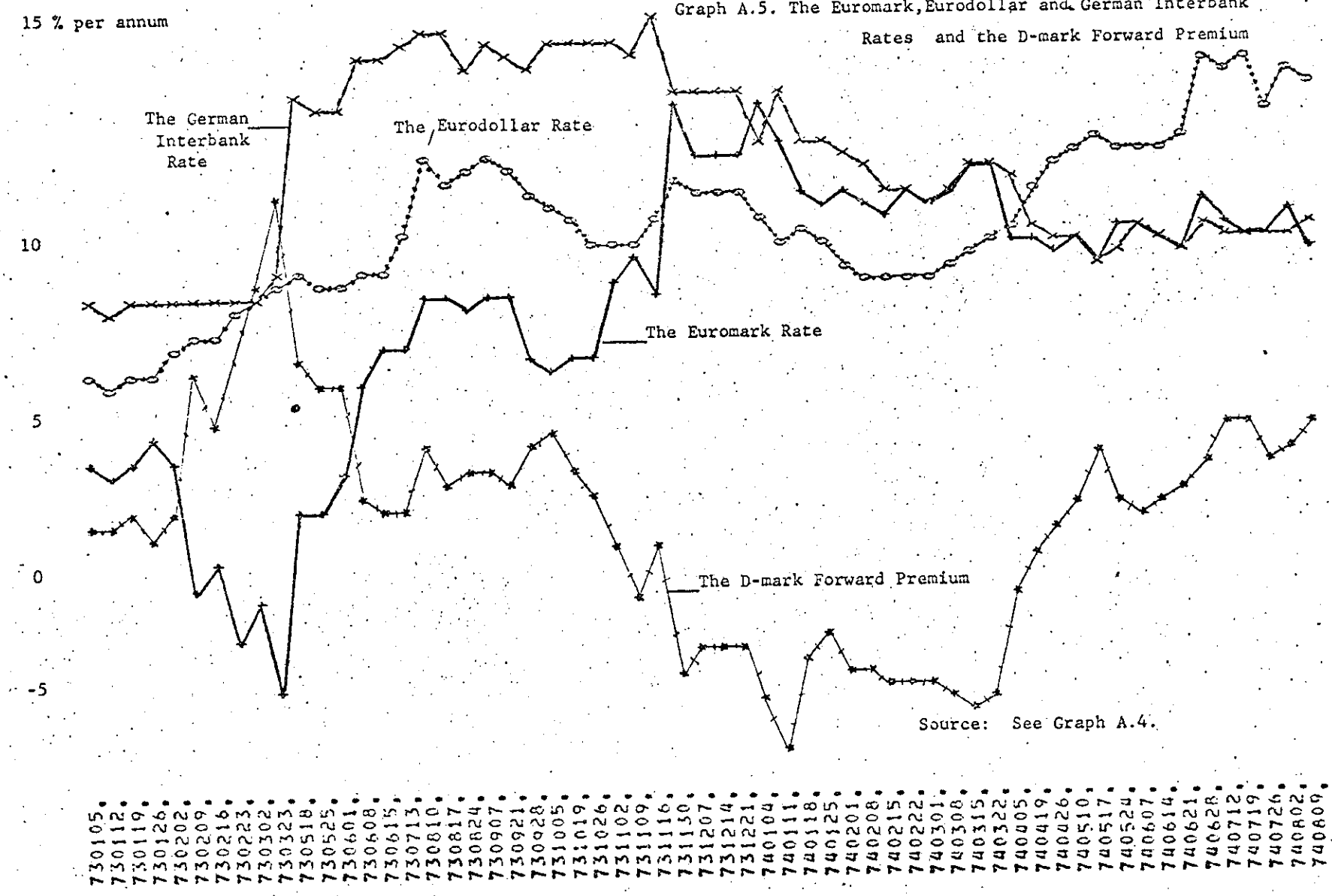
Source: World Financial Markets



Graph A.4. The Euromark, Covered Eurodollar and German Interbank Rates

Source: Money Manager for Euromark rate and Federal Reserve Board for all other interest and exchange rates. Euromark rate: Wednesday quotations on three-month D-mark deposits in London; German rate: . rate of interest in the Frankfurt interbank loan market for three month funds; Covered Eurodollar rate: the Wednesday quotations on the bid rate on three-month, U.S. dollar denominated time deposits in Londonminus the Wednesday D-mark premium quoted in Frankfurt.

