SECTION 2: FORWARD-PRICING EFFICIENCY

Forward pricing has always been an important economic role of the commodity futures market, but featuring it in published research has occurred mainly since the introduction and trading success of nonstorable commodities. For storable commodities, an analysis of forward pricing is generally tied to the inventory allocation process, and forward prices and the current cash price are viewed as being within a constellation. The set of current and forward prices is linked by storage costs, and their level is interpreted as that price which will allocate the inventory throughout the crop year.

For nonstorable commodities the allocation process is less direct, so the forward-pricing role is the research focal point. The set of current and forward prices is not viewed as within a single constellation, but in many cases the prices are considered independent of each other. Hence, there is a rapidly growing body of literature concerned with the forward-pricing ability of futures markets. Such research comes under the titles of market efficiency, market performance, and forward-pricing accuracy; much of it is reviewed by Leuthold and Hartmann (1979).

Parallel to this commodity futures-market literature, another body of literature has been developed by financial analysts and macroeconomists investigating the efficiency of forward-exchange and interest-rate markets. Although the jargon varies between the two sets of literature, the basic hypotheses and methodological approaches are often identical. Surely, in a few short years these efforts will be more closely linked, and hopefully, this anthology will contribute to that process.

Many of the commodities possessing characteristics that attract tests of forward-pricing efficiency are traded on the Chicago Mercantile Exchange. So, an emphasis on this subject among this set of fellowship papers is not surprising. In this section, papers by Panton and Joy, and Levich test the efficiency of the international-currency futures market, while Marquardt compares the forward-pricing ability of agricultural futures markets with public "outlook" advice. Folks and Stansell are concerned indirectly with futures markets, attempting to ascertain if pending exchange-rate changes can be detected in advance.

In the finance literature, concern with the efficiency of forward-exchange markets dates back to the early 1800s, as documented by Levich. The one article that most carefully distinguishes among different approaches to studying market efficiency, and is a focal point for recent empirical work, is by Fama (1970). He classified empirical tests into "weak form," "semi-strong form," and "strong form," terms now widely used by foreign-currency and financial-instrument analysts. Although applicable, these terms have not received much attention by agricultural economists.

In the agricultural literature, Working (1949) first wrote about economic expectations and futures markets. He coined the phrases "necessary inaccuracy" and "objectionable inaccuracy." Necessary inaccuracy refers to that forward-pricing error due to the lack of information, which comes randomly, making this error unpredictable. Objectionable inaccuracy is the remaining portion of the total error, and might result from poor quality speculation, inability to assess or react to information, a market imbalance, or possibly even manipulation. It may be possible to predict this error.

These phrases have not received much attention, despite the possibility of distinguishing empirically between the two inaccuracies. Many studies in the finance literature of the efficient-market hypothesis essentially test for the existence of objectionable inaccuracy. Most of the tests of market efficiency on agricultural commodities have been of the "weak form" type. (See references in Section 1, Price Behavior.) These studies usually investigate whether a historical price series is random or not. Leuthold and Hartmann (1979) provide an initial attempt to combine terminology and hypotheses from financial and agricultural economics literature, and perform a "semi-strong form" test of the live-hog futures market. More "semi-strong form" tests are needed to ascertain if markets utilize all of the available information and only necessary inaccuracy exists.

Also in this section, Panton and Joy may be one of the first to investigate the performance of international-currency futures contracts such as those traded on the International Monetary Market of the Chicago Mercantile Exchange. Specifically, they examine: 1) whether currency-futures prices are consonant with the interest rate parity theorem; 2) whether currency-futures prices are biased; and 3) what has been the holding-period return of currency futures. In examining futures contracts for eight currencies, they find mixed results concerning whether currency-futures prices are at a level that would be predicted from the interest rate parity theorem. Only the Mexican peso exhibits a significant bias in its futures price, while with the use of a simple model, the returns to speculators from the long side were not, in most cases, significantly different from zero over the data tested.

Levich tests the efficiency, or performance, of international-money markets. The prices in these markets contain information for forecasting future spot-exchange rates. The efficient-market hypothesis states that market prices reflect all available information. Using data from nine countries and the United States, Levich tests the accuracy of exchange-rate forecasts implied by the market prices and finds that the markets efficiently reflect available information concerning future exchange rates. However, a composite forecasting model can reduce forecast errors. Since the markets are efficient, forecasts based on publicly available information do not lead to unusual profits in forward speculation.

