Currency Substitution and Money Demand in the United States, West Germany and Japan

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In a 1973 article, *Stephen Goldfeld* concluded that a standard *Keynesian* money demand function specified as linear in the logs of the variables was a powerful predictive tool (*Goldfeld* 1973). Less than a year later, the Goldfeld equation began to seriously overpredict money demand.

This shortfall of money demand from its expected levels has inspired explanations that run the gamut of economic science. Among the explanations offered for the overprediction is currency substitution. Some scholars have suggested that the currency composition of financial portfolios varies with alterations in currency prices. The purpose of this paper is to examine this thesis using more direct techniques than have been employed in the past.

In explaining the failure of the *Goldfeld* model, some scholars have indicated that the Goldfeld experience is but another manifestation of limitations inherent in traditional econometric analysis (*Hafer* and *Hein* 1982; *Rose* 1984; *Laidler* 1985). Other analysts have argued that the "missing money" reflected an error in the specification of the Goldfeld model (*Hamberger* 1977). Then, too, there is a legion of researchers who believe that the missing money can be found by including independent variables that somehow capture the financial innovation spawned by structural changes in the global economy that occurred after 1973. This group basically subscribes to the idea that econometric technique has been underemployed in locating the lost money.

A subset of this group of economists hypothesizes that developments in the internatonal monetary system in the past decade and one-half have been responsible for changes in the currency composition of cash balances (*Miles* 1978; *Brittain* 1981; *McKinnon* 1982; 1984; *Baade* 1985; *Akhtar* and *Putnam* 1979; *Hetzel* and *Mehra* 1986). Other scholars have concluded that currency substitution is not important in accounting for the missing money (*Batten* and *Hafer* 1984).

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This paper draws its inspiration from the debate on currency substitution and has a two-fold purpose. First, evidence will be analyzed for the United States, West Germany, and Japan on whether currency substitution has occurred since the standard money demand equation began to yield unsatisfactory results, a time that roughly coincides with a global commitment to a system of flexible exchange rates. Second, evidence will be examined on the extent to which currency substitution explains errors in money demand predictions for the United States, West Germany, and Japan.

The paper is organized as follows. Section one provides a more detailed review on the theory and evidence relating to the currency substitution thesis, and explains the particular contribution of this study. Sections two and three present the analysis corresponding to the twin objectives of the study. A summary and concluding remarks are provided in part four.

I. Theory and Evidence Relating to the Currency Substitution Hypothesis

Money demand in the U.S. was stable in the 1950s and 1960s, and the U.S. was the reserve currency country in a fixed exchange rate regime. Dollar demand ceased to be stable in 1973 and 1974, a time that coincides with a global adoption of a system of flexible exchange rates. Was this coincidence? Perhaps, but there is a theoretical basis for arguing that this development could have been anticipated. The only question seems to be one of degree. Are money holdings sufficiently transnational in character to help explain the shortfall in dollar demand? Casual empiricism supports a dollar substitution thesis for the mid 1970s. As economic events promised a reduction in the dollar's foreign currency values, actual dollar demand would be expected to fall. Thus it would follow that models for dollar demand that ignored the flexible exchange rate influence would overpredict dollar demand. The argument should be symmetric. Models that ignore the influence that alterations in foreign currency prices of dollars have on dollar demand, should underpredict dollar demand when the foreign currency price of dollars is expected to increase. Of course, it could be argued that the adoption of a system of flexible exchange rates induces a once and for all downward shift in money demand schedules reflecting the risk of greater exchange rate variability.

Literature on the currency substitution question does not have a long history. *Chow-Nan Chen* (1973) may have been the first to argue that currency substitution undermines the much-heralded insulating power of a flexible exchange rate regime. However, Chen's conclusions qualify as conjecture since most of our experience with flexible exchange rates followed his work.

Marc Miles (1978) performed some early empirical tests on currency substitution between the U.S. and Canada. He concluded that currency substitution by the private sector has characterized the flexible exchange rate regime, and in effect replaced the "substitution service" provided by the public sector during the Bretton Woods era. While Miles' methodological approach based on a CES production function for money services was impressive, his findings were limited by both the number of countries studied and the number of observations.