Graph A.5. The Euromark, Eurodollar and German Interbank Rates and the D-mark Forward Premium



Source: See Graph A.4.

Footnotes

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[1] In the Appendix we discuss the recent behavior of forward exchange rates and Eurocurrency and national interest rates in the D-mark and dollar markets. Aliber (1973) and Marston (1972, Ch. VI, and 1973) present statistical evidence establishing that the forward rate and Eurocurrency interest rates are maintained at interest parity.

[2] The risk that capital controls might be imposed on financial centers is an important factor limiting arbitrage involving national investments. But the risk of capital controls is of minimal importance in transactions between Eurocurrencies simply because it is unlikely that future capital controls would be applied to one Eurocurrency market and not another. Although governments have compelling reasons to formulate special regulations for transactions in securities denominated in the home currency, there is no incentive for them to formulate regulations which discriminate among securities denominated in different foreign currencies. See Aliber (1973) and Marston (1972 and 1973).

[3] The inherent simultaneity in the relationship between the forward rate and Eurocurrency rates is evident from the way in which transactions are conducted. In a series of interviews we conducted at a major New York bank, we found that Eurocurrency and forward exchange traders each based quotations in their own market on rates established in the other market. Foreign exchange traders said that Eurocurrency rate differentials determined the forward rates that they quoted, while Eurocurrency traders said that forward exchange rates determined differentials

between non-dollar Eurocurrency rates and the Eurodollar rate. It is clear from the way in which rates are quoted that neither the impact of forward rates on Eurocurrency interest rates nor the impact of Eurocurrency rates on forward rates can be ignored.

[4]For the development of the modern theory of forward exchange see Jasay (1958), Spraos (1959), Tsiang (1959), Grubel (1966), Kenen (1965), Stoll (1968), and Kesselman (1971). An exception to this tradition is a study by Black (1973) which presents a fully simultaneous model in which the spot and forward exchange rates and national interest rates are jointly determined.

[5]Because we wish to focus on simultaneous interactions between the forward rate and interest rates, we shall follow the tradition in the forward exchange market literature of treating the spot exchange rate as fixed by official intervention. In a future paper, we hope to extend these results to the case of floating exchange rates.

[6]Germans are assumed to hold no foreign (including no Eurocurrency) assets and liabilities, and Americans hold no German assets or liabilities.

[7]Alternatively, one might argue that the dollar markets are sufficiently large in comparison to any other financial markets that the impact of shocks in any one of the non-dollar markets on the dollar markets may be neglected. The assumption that U.S. interest rates are exogenously determined is common to many models of international portfolio adjustment. The additional assumption that Eurodollar and U.S. interest rates are tied closely together is an approximation to reality which considerably simplifies the analysis. Note that in recent months, since the dismantling of controls on U.S. resident investment, U.S. and Eurodollar rates on comparable assets have diverged by much less than the interest rates on U.S. bank instruments and U.S. Treasury securities. See the Appendix for a description of recent interest rate movements in the two dollar markets.

[8]We assume that the margin between the deposit and loan rates for either Eurocurrency is fixed by competitive bidding among Eurocurrency banks. (Freedman (1973) adopts a similar assumption about deposit and loan rates in his model of the Eurodollar market). For simplicity we assume that the margin is zero. Note that we have adopted the Freedman terminology in referring to nonbank investors <u>demanding</u> Eurocurrency deposits and nonbank borrowers <u>supplying</u> Eurocurrency loans. This terminology reverses that found in Marston (1972, 1973).

[9] "fp" is the forward premium defined as (F - S)/S where F is the forward exchange rate and S is the spot rate. Both exchange rates are expressed in \$/DM. "sp" denotes the speculative premium, the expected return from holding a spot position in D-marks. $sp = ((S^e - S)/S$ where S^e is the expected future spot rate. For easy reference, all symbols and their definitions are listed in Appendix I.

[10] Eurobanks also maintain transactions balances with U.S. and German banks. Most investigators have found that these balances are very small relative to the volume of Eurocurrency deposits outstanding (see Hewson and Sakakibara (1974, p. 315) and the references listed there). Hence, to simplify the notation, we shall omit them from the analysis.

