CURRENCY FUTURES: SOME IMPLICATIONS FOR INTERNATIONAL FINANCIAL MANAGEMENT

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Abstract

This paper tests the contemporary currency futures market for interest-rate parity, purchasing-power parity, market efficiency, and hedging effectiveness. The study finds that the currency futures market is a highly efficient, hedging-effective market exhibiting significant degrees of interest-rate parity and (longer-term) purchasing-power parity. Finally, the study infers from such findings some practicable policy tools for international cash management, multi-country capital budgeting, currency forecasting, and the risk management of foreignexchange exposure.

I. INTRODUCTION

This paper tests the contemporary currency futures market for interestrate parity, purchasing-power parity, market efficiency, and hedging effectiveness. Such properties have significant implications for international cash management, multi-country capital budgeting, currency forecasting, and the risk management of foreign exchange exposure. The paper is organized as follows.

The second section tests the currency futures market for interest-rate

parity. The third section utilizes the purchasing-power-parity theorem to test the ability of currency futures to predict differences in inflation rates between and among countries. The fourth section tests the ability of currency futures to unbiasedly predict subsequently realized spot rates. The fifth section ascertains the hedging effectiveness of the currency futures market. The final section synthesizes and elaborates upon the policy implications discussed in the previous sections.

II. CURRENCY FUTURES AND INTEREST RATE PARITY

In equilibrium, the process of arbitrage will effect the condition{1}

$$f_{j,t} = E(s_{j,t+n}) \quad (1)$$

where $f_{j,t}$ is the futures price of currency j (expressed as $\$/j$) at time t , for a contract maturing at time $t+n$; $s_{j,t+n}$ is the spot price of currency j at time $t+n$; and $E(.)$ is the expectations operator conditional upon all information available at time t . Arbitrage will also ensure that the futures price of currency j is its current spot price plus a carrying charge, c ,

$$f_{j,t} = s_{j,t} + c \quad (2)$$

where c , for currency futures, is either a positive or negative carry determined by the difference between $i_{d,t}$, the domestic-currency rate of interest, and $i_{j,t}$, the equivalent rate of interest in currency j , at time t ,

$$c = s_{j,t} (i_{d,t} - i_{j,t}). \quad (3)$$

Substitution of (3) into (2) yields

$$f_{j,t} = s_{j,t} [1 + (i_{d,t} - i_{j,t})] \quad (4)$$

so that the basis in currency-futures contracts is determined by the interest differential. If the interest differential is small, then, to a close approximation,

$$f_{j,t} = s_{j,t} (1 + i_{d,t}) (1 + i_{j,t})^{-1}. \quad (5)$$

which is the familiar Interest Rate Parity Theorem (IRPT).

Panton and Joy [22] test (5) for six major currencies covering the period June, 1972, to December, 1976. The authors find that the mean differences between actual futures prices and those predicted by (5) are insignificantly different from zero for all currencies tested with the exception of the British pound. However, in analyzing the arbitrage possibilities of individual contracts, the authors find numerous profit opportunities which lie outside a transaction-costs band about the IRPT predictions. The authors suggest that these deviations from interest rate parity could be caused by many factors, including differential tax treatments, governmental controls, and measurement error.

Besides obtaining mixed results and thereby being unable to draw a definitive conclusion regarding interest rate parity, Panton and Joy examined currency futures for the period 1972-76, during which time annual trading volume was less than two percent of current trading volume.

Essentially, then, interest rate parity

remains an untested proposition for the currency futures market.

This section tests the contemporary currency futures market for interest rate parity by examining five major currencies: the British pound, the Canadian dollar, the German deutsche-mark, the Japanese yen, and the Swiss franc, all expressed in U.S. dollars. Together, the five currencies being tested account for 99.4% of currency futures trading at the Chicago Mercantile Exchange (CME), which in turn accounts for the majority of such trading on a worldwide basis. (See Exhibit 1.)

Regarding data, futures prices are monthly averages of daily settling prices for contract months (March, June, September, and December) from March, 1978, through December, 1983, as obtained from the statistical yearbooks of the CME's International Monetary Market (IMM).{2} Spot rates are commensurate monthly averages of noon buying rates in New York, certified for cable transfers, as obtained from monthly issues of the Federal Reserve Bulletin.