M. A. Akhtar and *Bluford H. Putnam* (1979) analyzed the relationship between exchange risk and the demand for money in Germany between 1972 - 76. Although their findings did not prove currency substitution, they concluded that the German demand for money schedule shifted downward with the advent of a system of flexible exchange rates. Like the *Miles* research, the Akhtar and Putnam study was limited by the data available relating to a flexible exchange rate system.

One of the more complete and direct tests of the currency substitution phenomenon was undertaken by *Dallas S. Batten* and *R. W. Hafer* (1984). They included a variable that captured the expected return from holding foreign money balances (the threemonth forward premium/discount) in Goldfeld-type money demand equations for Canada, France, Germany, the Netherlands, and the United Kingdom for the 1966 - 1983 period. They found that only for Canada and Germany during the flexible exchange rate years did the expected return from holding money balances exercise a significant impact on money demand. Interestingly these findings on Canada and West Germany conform to the earlier work supporting the currency substitution thesis.

Other research has explored the currency substitution question through less direct techniques than that employed by *Batten* and *Hafer*. *Ronald I. McKinnon* (1982, 1984) has advanced the currency substitution hypothesis through the development of a model which leads him to conclude that the global money supply is more closely correlated with U.S. prices than is the U.S. money supply. *Henry Goldstein* and *Stephen Hayes* (1984) and *Christopher Radcliffe, Arthur D. Warga,* and *Thomas O. Willet* (1984) reject *McKinnon's* world money supply hypothesis, and, in the process, take issue with his position on currency substitution.

Robert L. Hetzel and *Yash Mehra* (1986) studied the relationship between U.S. inflation and the real exchange rate, and offered some insight based on a quantity theory perspective. They concluded that the relationship they observed between inflation and the real exchange rate very likely reflected one of three phenomena. First, the real exchange rate affects the rate of

inflation through a wealth effect that operates through the demand for money. Second, real exchange rate changes influence the currency composition of cash holdings, and, in turn, alter the rate of inflation through an alteration in interest rates. Third, changes in the real exchange rate directly influence the money supply and prices. *Hetzel* and *Mehra* tentatively endorse the second explanation, and the tenuousness of their currency substitution conclusion reflects the indirect test of the thesis.

In summary, there is a paucity of evidence that directly addresses the currency substitution question. The issue is of vital interest since shifts in money demand schedules can influence interest rates, employment, and prices. Furthermore, evidence offered on the currency substitution question to date has been ambiguous. The empirical work summarized in the next two sections of the paper attempts to provide more conclusive evidence on the issue. Before the direct tests on the currency substitution thesis were conducted, it seemed logical to define money demand functions for the three countries we believed would be most significantly involved in any currency substitution. The estimated money demand equations for Japan, Germany, and the United States are reported in the next portion of the paper based on the premise that currency substitution can be captured and tested by analysing the residuals of the money demand equations for the three above mentioned countries. Tests on the currency substitution thesis are reported in Section III. Section IV offers some concluding remarks.

II. Test Results Relating to Money Demand in Germany, Japan and the United Stated

The data used to estimate money demand equations for Germany, Japan, and the United States[1] were quarterly observations that were seasonally adjusted either at the source or by the authors using the Census X-11 program.[2] Specifically, the following equations were estimated:

$$(2.1) \qquad \ln (M/P)_{t,j} = \beta_{0,j} + \beta_{1,j} \ln (M/P)_{t-1,j} + \beta_{2,j} \ln (Y_{t,j}) + \\ + \beta_{3,j} \ln (r^1_{t,j}) + \beta_{4,j} \ln (r^2_{t,j}) + e_{t,j},$$

[1] The data for the U.S. were directly obtained from the Fed while those of Germany and Japan were found in various issues of International Financial Statistics.