[11] M^L_{mf} and M^L_{ms} denote the partial derivatives of M^L with respect to the covered ($i_{mf} = im + fp$) and uncovered($i_{ms} = i_m + sp$) returns on Euromark loans. $M^L_\$$ is the partial derivative with respect to the Eurodollar interest rate. The partial derivatives of M^d are defined analogously. The behavior of NMP is discussed below.

[12] The Eurobanks may require some margin between the rate paid on Eurodollar deposits (adjusted for forward cover) and the rate of interest on Euromark loans, but that margin is assumed to be constant over the relevant range of net currency positions undertaken by Eurobanks. For convenience, we have assumed the margin to be zero.

[13] In Marston (1972 and 1973), the relationship among Eurocurrency rates and forward premiums is investigated in detail. Over the seven year period, 1965-71, the Eurocurrency rates and forward premiums for the three principal Eurocurrencies, the D-mark, Swiss franc, and sterling, are shown to adhere closely to interest parity with respect to the Eurodollar rate. The arbitrage operations of Eurobanks have been discussed often in the institutional literature on the Eurocurrency markets. An official of the First National City Bank, for example, has explained the determination of the Eurocurrency rates in the following terms (from the Eurodollar and Eurobond International Seminar, Transcript of Speeches, December 1969, London):

> Wherever a forward market exists between currencies, then Euro-deposit rates can be compared and arbitrage takes place. The difference in deposit rates of two Euro-currencies will equal the cost of conversion spot and reconversion forward. If not, arbitrage operations will bring them back into line.

[14]The Eurocurrency rates are said to be at interest parity if the covered return on Euromarks $(1 + i_m)\frac{F}{S}$ is equal to the return on Eurodollars $(1 + i_\$)$. If second order terms are neglected, then the interest parity condition reduces to $i_m = i_\$ - fp$, where $fp = (F - S)/S$.

[15]Since the Eurobanks set i_m equal to $i_\$ - fp$, <u>covered</u> investment (or borrowing) of Euromarks by nonbanks is generally unprofitable, and therefore can be neglected. Denoting covered investment (borrowing) by $\hat{M}^d$ $(\hat{M}^L)$, we assume that $\hat{M}^d = \hat{M}^L = 0$.

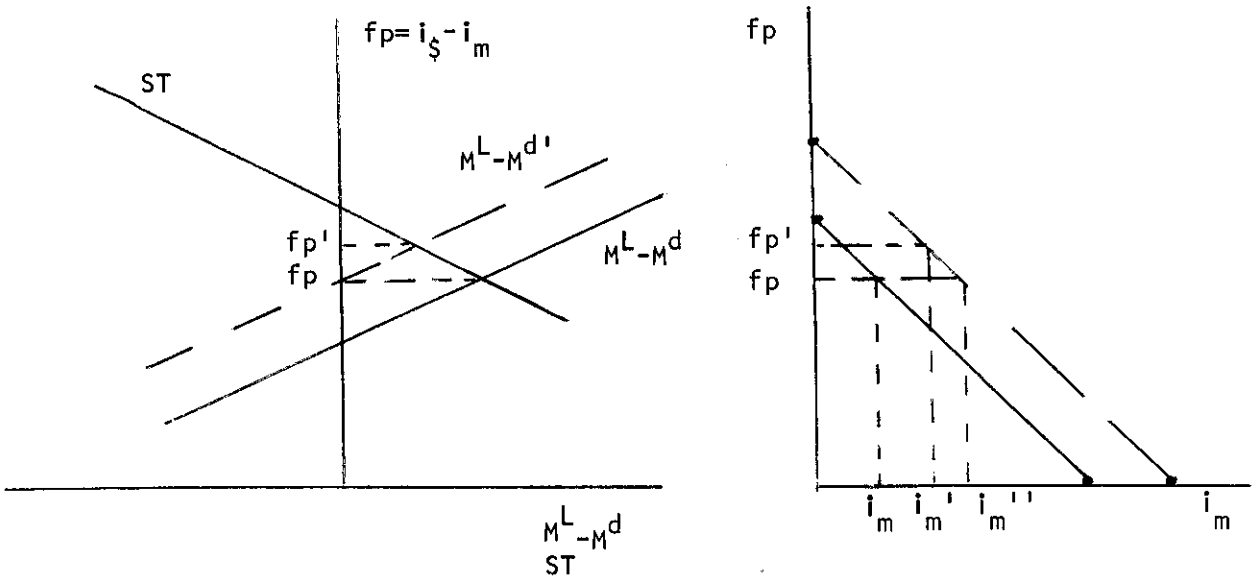
[16]Since Eurobanks are willing to provide an indefinite quantity of Euromark loans (or deposits) at the interest parity rate, the actual quantity of loans (and hence the quantity of D-marks offered by Eurobanks in the forward market) is determined by the net supply of loans by nonbank investors and borrowers.

