THE JOURNAL OF FINANCE • VOL. XXXV, NO. 6 • JUNE 1980

Money Demand and Foreign Exchange Risk: The German Case, 1972-1976

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THE OPTIMAL LEVEL OF domestic money balances may vary according to different degrees of uncertainty concerning the foreign exchange value of the domestic money. That is, in addition to the fundamental determinants of the demand for money—wealth, income, and opportunity cost—certain types of risks, in this case foreign exchange rate uncertainty, may play a role, albeit a small one. In this note, we consider the theoretical arguments supportive of this contention and then present some empirical evidence, based on a variety of money demand functions and using the German economy as the test case. Our findings are strongly suggestive that foreign exchange risk does play a role in determining real money balances.

I

A flexible exchange rate system, even with extensive central bank intervention, will experience periods of relative calm and periods of turbulence on foreign exchange markets. Business cycles may get into and out of phase, monetary and fiscal policies may be directed at different goals in different countries; these policies may shift abruptly, or certain exogenous events (i.e., the OPEC price hike) may impact countries in varying ways. Regardless of the ultimate factors behind calm or turbulence in exchange markets, the uncertainty associated with value of domestic money in terms of foreign exchange will vary accordingly. Changes in the actual or perceived risk associated with foreign exchange may have direct and indirect effects with respect to the demand for domestic money by the private sector.

The direct effect of transactors responding to increases in the riskiness of currency values is a tendency to diversify and hold smaller amounts of domestic money. Domestic currency no longer provides the same informational content concerning international transactions as previously and may no longer serve as an optimal store of value for a given level of transactions. For instance, given three currencies, A, B, and C, an increase in the risk associated with exchange rates A/B and A/C does not necessarily imply an increase in the risk associated with exchange rate B/C. Some portfolio holders will find it desirable to adjust their holdings of A, B, and C to reflect the new risk structure, that is, reduce their

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The views expressed in this paper are solely those of the authors and do not necessarily reflect the views of their respective institutions. The authors wish to thank James Rasulo, Sykes Wilford and Aris Protopapadakis for helpful comments on earlier versions of this paper.

holdings of domestic money and increase their holdings of foreign monies. This argument can also be made with respect to different assets all of which are denominated in the domestic currency, since some assets may be more price sensitive to exchange rate changes than others and may serve as better hedges against foreign exchange risk.[1]

The indirect effect of changes in foreign exchange risk is associated with its impact on the volume of international transactions. Increased foreign exchange risk will increase the cost of international trade. Even with efficient forward markets, the risk premium associated with a given currency may rise to compensate the risk-taker more fully. Furthermore, not all transactions can be effectively covered in forward markets since there often exists uncertainty concerning the timing of foreign exchange receipts and expenditures.

Existing empirical evidence concerning this hypothesis is somewhat conflicting.[2] With respect to the hypothesis that exchange rate uncertainty increases the cost of trade, a study by Frenkel and Levich (10) provides some support. As to whether the increased costs affect trade volume, studies by Akhtar and Rob (2) and Clark and Haulk (6) related to the Canadian experience are inconclusive, while Hooper and Kohlhagen (12) found no evidence of the negative impact on trade volume in the case of U.S./German trade flows. Their results for the U.S./U.K. trade flows, however, provided some support for the hypothesis under consideration. Similarly, Makin (16) found only negligible impact of exchange rate fluctations for multilateral import volumes of four countries. Due to the modern world's limited experience with flexible exchange rates in a period marked by such major shocks to the world's economy as the OPEC price hikes, a comprehensive analysis of this hypothesis is not yet possible. However, if the increase in the cost of international transactions reduces the volume of international transactions below what it otherwise would have been, then the demand for real money balances is also reduced.

One should note that while the indirect effect does posit a reduction in the volume of international transactions below what it otherwise would have been, this is not an assumption concerning the direct effect. Also, both effects are assumed to impact the demand for domestic money balances in the same direction. That is, an increase in the risk associated with foreign exchange tends to decrease the demand for domestic money.