[2] Controversy on the advantages and disadvantages of using seasonally adjusted data is by no means resolved. Here we used seasonally adjusted data since almost all observations were seasonally adjusted at the source. (See *Bell* and *Hillmer* 1984 for a discussion of seasonal adjustment of economic time series).

where,

j = 1, 2, 3 representing the United States, Japan, and Germany, respectively,
M = $M1$ domestic nominal money stock,
P = the consumer price index,[3]
Y = Real GNP (1972 dollars)
r^1 = passbook rate in the U.S. and the discount rate in Germany and Japan,
r^2 = commercial paper rate used in the case of the U.S. only
e = stochastic error.

The application of *Durbin*'s (two-sided) M-Test[4] to equation 2.1 indicated the presence of first-order autocorrelation for the United States and Japan, but no such problem for Germany. In particular, the regression of the error terms on all independent and dependent variables and on the lagged values of the residuals resulted in the t-statistics for the coefficients of the lagged error terms recorded in Table 2.1.

Table 2.1

The t-statistic for the Durbin M-test

Country	t-statistics
U.S.	1.7011
Japan	−4.4523
Germany	1.1844

Given the results presented in Table 2.1, ordinary least squares (OLS) was used to estimate Germany's money demand equation and the *Hildreth-Lu* (H-L) (1960) procedure was employed to estimate money demand models for the U.S. and Japan. A refined grid value of 1×10^{-4} was adopted to guarantee the convergence of the H-L procedure to a global optimum. The complete estimation results are recorded in Table 2.2.

It is observed that such standard money demand functions specified as linear in the logs of the variables has high explanatory power for all three countries. The adjusted coefficients of determination all exceed 96% indi-

[3] The GNP deflator was used as a measure of this variable for the U.S. while in the case of Japan and Germany we employed the wholesale price to construct the CPI that was used instead of the GNP deflator.

[4] Almost all other empirical studies that we know of in this field use the *Durbin* h-test. Our preference for the Durbin M-test stems from the Monte Carlo results of Spencer, 1975.

Table 2.2: **Money Demand Equations for the United States, Germany, and Japan**

Country and Sample period \ Statistic	$b_{0,j}$	$b_{1,j}$	$b_{2,j}$	$b_{3,j}$	$b_{4,j}$	R^2	$\bar{R}^2$	$\hat{\varrho}$
United States 1965.3 - 1985.1	.1646 (.8047)*	.9196 (28.54)	.0563 (2.98)	–.0594 (– 2.44)	–.0183 (– 5.01)	.9322	.9280	–.034
Japan 1965.3 - 1985.1	.2660 (3.64)	.7890 (14.62)	.1901	–.0612 (– 3.26)	NA**	.9918	.9915	–.424
Germany 1965.3 - 1985.3	.0359 (1.54)	.9180 (25.13)	.0700 (1.96)	–.0409 (– 3.88)	NA	.9779	.9770	NN**

* All numbers in paranthesis represent the t-statistics.
** Not available.

cating that at least 96% of the variation in money demand is explained through the specified equations. Furthermore, all variables have the expected signs and all are significant except for the commercial paper rate coefficient for the United States.

The *Chow* test was then used to discern whether or not a structural shift that coincided with the adoption of a system of flexible exchange rates, had occured in the money demand equations. This test was performed for each quarter of 1974 separately. The null hypothesis of no structural change had to be accepted at 1% level of significance for the first three quarters of 1974 and rejected for the fourth quarter of that year. The same test did not indicate any support for the hypothesis of structural change in 1975. The same behavior was detected for the Japanese and the German money demand equations. Table 2.3 provides the *f*-statistics for the Chow test for all three countries and for all four quarters of 1974. As can be seen, the evidence supports the occurrence of a structural shift in the money demand equations for the fourth quarter of 1974. This evidence pertains to all three countries and indicates a simultaneous change in demand for money in the United States, Japan and Germany which coincided with the advent of flexible exchange rates. Therefore it may be hypothesized that currency substitution played an important role in effecting the demand for money in the post-1974 period. In the next section such a possibility is examined and tested.