The primary advantage of using averages is that random deviations from IRPT equilibrium, as described in (5), should sum to zero. An ancillary advantage of using averages is that the methodology requires averaging the spot and futures averages, thus imparting gaussian properties to the findings and thereby strengthening conclusions.

For interest rates, the U.S. rate is the (annualized) three-month Eurodollar rate; the British, German, and Swiss rates are the respective three-month interbank loan rates; and the Japanese rate is the Gensaki rate on loans and discounts which can be called after having been held a minimum of two month-ends. All interest rates were obtained from the Federal Reserve Bulletin.

From (5), it follows that the null IRPT hypothesis is:

$$A_{j,t+k} - P_{j,t+k} = u_{j,k} = 0 \quad (6)$$

where $A_{j,t+k}$ is the actual futures price of currency j with k months remaining until contract maturity; $P_{j,t+k}$, calculated as

$$P_{j,t+k} = s_{j,t} [(1+(i_{d,t})(k/12)) [(1+(i_{j,t})(k/12))^{-1}] \quad (7)$$

is the IRPT-predicted futures price of currency j with k months remaining until contract maturity; and $u_{j,k}$ is their difference, expected to be insignificantly different from zero. The mean difference $\bar{u}_{j,k}$ ($\bar{u}_{j,k} = \sum u_{j,t} / n$ where n is sample size) was calculated for each contract, and t -statistics were then calculated for the mean differences.

Exhibit 2 presents the results of the IRPT test embodied in equation (6). Only the t -statistics for the short-term mark and Swiss franc contracts are significant, indicating that interest rate parity with the U.S. generally characterizes the British, Canadian, and Japanese money markets, but does not characterize the short-term segments of the German and Swiss money markets. {3}

To multinational corporations, such findings imply that the net effective

cost of needed funds (or the net effective return on surplus funds) will generally be the same as in the U.S. for operations in Britain, Canada, and Japan. However, such is not the case for operations in Germany and Switzerland. Utilizing the predictive properties of currency futures discussed in section IV of this paper, significant savings can be realized by appropriate cash management of marks and Swiss francs. Such policy implications will be discussed more fully in the conclusion of this paper.

III. CURRENCY FUTURES AND PURCHASING POWER PARITY

In a formal proof, Giddy [7] demonstrates that the interest differential is equal to the expected inflation-rate differential so that, from (4),

$$f_{j,t} = s_{j,t} [1 + E(\pi_{d,t} - \pi_{j,t})] \quad (8)$$

where $\pi_{d,t}$ and $\pi_{j,t}$ are, respectively, the domestic and j-country rates of inflation existing at time t. Rearranging (8), the expected inflation rate differential becomes

$$E(\pi_{d,t} - \pi_{j,t}) = f_{j,t}/s_{j,t} - 1 \quad (9)$$

which is the predictive model utilized by this study. From (9), it follows that the null hypothesis is

$$\alpha_{j,t} - \pi_{j,t-k} = \mu_{j,t} = 0 \quad (10)$$

where $\alpha_{j,t}$ is the actual inflation-rate differential between country j and the U.S. at time t; $\pi_{j,t-k}$ is the predicted differential from k months prior ($k = 3, 6, 9, 12$); and $\mu_{j,t}$ is their difference, expected to be insignificantly different from zero. Mean differences were calculated for each contract, and t-statistics were then calculated for all mean differences.

For data, futures prices are the same as those utilized in the prior section (and in all subsequent sections). Inflation-rate data are percentage changes of consumer prices indices published by the respective governments, as reported in the statistical yearbooks of the IMM. The number of observations varies from country to country due to index rebasing by Canada, West Germany, Japan, and Switzerland during the time period examined.

Exhibit 3 presents the results of the PPPT-test embodied in equation (10). As can be seen from the t-statistics, the currency futures market cannot predict short-term inflation differentials, but can predict longer-term differentials for all countries except Britain. This is evident from the diminution of the t-statistics as the time horizon increases.[4] Such properties are significant for capital budgeting purposes, and will be elaborated upon in the conclusion.