[17]The excess supply of Euromark loans by nonbanks is a function of the Euromark rate, not the forward premium. But the arbitrage operations of Eurocurrency banks ensure that the Euromark rate and forward premium are tied together in the interest parity relationship. So $M^L - M^d$ can be expressed in terms of either fp or i_m.

[18]There is a net decrease in $M^L - M^d$ as long as the excess supply of Euromarks responds more to a change in the Euromark rate than to an equal change in the Eurodollar rate (i.e., as long as $-M_{ms}^{L-d} > M_\$^{L-d}$).

[19]The rise in the Eurodollar rate, by reducing the nonbank excess supply of Euromark loans, leads to a leftward shift of the Euromark schedule in the forward market diagram (Figure 5' below), and a rise in the forward premium. If the forward premium were not allowed to adjust, the Euromark rate would have to increase by the same amount as the Eurodollar rate (to i_m'' in Figure 5'). But with the forward premium adjusting upward to fp', the Euromark rate adjusts only to i_m'.

Figure 5'



[20]Nonetheless, it may still be possible to make statements regarding causality, albeit of a much more limited nature. If the transactions of traders and speculators dominate movements in the forward rate (that is, shifts in ST account for most changes in fp) then the direction of causation generally will be from the forward premium to the Euromark rate.

[21]In particular, we can determine whether the fact that the forward premium is maintained at interest parity with respect to the Eurocurrency rates necessarily implies that it is not influenced by the rate of interest in Germany.

[22]These assumptions imply that banks neither borrow reserves not hold excess reserves. Although free reserve behavior could easily be accommodated, it would complicate the exposition without altering the basic conclusions of the analysis.

[23]With i_m maintained equal to $i_\$ - fp$, there is no incentive for nonbanks to hold Euromarks on a covered basis. Thus we have omitted $i_m + fp$ as a factor in the nonbank functions. Its inclusion would not reverse any of the conclusions below.

[24]For simplicity we have assumed that the German Monetary Authority does not attempt to sterilize capital flows. This assumption could be relaxed to reflect more complex central bank behavior. (See Herring and Marston (1974).)

[25]This will be accompanied by a reduction in the external mark rate because Eurobanks maintain i_m equal to $i_\$ - fp$.

[26]This shift in net private demand will not be the final equilibrium position, however, since the increased demand for covered holdings of German securities will lead to an increased supply of forward D-marks and further changes in fp and i_m. The forward market and the German bond market must be solved simultaneously to determine the equilibrium set of rates.

[27]If equation (3), the equilibrium condition in the bond market, is differentiated with respect to i_g, fp and i_m (with dfp equal to $-di_m$), and the expression is solved for dfp/dig, we obtain:

$$\frac{dfp}{dig} = \frac{(-qDD_g^g + G_{gf}^{ad} + G_{gs}^{ad}).}{-(G_{gf}^{ad} - G_{ms}^{ad})}$$

It is evident that

$$\frac{dfp}{dig} \lesseqgtr -1$$

as long as $-qDD_g^g + G_{gs}^{ad} \gtreqless -G_{ms}^{ad}$. A sufficient condition for this inequality to hold is that an equal rise in the uncovered returns

on German Bonds and Euromark deposits lead to an increase (or no change) in holdings of German bonds (i.e., $G_{gs}^{ad} + G_{ms}^{ad} \geq 0$). Note that if German Bonds and Euromark deposits are close substitutes (i.e., G_{gs}^{ad} and G_{ms}^{ad} are very large in absolute value), $\frac{dfp}{dig}$ will approach -1; i_g will be (approximately) equal to i_m and both rates will be maintained at interest parity with respect to $i_\$$.