Table 2.3

F-statistics for Test for Structural Change

	U.S.	W. Germany	Japan
1974.1	2.1	3.4	1.9
1974.2	1.8	3.2	1.6
1974.3	3.8	3.6	2.7
1974.4	8.5	9.2	7.1

III. Testing For Currency Substitution

In order to examine the possible effect of currency substitution on the U.S. money demand, we regressed the residuals of the U.S. money demand equation on the error terms generated by the money demand equations for Germany and Japan. This test could help to detect a possible link between the overestimation of the United States' money demand equation and a pos-

sible underestimation of the German and Japanese money demand models. The regression resulted in a very low coefficient of determination ($R^2 = .002$) suggesting that the residuals (overestimation) of the money demand equation for the U.S. dollar cannot be significantly explained by the residuals (underestimation) of the money demand equations for the deutschmark and the Japanese yen. The same experiment was repeated by regressing the German money demand error terms on those of Japan and the U.S., and by regressing the Japanese residuals on the error terms of the money demand equations for the U.S. and Germany. For both cases low coefficients of determination were obtained ($R^2 = .031$ and .032, respectively) and none of the independent variables (residuals from the money demand equations of the other two countries) were significant. However, these regression models performed much better when only the Post-1974.4 data was employed, with R^2's of .055, .108, and .116 for the three cases, respectively.

While such tests are not particularly appropriate for direct examination of the currency substitution hypothesis, they shed some light on the problem. For example, the evidence suggests that the error terms from the Japanese money demand seem to be best explained by the error terms of the other two countries, while that of the U.S. is least explained by the error terms of Japanese and German money demand error terms. Therefore it seems plausible that the Japanese money demand could be more strongly influenced by currency substitution and that the U.S. money demand is perhaps least affected.

An explanation for this may lie in the analysis of the size of a country's international sector relative to the size of its economy. In other words, since in the case of Japan the international sector constitutes a relatively large part of the economy, currency substitution will exhibit more of an effect on the money demand, while in the case of the United States the substitution effect is nominal given the relatively small size of its international sector. This possibility is further confirmed by examining the cross correlations for the residuals of the three money demand equations. Results of such a comparison are given in Table 3.1 where the numbers in parentheses represent relevant *t*-statistics. As can be seen from the Table, all correlations are insignificant prior to the advent of flexible exchange rates and are all significant for the post 1974.4 period. This evidence can provide further support for the currency substitution thesis.

In order to present a more formal and direct test of currency substitution we added the residuals obtained from the Japanese and the West German money demand equations as independent variables for the money demand

Table 3.1

Cross Correlation of Residuals

	Pre-1974.4		Post-1974.4	
	U.S.	Germany	U.S.	Germany
U.S.	–	.2644 (1.64)	–	–.2827 (1.78)
Japan	–.1328 (–.834)	–.0612 (–.368)	–.1984 (– 2.12)	–.3000 (1.85)

regression for the United States as given by equation (2.1). This resulted in an increased explanatory power as judged by the new adjusted R^2 of .934 relative to the old value of .928. When considered separately the residuals of the Japanese and the German money demand regressions prove not to be significant, however, an *f*-test for the joint significance of these residuals led to an *f*-value of 15.8 which supports their joint significance in explaining variations in the demand for many in the U.S.

To summarize our empirical investigation we first tested the money demand equations in the U.S., Japan and Germany for structural change. Once the occurrence of structural shifts beginning in 1974 was established, we employed residual analysis as a weak test for examining the effect of currency substitution on money demand. Our results indicated that: (1) currency substitution while very likely insignificant prior to 1974 may have played an expanded role in affecting money demand in the U.S., Japan, and Germany beginning in the third quarter of 1974; (2) this effect was not uniform across all three countries; in particular, currency substitution is likely a stronger determinant of money demand in a country with a relatively larger international sector; (3) currency substitution does not seem to be able to explain a substantial portion of the errors in money demand predictions. However, the residual analysis employed may underestimate the significance of currency substitution. Since currency prices likely are correlated with the independent variables in the Goldfeld equation, some of the relationship between currency prices and money demand has been accounted for through those variables.