IV. CURRENCY FUTURES AND MARKET EFFICIENCY

Working [29] postulates that changes in futures prices follow a random process due to the random nature in which information flows to the market. Samuelson [23], assuming risk neutrality, establishes a formal proof of this hypothesis demonstrating that the correlation coefficient between successive price changes will be zero, i.e., price changes will follow a "fair game." Samuelson also establishes a formal proof demonstrating that, under conditions of risk aversion, futures prices are essentially the certainty equivalent of their respective random spot prices, and this difference can be interpreted as a risk premium in accordance with Keynes' "normal backwardation" hypothesis. If currency futures markets are efficient in the sense that their prices fully and immediately reflect all available information, then Samuelson's model implies that futures prices are unbiased

estimates of subsequent spot prices or, if not, then this bias can be interpreted as a risk premium coincident with risk aversion.

Kamara [13] surveys the available evidence and finds that "on average futures prices do not contain a significant risk premium (p. 273)." Relatedly, Levich [15] finds no strong evidence in favor of a risk premium in the forward market. Cornell and Reinganum [3] find the mean differences between forward rates and currency futures prices to be insignificantly different from zero. Together, the Levich and Cornell and Reinganum studies also contraindicate the existence of risk premia in the currency futures market. Resultingly, as implied by Samuelson's proof discussed above, currency futures should be unbiased estimates of subsequently realized spot rates.

Hill & Schneeweis [10] test the forecasting efficiency of currency futures by using the "standard" OLS regression test. {5}

$$s_{j,t+n}/s_{j,t} = \alpha + \beta (f_{j,t}/s_{j,t}) + \mu_t \quad (11)$$

Acceptance of the null hypothesis ($\alpha=0$ and $\beta=1$) implies that futures prices are unbiased estimates of subsequent spot prices. Testing the one-, three-, and six-month forecasting accuracy of currency futures in pounds, marks, yen, Swiss francs, and Canadian dollars over the period September, 1972, to December, 1978, Hill & Schneeweis cannot reject the null hypothesis and thus find currency futures prices to be unbiased estimates of subsequent spot prices. The authors corroborate their results by essentially replicating the tests for the pound and the mark in another study (Hill & Schneeweis [11]) wherein they again cannot reject the null hypothesis.

A second common technique for ascertaining market efficiency analyzes the statistical properties of the fore-

casting error:

$$\mu_t = s_{j,t+n} - f_{j,t} \quad (12)$$

In the absence of a risk premium, the average μ_t --the mean forecasting error (MFE)--should be insignificantly different from zero. If the MFEs are significantly positive or negative, then such a bias can be interpreted as evidence of a risk premium.

Hill & Schneeweis, in both of the studies cited above, find MFEs which are insignificantly different from zero, with few (seemingly random) exceptions. Consistent with the survey findings of Levich [15], the authors also find that the forecasting error increases as the forecasting horizon increases.

Panton & Joy [22] examine the forecasting accuracy of eight major currencies during the 1972-76 time period. With the exception of the Mexican peso, the authors find no statistically significant systematic bias in the MFEs. The authors offer one possible explanation of the peso results by hypothesizing that the market was anticipating the September, 1976 peso devaluation. Lizondo [16] develops a formal proof of such an hypothesis and demonstrates that such results are still consistent with market efficiency.

A third "standard" test of market efficiency analyzes the n-period rate of return from speculation in currency j,

$$R_{j,t+n} = [(s_{j,t+n} - f_{j,t})P_t] (M_{j,t} f_{j,t})^{-1} \quad (13)$$

where P_t is the speculative position

taken at time t (+1 for long; -1 for short) and $M_{j,t}$ is the initial margin

(expressed as a percent) required for currency j.

Panton & Joy calculate (13) for long positions (i.e., $P=+1$) in eight major currencies. With the exception of the three-month peso contract, the authors find the mean speculative returns to be insignificantly different from zero.

Naidu & Shin [18] test the profitability of various filter rules vis-a-vis a buy-and-hold strategy for five major currencies between 1973 and 1976. They find no specific filter rule which can consistently outperform a buy-and-hold strategy. The authors also calculate the serial correlation coefficients of these particular currency futures for up to six weeks, essentially finding randomness which is additional evidence in favor of market efficiency.

Adler [1] examines the profitability of various spreads in currency futures. He concludes that, unless the spreader can predict the direction of interest rates (and, sometimes, exchange rates), systematic spreading profits are not possible, at least not by using his particular spreading strategies. Such findings are consistent with an efficient currency futures market.