II

In attempting to provide empirical verification of the conclusion drawn in the preceding analysis, two issues are of critical importance. They are the choice of

[1] This argument is closely associated with the currency substitution theories developed by, among others, Russell Boyer [3, 4], Lance Girton and Don Roper [11], Marc Miles [17]; and David T. King, Bluford H. Putnam, and D. Sykes Wilford [13].

[2] A brief review of the main arguments concerning the effects of exchange rate uncertainty on the volume of international transactions is presented in M. A. Akhtar and A. K. M. A. Rob [2]. See also Andrew Crockett and Morris Goldstein [7], Peter Clark [5], Henry Wallich [18], and Paul Einzig [9].

the variable to proxy foreign exchange risk and the specification of the money demand function.[3]

In this investigation, the degree of foreign exchange risk will be measured by the degree of variability in the exchange rate. In some sense this is an arbitrary choice, since variability does not necessarily imply unpredictability. But, exchange rates in the seventies have been considerably more variable and less predictable than in the Bretton Woods period of fixed exchange rates.[4] Furthermore, a number of foreign exchange forecasting services have begun to sell their wares to multinational clients. Presumably, corporations that pay for these services do so, at least in part, because they feel that it helps them reduce their foreign exchange risk. However, as a study of these services by Levich (15) shows, forecasting exchange rates during recent periods has been extremely difficult. Thus, while our choice of the exchange rate variance can be questioned, the assumption of an association between variance and unpredictability in the exchange markets seems reasonable.[5]

One might prefer the use of the variance of the forward exchange rate rather than the spot rate, arguing that the forward is in some sense the market's prediction of the future spot rate. Unfortunately daily forward rate (3 month) data were not available in a consistent form for the entire period. However, our investigation indicates that since mid-1973, when our forward rate data became available, the standard deviation of the spot rate virtually equalled that of the forward rate in every period. Thus, the use of the forward rate instead of the spot rate as measure of risk would produce empirically very similar results.

Also, another option would be to consider the currency in question as part of multi-currency world in which the pattern of covariance among the currencies is the appropriate measure of exchange risk. In the case empirically investigated here, there is a presumption of relative stability among currencies in the German mark currency sector. This stability was enforced for much of the period under study by the "snake" currency arrangement. Thus, for empirical simplicity, these covariances are assumed unimportant, and the focus is entirely on currency risk vis-a-vis the primary international currency, the U.S. dollar.

In this study, the empirical counterparts of exchange rate risk are quarterly standard deviations based on daily 9:00 a.m. U.S. Dollar/German mark spot rates in New York from January 1972 through December 1976. In all of the subsequent empirical work presented here, the standard deviation of the \$/DM spot rate enters the money demand function in log form. While this specification produced the "best" results (judged in terms of R^2s and standard errors), other specifications such as non-log, a rank index, and the ratio of the standard deviation to the spot rate produced results broadly consistent with those reported here.

[3] For a more complete theoretical discussion of these issues and additional empirical results, see M. A. Akhtar and Bluford H. Putnam [1].

[4] See, for example, Dooley and Shafer [8].

[5] The choice of the exchange rate variance is a very narrow specification of exchange risk, and ignores several closely related sources of exchange market uncertainty such as expectations about capital controls and trade barriers. As in the other studies of exchange risk, we have neglected these other sources of exchange market uncertainty since they are not quantifiable (see Yeager [19] and Hooper and Kohlhagen [12]).

With respect to the money demand specification, the objective is to demonstrate the importance of including foreign exchange risk, regardless of the specification that one prefers for the demand for money. Thus, many forms of the money demand function were investigated, the two basic versions being:

$$\ln(M) = a_0 + a_1 \ln(Y/P) + a_2 r + a_3 \ln(v) + a_4 \ln(P) + u_1 \quad (1)$$

$$\ln(M/P) = a_0 + a_1 \ln(Y/P) + a_2 r + a_3 \ln(v) + u_2 \quad (2)$$

where M = currency in the hands of the public and sight deposits, Y = nominal national income, r = interest rate, v = standard deviation of daily \$/DM spot rates, P = general price level, and u_1 and u_2 are the error terms. Both specifications postulate continuous equilibrium in the money market and specification (2) assumes that money demand is homogenous of the first degree in prices. The interest rate enters both specifications in non-log form as postulated by several money demand specialists.[6]