Marquardt, also concerned with information, tests whether the futures market forward prices more accurately than "outlook letters" disseminating from commercial advisory services, government, and land-grant college sources. The gathering of this information is costly to the individual. In general, Marquardt found futures markets give more accurate information both in terms of average deviation errors and in direction of change. Most importantly, futures markets provide more frequent and timely information about future conditions than do alternative information sources. These tests are made with the wheat, corn, soybeans, cattle, and hog futures contracts.

Folks and Stansell, while being concerned with exchange-risk management by U.S. corporations with overseas investments, attempt to ascertain if the statistical technique, multiple discriminant analysis, is of any value in providing an early warning of impending exchange-rate changes. Using readily available macroeconomic data for 38 countries, they find the technique useful in discriminating between potentially devaluing and nondevaluing countries. Apparently, the data contain substantial information warning of future exchange-rate changes. This information can be valuable to corporate exchange-risk managers attempting to minimize risk exposure when assets are held in several currencies.

Missing from this set of papers is any reference to the tie between market efficiency and rational expectations, a relationship that has important theoretical and empirical bearing on research. Articles by Hamburger and Platt (1975), and Cargill (1975) will introduce the reader to that literature and locate citations to important works.

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Empirical Evidence on International Monetary Market Currency Futures

Don B. Panton and O. Maurice Joy

INTRODUCTION

This paper empirically investigates three questions concerning currency futures traded on the International Monetary Market (IMM) of the Chicago Mercantile Exchange: 1) Are currency futures prices consonant with the interest rate parity theorem? 2) Does a characteristic bias exist in the currency futures prices? 3) What has been the holding period return experience of currency futures since their inception on the IMM?

One of the uncertainties in international business is that which is associated with the future currency exchange rate between the domestic currency and the currency of the foreign country. When an agreement calls for a future cash flow in a foreign currency, economic agents may ultimately face an exchange rate quite different from the one in effect at the time the agreement was signed. One method of hedging against this uncertainty is through the use of currency futures contracts that are traded on the International Monetary Market of the Chicago Mercantile Exchange.

Another alternative open to the hedger is to enter into a "forward" contract with the foreign-exchange department of a bank. In theory, there is little difference between a forward contract and a futures contract. As a practical matter, however, there are some considerable differences. For example:

1. Regulation — The forward market is self-regulating; the futures market is regulated by the Commodity Futures Trading Commission.

2. Price fluctuations — The forward market has no daily limit on price fluctuations; the futures market has a daily limit imposed by the exchange.

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3. Frequency of delivery — More than 90 percent of forward contracts are settled by actual delivery; less than 1 percent of the IMM futures contracts are settled by delivery.
4. Accessibility; Size of contract — Individually tailored contracts in the forward market tend to be much larger than the standardized contract on the futures market.

Each market offers some advantages not available in the other. Since the forward market has enjoyed recent examination,[1] we direct our study to the relatively neglected IMM futures market.

A currency futures contract is an agreement to buy and receive or to sell and deliver a quantity of a specified currency at a future date. The exchange rate that will be in effect at that future date, for the purposes of the futures contract, is determined at the time of contract acceptance. This "contract price" or futures price is binding on both parties to the agreement. Since the currency futures contract represents an example of a zero-sum game (at least in terms of monetary reward), except for transaction costs, any gains reaped by one of the two parties to the transaction are the losses of the other party.

As indicated, we are concerned with three empirical questions in this paper. The first is a test of the interest rate parity theorem, which maintains that, in the absence of transaction costs and exchange accessibility restrictions,[2] the following relation[3] must hold:

$$F_i = S_i(1 + r_d)/(1 + r_i) \qquad (1)$$

where F_i = futures price of one unit of foreign currency i, quoted in units of the domestic currency

S_i = spot price of one unit of foreign currency i, quoted in units of the domestic currency

r_d = present domestic interest rate on risk-free instruments with maturity equal to that of the relevant futures contract, and

r_i = present interest rate in foreign country i on risk-free instruments with maturity equal to that of the relevant futures contract.

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[1] See, for example: Kohlhagen (1975), Giddy and Dufey (1975), Kaserman (1973), and Brown (1971).

[2] Exchange accessibility restrictions include all capital movement prohibitions contemporaneous with the initial contracting and the risk of the imposition of any such restrictions during the remaining life of the contract.

[3] See, for example, the discussions in Sharpe (1978), and Rodriguez and Carter (1976). Some may object to the causal relationship implied by Equation 1. We recognize that the equilibrating process permits simultaneous adjustment of all four variables. However, interest rates are not particularly sensitive to foreign arbitrage operations; rather, they are predominantly determined by domestic transactions and monetary policies. Similarly, spot rates are most influenced by trade demands and government influences.