Regarding the empirical distribution of currency futures prices, Working [29], building upon earlier studies, postulates that futures prices essentially constitute the sum of a large number of independent, identically distributed random variables with finite variance. Assuming a uniform distribution intertemporally, changes in futures prices would, by virtue of the central limit theorem, follow a normal distribution. Kamara [13] surveys commodity-market studies which find changes in futures prices to be more leptokurtic than gaussian.

Summarizing the discussion of market efficiency, the evidence from the 1970s is mixed but generally suggests an efficient currency-futures market. However, trading volume in the early to mid 1970s was only a small percentage of current volume, and the contempo-

rary currency futures market essentially remains untested for market efficiency.

This section tests the contemporary efficiency of currency futures by testing equation (12)--the most common test of a market's ability to make unbiased forecasts--over the period 1978-1983. Exhibit 4 presents the results.

With the exception of the 6-month Canadian contract (which is barely significant and is most likely a statistical aberration), currency futures uniformly predict subsequently realized spot prices. Importantly, the absolute values of the 3-month MFEs of the currency futures predictions are in every case markedly less than the absolute values of the 3-month MFEs of the forward rate predictions reported by Levich [15].{6} In fact, a perusal of the mean differences reported in Exhibit 4 reveals that currency futures are exceptionally accurate predictors of subsequently realized spot rates. Such predictive abilities will be discussed more fully in the conclusion of this paper.{7}

V. THE HEDGING EFFECTIVENESS OF CURRENCY FUTURES

Ederington [5], utilizing mean-variance analysis, develops a key measure of hedging effectiveness. Defining the hedge ratio b to be the proportion of the spot position which is hedged, Ederington derives an optimal hedge ratio b^* which minimizes the overall price variability of the hedged portfolio,

$$b^* = \frac{\sigma_{sf}}{\sigma_f^2} \quad (14)$$

where σ_{sf} is the covariance of the spot price and the futures price, and σ_f^2 is

the variance of the futures price{8}. By comparing the variance of the opti-

mally hedged portfolio to the variance of the unhedged portfolio, Ederington then derives a hedging effectiveness variable e which determines the percentage by which the price variability of the portfolio was reduced by hedging:

$$e = \frac{\sigma_{sf}^2}{\sigma_s^2 \sigma_f^2} \quad (15)$$

where σ_s^2 is the variance of the spot price.

Dale [4] calculates b^* and e for a series of two- and four-week hedges in pounds, marks, and yen, covering the period mid-1974 to mid-1980. He finds a mean b^* value of 0.9534, with individual b^* values ranging from 0.8708 to 0.9988. For hedging effectiveness, he finds a mean e value of 0.9934, with individual e values ranging from 0.9785 to 0.9990.[9]

Naidu & Shin [19] calculate b^* and e for two- and four-week hedges in pounds, marks, and Swiss francs, covering the period 1977-79. They find a mean b^* value of 0.6909, with individual b^* values ranging from -0.3427 to 1.0390.[10] For hedging effectiveness, they find a mean e value of 0.6403, ranging from 0.0110 to 0.9620. Overall, the b^* and e values for the Swiss franc demonstrate less range and higher means than for the pound and the mark.

Hill and Schneeweis [11] calculate the same statistics for the pound and the mark for monthly, quarterly, and semi-annual hedges, covering the period September, 1974, to December, 1978. Their mean b^* value is 0.95 with a range of 0.74 to 1.07. Their mean e value is 0.83, with individual e values ranging from 0.52 to 0.97.

Hill and Schneeweiss [12] then enlarge their study to include the Canadian dollar, the Japanese yen, and the Swiss franc. The authors also examine

different hedging durations for their second study, viz.: one-, two-, and four-week hedges. With the exception of the Japanese yen, the authors find all currencies to have both b^* and e values greater than 0.80 for the four-week hedge, with slightly lesser values for the one- and two-week hedges.