Estimates for equations (1) and (2) are presented in Table I, as regressions (A) and (B), along with some other variants of these basic specifications. All regressions reported are based on quarterly data for the Federal Republic of Germany where M is narrowly defined money at the end of the period, Y is nominal GNP, r is the public authorities bond yield, and P is the consumer price index.[7] In the following comments, we discuss first the exchange risk in terms of all the regressions (both reported and unreported) and then briefly note the differences due to the various specifications of money demand.

The results, taken as a whole, are extremely encouraging. In all cases, the exchange risk variable entered the estimated regression equation with a coefficient of the anticipated sign and is significantly different from zero at the 95% level, one-tailed test. Furthermore, the absolute value of the coefficient did not fluctuate across different specifications of the money demand function. The Durban-Watson statistics show a remarkable lack of autocorrelation for a log specification, and in most cases, the regression which included the exchange risk variable had less autocorrelation. Also, the standard errors of regressions were

[6] This specification avoids the theoretical problem of an undefined demand for money at a zero interest rate. See, for example, Benjamin Klein [14].

[7] Note that the concept of money employed here deals with the resident demand for domestic money, that is Ml. During periods of greater exchange rate risk, certain international firms might place some of their liquid funds into a store of value currency (such as Swiss francs), and thus increase the demand for that currency (i.e., increased exchange risk may exert a positive effect on German money demand in that international firms in other countries may increase their holdings of German marks). However, a multinational firm is most likely to carry-out this transaction in the Euromarkets and such a transaction would not affect the demand for domestic money as it is measured here. Only if the multinational firm transferred its liquid funds to a subsidiary which then converted the funds into the domestic money would the transaction affect our analysis. The magnitude of this possibility is likely to be quite small and is ignored in this analysis.

consistently 6 to 7 percent less for the specifications including the exchange risk variable, as compared to those without it.[8]

With respect to the particular money demand functions reported here, some points are of interest. The theoretical difference between functions (A) and (B) is that function (A) allows for the price elasticity of money demand to differ from unity, while function (B) does not. Both are common specifications for money demand functions, and the results with respect to the exchange risk variable are virtually identical. However, specification (A) does indicate that the price elasticity may be slightly higher than unity, and this specification does produce the highest R^2 statistic of the reported regressions. Specifications (B) through (E) constrain the price coefficient to unity, resulting in lower R-square statistics, but, generally, greater statistical significance for the income variable. In these latter four equations, there is no specification that is clearly preferred. A variety of permanent income specifications were employed in the initial investigations and the results with respect to the exchange risk term are consistent across permanent income specifications.[9] The permanent income specification used in functions (C) and (D) produced the "best" statistical properties for the entire regression, in terms of goodness of fit and absence of autocorrelation. Also, specifications (C) and (D) compare the log and non-log interest rate formulations, and there are no major statistical differences.

A variety of additional money demand specifications were estimated, including the use of (1) short-term interest rates, (2) both long and short-term interest rates, (3) international interest rate differentials, (4) changes in the rate of inflation, and (5) lagged adjustment. None of these experiments provided a statistically improved money demand function, but the exchange risk variable demonstrated a consistency across specifications, as it did in the reported results.