In our study, the domestic country is the United States. Proponents of this theory argue that if interest rate parity did not hold, riskless arbitrage transactions would be possible. The theory yields a succinct linking of the futures price with three explanatory variables; no variables other than the spot price and two interest rates are recognized as having any direct effect whatsoever.[4]

The second question addressed in this study is directed at the relation between the magnitudes of: 1) contract prices for currency futures prior to maturity, and 2) contract prices for the same obligations on the last day of trading for that specific contract. If the futures price on a currency contract is determined to be systematically greater or less than the contract price which occurs on the last day of trading, we shall conclude that a bias exists. Thus, our definition of bias is a tendency of the currency contract price observed prior to the last day of trading to deviate systematically in one direction from the contract price on the last day of trading. In an economic environment where international cash flows are increasingly prominent, knowledge of a contract price bias in currency futures is important to several groups. Financial officers of corporations that have a policy of avoiding exchange-rate risk may wish to re-examine that policy if the costs of hedging in currency futures outweigh the benefits. Speculators who require an expected return as payment for absorbing variance are interested in determining the magnitude of any possible return bias and whether that bias exists on the long or short side of the futures transaction.

Then, we summarize the rate of return evidence on IMM futures contracts that has accumulated since origination of this market. That section of the paper is purely descriptive of investor experience over the study period.

The next section of the paper discusses the data employed. The following section is devoted to methodology and presentation of results, and the last section summarizes the paper.

DATA

The primary data used in this study consist of three sets of observations covering the period June 18, 1972 to December 15, 1976. These data — futures prices, spot prices, and open-market interest rates — are described in detail below:

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[4] Frenkel and Levich (1975) concluded that, during the period 1962-1967, empirical data were consistent with the interest rate parity theorem and that covered interest arbitrage did not permit profit opportunities.

A. Futures prices. The eight foreign currencies represented in the study were:

1. British pound (BP)
2. Canadian dollar (CD)
3. German mark (GM)
4. Dutch guilder (DG)
5. French franc (FF)
6. Japanese yen (JY))
7. Mexican peso (MP)
8. Swiss franc (SF)

The futures quotes were settlement prices at five points in the lives of the futures contracts: contract maturity; and twelve months, nine months, six months, and three months prior to contract maturity. All such dated settlement prices were supplied by the Chicago Mercantile Exchange.

B. Spot prices. These exchange prices were noon selling rates in New York for cable transfers, collected from issues of the *Wall Street Journal.* The dates of the spot-exchange prices correspond to those of the forward prices in (A).

C. Interest rates. These are open-market rates on low-risk debt instruments in the U.S. and in six foreign countries. In the cases of Canada, the United Kingdom, and the Netherlands, these yields were based upon average returns on three-month treasury bills. The figures for West Germany were based upon average returns on 60- to 90-day treasury bills; yields for France and Japan were average money market rates for securities maturing in less than one year. Interest rate data on the U.S., Canada, the United Kingdom, West Germany, and the Netherlands were collected from monthly issues of the *Federal Revenue Bulletin;* interest rate data on France and Japan were collected from monthly issues of *International Financial Statistics.*

This particular portion of our primary data — that is, interest rates in the foreign countries — is, admittedly, somewhat lacking in precision. First, the foreign rates are monthly averages, not daily quotes. We would have preferred to have had the rates which were available on the corresponding days of the futures quotes in (A). Second, for the most part, interest rate yields in the foreign countries were for instruments having one specified maturity — usually three months. Optimally, a test of the interest rate parity theorem calls for yields on risk-free securities having maturities corresponding perfectly with those of the futures contracts in (A).

EMPIRICAL EVIDENCE

The Interest Rate Parity Theorem

The interest rate parity theorem maintains that, in equilibrium, the forward-exchange price for currency *i*, the spot price for currency *i*, the domestic interest rate, and the foreign interest rate are related according to Equation 1 in the previous section. When Equation 1 is satisfied, there exist no profit opportunities from covered interest arbitrage. Strictly speaking, however, the theory requires that there be zero transaction costs and no access restrictions to exchange-rate markets either now (at initial contract time) or in the future (during contract life). Observed, significant deviations from the interest rate parity theorem would indicate that there are substantial transaction costs, governmental controls[5] to market access, a time differential between observing a profit opportunity and executing the arbitrage activity, differential tax treatments,[6] or inexact interest rate and spot-exchange-rate data.