One possible reason explaining the diversity of results found by Dale, Naidu & Shin, and Hill & Schneeweis is offered by Grammatikos & Saunders [9]. The authors examine the question of whether or not b^* is stable over time. Since the optimal hedge ratio is actually the beta coefficient of the OLS regression of spot-price changes (dependent variable) against futures-price changes, Grammatikos & Saunders use three different econometric techniques to examine the stability of b^* (and thus e) for the British pound, the German mark, the Swiss franc, the Japanese yen, and the Canadian dollar, for the period covering January, 1974 to June, 1980. For the entire sample period, the authors find a mean b^* value of 0.9417 with individual b^* values ranging from 0.9216 to 0.9703. For hedging effectiveness (the regression R^2) over the entire period, they find a mean e value of 0.9085 with individual values ranging from 0.8457 to 0.9437. First re-estimating b^* using a moving-window procedure, the authors find the optimal hedge ratios to increase significantly over time for the pound and the yen. Utilizing a second test which identifies structural changes in beta coefficients, the authors find statistically significant inter-temporal structural changes for the pound and yen. Finally, testing for randomness in the coefficients, the authors find essentially no evidence in favor of hedge ratio randomness. The authors suggest that intertemporal changes in volume and open interest could explain their findings.

Exhibit 5 presents the results of this section.[11] The optimal hedge ratio (b^*) ranges from .843 to .974, indicating that most but not all of spot

foreign exchange portfolios should be hedged. The hedging effectiveness variable (e) ranges from .868 to .917, with an average of .905, indicating that, on average, the variability of foreign-exchange portfolios can be reduced by more than 90% when hedged with currency futures. These results are discussed more fully below.

VI. CONCLUSION

This study has found that: 1) the British, Canadian, and Japanese money markets exhibit interest-rate parity with the U.S., but the shorter-term segments of the German and Swiss money markets do not; 2) currency futures possess the ability to predict (longer-term) differential inflation rates between the U.S. and: Canada, West Germany, Japan and Switzerland; 3) currency futures are unbiased estimates of subsequently realized spot rates, and such estimates are markedly more accurate than forward-rate forecasts; and, 4) most of an open position in British pounds, Canadian dollars, German marks, Japanese yen, or Swiss francs should be hedged, and currency futures are very effective hedging tools for such open positions. What policy implications do these findings have for international financial management?

The first policy to be derived from these findings involves net effective interest rates. If a U.S. MNC generally covers its foreign-exchange exposure, the IRPT findings of this paper imply that the firm's net effective cost of borrowed funds (or net effective return on surplus funds) will be the same in Britain, Canada, and Japan as it is in the U.S., regardless of where such funds are borrowed (or invested). If the MNC does not cover, then the IRPT findings coupled with the efficient-market findings imply the same result, i.e., the equality of net effective interest rates. This is significant information to MNC treasurers, who spend long hours calculating net effective rates in

attempts to minimize their cost of funds (or maximize their return on funds).

However, such rate equality is not the case with the German and Swiss money markets vis-a-vis the U.S. By considering existing nominal rates in these markets and then utilizing the exchange-rate forecasts implied in currency futures, MNC treasurers could realize better rates in one market than another. For example, suppose the MNC's U.S. borrowing rate were 10% and the equivalent German rate were 6%, implying that the market expects the dollar to depreciate by 4% against the mark. If the forecast implied by currency futures predicted only a 3% depreciation of the dollar, then the MNC treasurer knows that he can borrow his needed funds at a net effective cost of 9% in Germany instead of paying 10% in the U.S. Considering the magnitude of the typical international capital flow, even a savings of a few basis points can translate into significant dollar savings.

A second policy tool of international financial management can be forged from the efficient-market findings of this paper. Currency futures are excellent predictors of subsequently realized spot rates--even more accurate than forward rates, which heretofore have generally been considered the consistently most accurate predictors of exchange-rates. Resultingly, dividend remittances, or any other type of international cash management, can be planned with relative accuracy by utilizing the exchange-rate forecasts implied in currency futures.

By coupling the predictive properties of currency futures with the purchasing power parity findings, we have a third policy tool. Undoubtedly, the two biggest obstacles to accurate international capital budgeting are unanticipated inflation-rate changes and exchange-rate changes. Since currency

EXHIBIT 1

IMM CURRENCY FUTURES VOLUME BY CONTRACT

Represents trading in British Pounds (introduced in 1972), Canadian Dollars, Deutsche Marks (1972), Dutch Guilders (1973), French Francs (1974), Japanese Yen (1972), Mexican Pesos (1972) and Swiss Francs (1972).