IV. Summary and Conclusions

Scholarship on the question of currency substitution in a system of flexible exchange rates is of relatively recent vintage: Given that there only has

been approximately fifteen years experience with floating rates, the paucity of research is not surprising. However, given the potential importance of the relationship between exchange rates and money demand, there is a need to improve our understanding of how these variables relate. Evidence on this phenomenon has been ambiguous. In part, this reflects testing techniques that seemed indirect. We sought to test more directly the currency substitution thesis through regressing error terms for the money demand predictions for Germany, Japan, and the United States on one another. Our analysis indicated that there has been structural changes both in money demand schedules and in the correlation of money demand errors for Germany, Japan, and the U.S. coinciding with the adoption of a system of flexible exchange rates. However, while currency substitution may have become a more significant phenomenon since 1974, it could only explain a small fraction of the errors in money demand prediction for these three countries since 1974.

Bibliography

Akhtar, M. A. and *Putnam,* Bluford H. (1979): "Exchange Risk and the Demand for Money in Germany, 1972 - 76." Unpublished Mimeograph. – *Baade,* Robert A. (1985): "An Investigation of the Nexus Between Floating Exchange Rates and Economic Instability." Paper presented at the Eastern Economic Association Meetings, Pittsburgh, PA. March 21 - 23. – *Batten,* Dallas S. and *Hafer,* R. W. (1984): "Currency Substitution: A Test of Its Importance." Federal Reserve Bank of St. Louis Review. August/September. 66.6 - 11. – *Bell,* W. R. and *Hillmer,* S. C. (1984): "Issues Involved With the Seasonal Adjustment of Economic Time Series." October, pp. 291 - 320. – *Brittain,* Bruce (1981): "International Currency Substitution, and the Apparent Instability of Velocity in Some European Economies and the United States." Journal of Money, Credit and Banking. May, 13. 135 - 155. – *Chen,* C.-N. (1973): "Diversified Currency Holdings and Flexible Exchange Rates." Quarterly Journal of Economics. February, 87. 96 - 111. – *Enzler,* Jared, *Johnson,* Lewis, and *Paulus,* John (1976: 1): "Some Problems of Money Demand." Brookings Papers on Economic Activity. 261 - 280. – *Garcia,* Gillian and *Pak,* Simon (1979): "Some Clues in the Case of the Missing Money." American Economic Review. May, 69 (2). 330 - 334. – *Goldfeld,* Stephen M. (1976: 3): "The Case of the Missing Money." Brookings Papers on Economic Activity. 683 - 730. – *Goldfeld,* Stephen M. (1973: 3): "The Demand for Money Revisited." Brookings Papers on Economic Activity. 577 - 638. – *Goldstein,* Henry N. and *Haynes,* Stephen E. (1974): "A Critical Appraisal of McKinnon's World Money Supply Hypothesis." The American Economic Review. March 74. 217 - 226. – *Hafer,* R. W. and *Hein,* Scott E. (1982): "The Shift in Money Demand: What Really Happened?" Federal Reserve Bank of St. Louis Review. February, 11 - 15. – *Hamburger,* Michael J. (1977): "Behavior of the Money Stock: Is There a Puzzle?" Journal of Monetary Economics. 265 - 288. – *Hetzel,* Robert. L. and *Mehra,* Yash. (1986): "U.S. Inflation and the Real Exchange Rate." Paper presented at the Western Economic Association Meetings in San Francisco, CA. July. – *Hildreth,* G. and *Lu,* J. Y. (1960): "Demand Relations with