[28]Of course, the initial shift in the arbitrage supply curve will not be the final equilibrium position, since adjustments will occur in both the bond market and the forward market.

[29]Equation (2.b), the equilibrium condition in the forward market, is differentiated with respect to i_g, fp, and i_m, and di_m is set equal to -dfp. If this expression is solved for $\frac{dfp}{dig}$, we obtain:

$$\frac{dfp}{dig} = \frac{-(\hat{G}_{gf}^{ad} + \hat{G}_{gs}^{ad} - M_{gf}^{d-L} - M_{gs}^{d-L})}{(-ST_f + \hat{G}_{gf}^{ad} - M_{gf}^{d-L} - \hat{G}_{ms}^{ad} + M_{ms}^{d-L})}$$

It is evident that $-1 \leq \frac{dfp}{dig} < 0$ as long as:

$$-ST_f + \hat{G}_{gf}^{ad} - \hat{G}_{ms}^{ad} + M_{ms}^{d-L} \geq \hat{G}_{gf}^{ad} + \hat{G}_{gs}^{ad} - M_{gs}^{d-L} \geq 0.$$

Sufficient conditions for this inequality to hold are that:

$$\hat{G}^{ad}_{gs} + \hat{G}^{ad}_{gf} \gtrless 0 \text{ and } M^{d-L}_{ms} + M^{d-L}_{gs} \gtrless 0.$$

These conditions are analogous to those discussed earlier. Note that if Euromark deposits and German bonds are close substitutes (i.e., M^{d-L}_{ms} and M^{d-L}_{gs} are large in absolute value), the ratio will approach negative one.

[30]Thus we have established that the German bond market curve (GG) must be of steeper (negative) slope than the forward market curve (FF). Note that the GG schedule must be of steeper slope than FF if equilibrium in the two markets is to be stable.

[31]The fact that fp falls in response to the tightening of German monetary policy is in accord with the traditional theory of the forward market. In the present model, however, the fall in fp is accompanied by simultaneous adjustments in the Euromark and German markets.

[32]Note that the German spot rate was not fixed during this period, so adjustments in that exchange rate may also have occurred.

[33]In fact, strictly speaking, either condition is sufficient alone. For an algebraic description of this convergence, see footnotes 27 and 29.

[34]See Graph A.4.

[35]Nor does it imply that the German interest rate is determined solely by the Eurodollar rate. The German interest rate may vary so long as the forward premium varies inversely to it.

[36]When the arbitrage demand for German bonds is infinitely elastic at the covered Eurodollar rate, the actual quantity of bonds purchased and hence the quantity of forward exchange supplied by arbitrageurs is determined by the quantity of bonds supplied in the market by non-arbitrageurs (G^s) at $i_g = i_\$ + fp$. This quantity will equal the net government supply ($\bar{\bar{G}}-\bar{G}^{md}$) less the demand by private German residents ($\bar{W}-qDD^g$) less the demand by foreign speculators ($\tilde{G}^{ad}$).

[37]For an analysis of the interest arbitrage schedule, see Officer and Willett (1970).

[38]To the extent that marginal reserve requirements differ between the Eurodollar and CD markets, incentives for arbitrage by bank borrowers will differ from incentives for arbitrage by nonbank lenders. In the period prior to June 1973, the marginal reserve requirement on U.S. bank borrowing from foreign branches (20%) was substantially higher than the reserve requirement against large Certificates of Deposit (5%). However, during June 1973, the marginal reserve requirement on foreign borrowing was reduced to 8% and a marginal reserve requirement of 8% was introduced on large CDs. With certain temporary exceptions, the marginal reserve requirements remained equal throughout the remainder of the period.

[39]See, for example, World Financial Markets, July 1974, p. 13.

[40]In the early January 1974, the German authorities abolished the 60% marginal reserve requirement on bank liabilities to foreigners and lowered the average reserve requirement on foreign liabilities. Effective January 30, 1974, administrative restrictions on capital movements were largely abolished. In addition, the cash deposit ratio required on foreign borrowing was lowered from 50% to 20%, and other provisions of the cash deposit scheme were liberalized. See the Monthly Report of the Deutsche Bundesbank, various issues, and the Report of the Deutsche Bundesbank for 1973.

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