TYPE OF CONTRACT	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
British Pounds	14,033	15,015	33,465	78,701	240,099	513,682	1,263,750	1,491,102	1,321,701	1,614,993
Canadian Dollars	3,699	2,677	17,068	161,139	207,654	399,885	601,925	475,585	1,078,467	558,741
Deutsche Marks	49,447	54,793	44,887	134,368	400,569	450,856	922,608	1,654,891	1,792,901	2,423,508
Dutch Guilders*	1,527	927	392	2,812	3,585	22	4	4	128	162
French Francs	11,359	6,238	5,968	3,150	4,449	406	144	2,080	16,474	26,348
Japanese Yen	7,239	1,790	1,449	82,261	361,731	329,645	575,073	960,598	1,762,246	3,442,262
Mexican Pesos	90,941	48,547	51,439	17,029	17,844	29,982	19,301	18,905	65,036	40,308
Swiss Francs	42,505	69,933	37,246	106,968	321,451	493,944	827,884	1,518,767	2,653,332	3,766,130
Total Volume	220,750	199,920	191,914	586,428	1,557,382	2,218,422	4,210,689	6,121,932	8,690,285	11,872,452

*Delisted 12/29/83

Source: Chicago Mercantile Exchange

futures can accurately predict the former on a long-term basis, and can accurately predict the latter on any term basis, the inflation-differential and exchange-rate forecasts implicit in currency futures enable MNCs to overcome these two classic obstacles. Resultingly, such forecasts should greatly facilitate the planning and implementing of international projects.

The final policy implied by this paper concerns hedging. The findings uniformly refute the traditional principle of hedging (which hedges 100% of the foreign-exchange exposure) and instead support the conclusion of Shapiro and Rutenberg [25] that "Financial of

ficers [in managing their foreign-exchange risk] should decide on a maximum exposure they dare take and constantly hedge the rest (p. 56)." Finally, the study finds that currency futures are a very effective means with which to hedge such exposure.

Summarizing, this paper has found that the currency futures market is a highly efficient, hedging-effective market exhibiting significant degrees of interest rate parity and (longer-term) purchasing power parity. As discussed above, such findings constitute effective and decisive policy tools for international financial management.

EXHIBIT 2

Differences Between Actual Futures Prices Less IRPT-Predicted Futures Prices: 1978-1983

<u>Currency</u>	<u>Contract Length</u>	<u>No. Obs.</u>	<u>Mean Diff.(\$)</u>	<u>Std. Dev. of Mean Diff.</u>	<u>t</u>
British Pound	3 months	24	-.000658	.003763	-.857
	6 months	24	-.000622	.009435	-.323
	9 months	24	-.000430	.018709	-.113
Canadian \$	3 months	24	-.000006	.000660	-.044
	6 months	24	.000205	.001730	.579
	9 months	24	-.035184	.173399	-.994
German Mark	3 months	24	.000611	.000391	7.647***
	6 months	24	.000270	.000432	4.347***
	9 months	24	.001336	.003950	1.657
Japanese Yen	3 months	24	.000002	.000025	.488
	6 months	24	.000011	.000032	1.808
	9 months	24	.000556	.001549	-1.757
Swiss Franc	3 months	24	.000502	.000649	3.786***
	6 months	24	.000331	.001473	1.010
	9 months	24	-.000182	.002474	-.360

***Significant at the .001-level.

EXHIBIT 3

Differences Between Actual U.S./Foreign Inflation Differentials Less PPPT-Predicted Inflation Differentials: 1978-1983

<u>Country</u>	<u>Prediction Period</u>	<u>No. Obs.</u>	<u>Mean Diff.</u>	<u>Std. Dev. Mean Diff.</u>	<u>t</u>
Britain	3 months	24	-.020185	.019084	-5.181***
	6 months	24	-.019731	.021098	-4.581***
	9 months	24	-.018231	.022828	-3.912***
Canada	3 months	20	-.005067	.030264	-.749
	6 months	20	-.005103	.029576	-.772
	9 months	20	-.004877	.028945	-.754
Germany	3 months	19	.020005	.025644	3.400**
	6 months	19	.008177	.026235	1.358
	9 months	19	.054546	.242434	.981
Japan	3 months	20	.032661	.022977	6.357***
	6 months	20	.019834	.023926	3.707**
	9 months	20	.164237	.373439	.769
Switzerland	3 months	17	.031887	.037958	3.464**
	6 months	17	.011843	.037235	1.311
	9 months	17	-.006037	.032871	-.757

** = significant at the .01-level

*** = significant at the .001-level

Note: The number of observations differs between and among countries due to index rebasing during the study period by all countries except Britain.