III

This paper has argued that the money demand function in an open economy should include not only the usual income or wealth constraint and interest rates

[8] On a referee's suggestion, we considered a proxy for uncertainty associated with the movements in domestic prices. Specifically, we included the variance of the domestic price level in regression equations. There is some rationale for this specification in that exchange rate changes may be correlated with price level changes. These estimates indicate that uncertainty concerning the domestic price level as measured by the standard deviation of consumer prices, *vp*, is not a significant explanatory variable, while the exchange risk variable remains statistically significant. However, the problem may lie more with our inability to adequately measure the variance of the price level rather than any deficiency in the concept. The following regression is representative of these results:

$$\ln M = \underset{(-2.39)}{-7.92} + \underset{(1.83)}{1.04}\ \mathrm{Ln}\left(\frac{Y}{P}\right) \underset{(-2.24)}{- 0.022\, r} \underset{(-1.74)}{- 0.22 \ln(v)} \underset{(-1.74)}{} + \underset{(0.01)}{0.0001\, vp} + \underset{(8.11)}{1.25 \ln(P)}$$

Standard Error = 0.0361; Adjusted R-Square = 0.929;
Durbin Watson = 2.27

[9] More complete results and additional permanent income specifications are reported in Akhtar and Putnam [1].

Table 1

Money Demand Results: Quarterly, 1972–76

		Standard Error	Adjusted R-Square	Durbin-Watson
(A)	$\ln(M) = -7.91 + 1.04 \ln\left(\frac{Y}{P}\right) - 0.022\, r - 0.020 \ln(v) + 1.25 \ln(P)$	0.0349	0.95	2.27
	$(-2.59)\ (1.95)\qquad (-2.33)\quad (-1.90)\qquad (8.45)$			
(B)	$\ln\left(\frac{M}{P}\right) = -6.62 + 1.72 \ln\left(\frac{Y}{P}\right) - 0.024\, r - 0.021 \ln(v)$	0.0368	0.64	1.80
	$(-2.71)\ (4.76)\qquad (-2.50)\quad (-1.84)$			
(C)	$\ln\left(\frac{M}{P}\right) = -7.40 + 1.84 \ln(Y^e) - 0.027\, r - 0.021 \ln(v)$	0.0359	0.65	2.04
	$(-2.95)\ (4.95)\qquad (-2.94)\quad (-1.93)$			
(D)	$\ln\left(\frac{M}{P}\right) = -7.06 + 1.83 \ln(Y^e) - 0.24 \ln(r) - 0.021 \ln(v)$	0.0365	0.64	1.99
	$(-2.76)\ (4.85)\qquad (-2.82)\qquad (-1.88)$			
(E)	$\ln\left(\frac{M}{P}\right) = -7.14 + 1.07 \ln\left(\frac{Y}{P}\right) + 0.73 \ln\left(\frac{Y}{P}\right)^* - 0.028\, r - 0.021 \ln(v)$	0.0344	0.75	2.35
	$(-3.10)\ (2.17)\qquad (1.80)\qquad (-3.04)\quad (-2.00)$			

Notes: (1) T-Statistics are in parentheses.

(2) $\left(\frac{Y}{P}\right)^* = (1/7) \sum_{i=1}^{7} (Y/P)_{t-1}$

(3) $Y^e = \{8(Y/P)_t + (Y/P)_{t-1} + (Y/P)_{t-2} + 2(Y/P)_{t-3}\}/12$

(4) All data except the daily exchange rates were taken from the International Financial Statistics, M = line 34, P = line 64, r = line 61b, y = line 99a/line 64. The daily exchange rates used to calculate v were from the foreign exchange data base maintained by the Federal Reserve Bank of New York.

(5) See text for notation.

but also some measures of the exchange risk arising out of exchange rate variability. Specifically, we have augued that the exchange risk tends to reduce the demand for domestic money, and that the recent German experience provides substantial support for this hypothesis. In this respect, we have discussed numerous estimates based on different specifications of the money demand function. The major conclusion is that, regardless of the specification of the money demand function, the exchange risk is an important contributor to an explanation of the behavior of money demand. The estimates are generally free of the usual statistical problems and the *t*-tests indicate that the exchange risk variable is significant, in most cases, at the 95 percent confidence level.

To be sure, the income and the interest rate variables are more important than exchange risk. However, irrespective of the specification, the exchange risk seems to exert an independent effect which is not captured by any of the other variables. The failure to include the exchange risk variable produces biased estimates with substantially less stable money demand functions. This finding indicates that changes in the exchange rate regime may require a reformulation of the money demand function.

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