Autocorrelated Disturbances," Michigan State University Agricultural Experiment Station, Technical Bulletin 276, November. – *Laidler,* David E. (1985): The Demand for Money: Theories, Evidence, and Problems. New York: Harper and Row, Publishers, Inc. – *Lieberman,* Charles (1979): "Structural and Technological Change in Money Demand." American Economic Review. May, 324 - 329. – *McKinnon,* Ronald I. (1984): An International Standard for Monetary Stabilization. Washington D.C.: Institute for International Economics. – *McKinnon,* Ronald I. (1982): "Currency Substitution and Instability in the World Dollar Standard." American Economic Review. June, 72. 320 - 333. – *Miles,* Marc A. (1978): "Currency Substitution, Flexible Exchange Rates, and Monetary Independence." American Economic Review. June, 68, 428 - 436. – *Porter,* Richard D., *Simpson,* Thomas D., and *Mauskopf,* Eileen (1979): "Financial Innovation and the Monetary Aggregates." Brookings Papers on Economic Activity. 213 - 228. – *Radcliffe,* Christopher, *Warga,* Arthur D., and *Willett,* Thomas D. (1984): "Currency Substitution and Instability in the World Dollar Standard: Comment." The American Economic Review. December, 1129 - 1131. – *Rose,,* Andrew R. (1985): "An Alternative Approach to the American Demand for Money." Journal of Money, Credit, and Banking. November, 439 - 455. – *Spencer,* B. G. (1975): "The Small Sample Bias of Durbin's Tests for Serial Correlation When One of the Regressions is the Lagged Dependent Variable and the Null Hyposthesis is True." Journal of Econometrics, August, pp. 249 - 254.

Zusammenfassung

Währungssubstitution und Geldnachfrage in den USA, Deutschland und Japan

Geldnachfragefunktionen für die USA, die für die späten fünfziger Jahre und über die sechziger Jahre gute Erklärungen lieferten, führten ab 1974 zu erheblichen Überschätzungen der Geldnachfrage. Dieses Rätsel „fehlenden Geldes" inspirierte eine Vielzahl von Deutungen. Da die Überschätzungen der Nachfrage nach Dollars mit der Einführung flexibler Wechselkurse zusammenfiel, hat ein Erklärungsansatz auf die zunehmende Tendenz abgestellt, in internationalen Portfolios den Dollar durch andere Währungen zu ersetzen. Der Zweck dieses Aufsatzes ist es, die These der Währungssubstitution zu testen. Die Autoren ziehen die Schlußfolgerung, daß es zwar eine strukturelle Verschiebung der Geldnachfrage gab, die möglicherweise auf Währungssubstitution zwischen den untersuchten Ländern zurückgeht, die Nachfrageüberschätzungen aber höchstens zum Teil durch Währungssubstitution erklärt werden können.

Summary

Currency Substitution and Money Demand in the United States, West Germany and Japan

Money demand equations for the United States that predicted well during the late 1950s and throughout the 1960s began to significantly overpredict money demand in 1974. This "missing money" puzzle inspired a myriad of explanations. Since the adop-

tion of floating exchange rates coincided with dollar demand overpredictions, one explanation has focused on a growing tendency to substitute other currencies for dollars in international portfolios. The purpose of this paper is to test the currency substitution thesis. The authors concluded that while there was a structural shift in the demand for money, perhaps induced by currency substitution among countries analyzed, currency substitution at best only partially explains dollar overpredictions.

Résumé

La substitution de monnaie et la demande monétaire aux Etats Unis, en République fédérale d'Allemagne et au Japon

Les équations de la demande monétaire pour les Etats Unis, qui ont fait de bonnes prédictions à la fin des années 50 et au cours des années 60, commencèrent à prédire de manière nettement excessive la demande de monnaie en 1974. Ce puzzle de „la monnaie manquante" a inspiré une myriade d'explications. Depuis l'adoption des taux de change flottants, coïncidant avec des prédictions exagérées de la demande de dollar, une explication s'est concentrée sur une tendance croissante à substituer d'autres monnaies au dollar dans les portefeuilles internationaux. Cet article examine la thèse de substitution monétaire. Les auteurs concluent ceci: même si la demande monétaire a subi un changement structurel, probablement induit par la substitution de monnaie dans les pays analysés, la substitution de monnaie n'explique tout au plus que de façon partielle les prédictions exagérées du dollar.