EXHIBIT 4

Differences Between Currency Futures Prices
Less Subsequently Realized Spot Rates: 1978-1983

<u>Currency</u>	<u>Contract Length</u>	<u>No. Obs.</u>	<u>Mean Diff.(\$)</u>	<u>Std. Dev. of Mean Diff.</u>	<u>t</u>
British Pound	3 months	24	-.015850	.105401	-.736
	6 months	24	-.024896	.176563	-.141
	9 months	24	-.029158	.233544	-.125
Canadian \$	3 months	24	-.004030	.014937	-.1.322
	6 months	24	-.008667	.019539	-2.173*
	9 months	24	-.013480	.022683	-.594
German Mark	3 months	24	-.010258	.024121	-.425
	6 months	24	-.18395	.039263	-.469
	9 months	24	-.006187	.114344	-.265
Japanese Yen	3 months	24	-.000054	.000280	-.945
	6 months	24	-.000101	.000468	-1.052
	9 months	24	.000616	.001772	1.704
Swiss Franc	3 months	24	-.012133	.039073	-1.521
	6 months	24	-.020408	.058222	-.351
	9 months	24	-.026874	.072418	-1.818

*Significant at the .05-level.

EXHIBIT 5

Hedging Results for Currency Futures 1978-83

<u>Currency</u>	<u>Hedging Contract</u>	<u>Optimal Hedge Ratio (b*)</u>	<u>Hedging Effectiveness (e)</u>
British Pound	3 months	.967	.915
	6 months	.972	.912
	9 months	.974	.908
Canadian \$	3 months	.928	.907
	6 months	.889	.889
	9 months	.857	.868
German Mark	3 months	.940	.917
	6 months	.922	.916
	9 months	.903	.912
Japanese Yen	3 months	.923	.910
	6 months	.910	.898
	9 months	see note	see note
Swiss Franc	3 months	.920	.913
	6 months	.879	.907
	9 months	.843	.904

Note: Data were insufficient for calculating the nine-month yen hedge.

FOOTNOTES

1. Although Samuelson [23] offers a formal proof of Keynes' [14] "normal backwardation" argument in favor of including a risk premium term in (1), Kamara [13] and Levich [15] find no evidence of risk-premia in advance-pricing currency markets. Risk premia are discussed more fully in Section IV of this paper.
2. Volume in currency futures was very shallow prior to 1978 (see Exhibit 1). As of April, 1986, the IMM had not yet released 1984 data. Also, the 12-month contract was too infrequent during the study period to be included in the analysis.
3. Such findings between domestic markets are not uncommon; see Levich [15] for a survey of similar findings during the 1960s and 1970s.
4. Such findings are expected, since purchasing power parity tends to be more of a long-term phenomenon than short-term; see Officer [21].
5. For a discussion of "standard" efficiency tests, see Levich [15].
6. Levich does not report MFEs for 6-, 9-, and 12-month forward predictions.
7. Interestingly, the consistently negative bias of the MFEs in Exhibit 4 constitute evidence of a small (but statistically insignificant) risk premium in the currency futures market.
8. "Traditional" hedging theory assumes $b^* = 1$; see Working [28].
9. For comparison purposes, Ederington (using two- and four-week hedges) finds a mean b^* value of 0.677, with individual b^* values ranging from 0.116 to 0.915; his mean e value was 0.579, with a range of 0.140 to 0.898.
10. Negative b^* values indicate that the hedger should have taken the same position in the spot and futures markets; b^* values greater than one indicate that the hedger should have taken a greater position in the futures market than in the spot market.
11. The foreign-exchange exposure being hedged is equivalent to an open position in each of the respective currencies for the time period being examined.

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