If the interest rate parity theorem holds, we would expect to see close congruence between actual (observed) futures prices traded on the IMM and predicted futures prices, where the prediction is via the interest rate parity theorem.

Let $AF_{i,k}$ = actual IMM futures price of currency i contract with k months remaining until contract maturity

$PF_{i,k}$ = predicted IMM futures price of currency i contract with k months remaining until contract maturity.[7]

then the interest rate parity theorem says:

$$u_{i,k} = 0$$

where $u_{i,k} = AF_{i,k} - PF_{i,k}$.

If $u_{i,k}$ is significantly different from zero, then there must be either substantial transaction costs associated with exchange or debt markets or there must be important accessibility blockages or risk of future blockage.

Table 1 presents evidence regarding the magnitude of these differences. Data are presented for only six of the eight foreign countries. Mexico and Switzerland were excluded because we were unable to find a series of weekly quotations for interest rates meeting the following two conditions: 1) the series covered the entire period of the study, and 2) the yields

[5] Exchange restrictions in effect during the period 1972-1976 are detailed in the *Twenty-Third* through the *Twenty-Sixth Annual Report on Exchange Restrictions*, published by the International Monetary Fund.

[6] See, for example, Aliber (1973), and Frenkel (1973).

[7] PF is determined by Equation 1. That is,

$$PF_{i,k} = S_i\left(1 + \frac{r_{d,k}}{12}\right) \Big/ \left(1 + \frac{r_{i,k}}{12}\right).$$

TABLE 1

DEVIATIONS OF OBSERVED FUTURES EXCHANGE RATES [$AF_{i,k}$] FROM PREDICTED FUTURES EXCHANGE RATES [$PF_{i,k}$], BASED ON THE INTEREST RATE PARITY THEOREM

$$u_{i,k} = AF_{i,k} - PF_{i,k}$$

Currency		Number of Observations	Mean Difference ($)	Standard Deviation of Mean Difference ($)	t
British pound	12 month	12	−.0407	.0077	
	9 month	13	−.0302	.0070	
	6 month	15	−.0237	.0054	
	3 month	14	−.0186	.0042	−4.43
Canadian dollar	12 month	10	−.0066	.0033	
	9 month	13	−.0020	.0026	
	6 month	13	−.0007	.0012	
	3 month	14	.0003	.0006	.50
German mark	12 month	11	−.0009	.0016	
	9 month	16	.0014	.0013	
	6 month	15	.0014	.0012	
	3 month	14	.0007	.0009	.78
French franc	12 month	5	.0013	.0025	
	9 month	6	.0026	.0021	
	6 month	6	.0018	.0018	
	3 month	6	−.0031	.0022	−1.41
Japanese yen	12 month	7	.0001	.00007	
	9 month	8	.0001	.00004	
	6 month	10	.0001	.00006	
	3 month	12	.0000	.00003	.00
Dutch guilder	12 month	7	−.0043	.0022	
	9 month	10	−.0030	.0017	
	6 month	9	−.0023	.0015	
	3 month	10	−.0003	.0010	−.30

were on short-term, government-backed securities. As illustrated by the *t* values[8] in Table 1, the mean deviation is significantly different from zero (at the 5-percent α-level) only in the case of the three-month[9] futures contract on the British pound. This evidence implies that, in the

[8] Mean difference $= \mu_u = \sum_n u_{i,k}/n$, where n is sample size.

Standard deviation of mean difference $= \sigma_\mu = \sigma_u/n^{1/2} = \left[\sum_n (u_{i,k} - \mu_u)^2/(n-1)\right]^{1/2}/n^{1/2}$.

$t = \mu_u/\sigma_\mu$.

[9] No statistical tests are offered for the 6-, 9-, and 12-month futures since these observations cover overlapping time periods and are thus not independent.

case of the pound, futures prices derived through use of the interest parity theorem were systematically greater than observed futures prices.

Thus far we have only tested one implication of the interest rate parity theorem, namely, that the mean difference between actual and predicted futures prices is zero. Strictly speaking, that is not a sufficient test of the interest rate parity theorem. A test of mean difference is not sufficient because the actual arbitrage mechanism works with respect to individual contracts. Thus, there may be no statistical difference across all contracts, but there may be profitable arbitrage opportunities in one or more individual contracts. A more exhaustive test of the interest rate parity theorem would entail an analysis of each pair of actual and predicted prices.

Whereas even one instance of a discrepancy between actual and predicted futures prices would, in theory, refute the validity of the interest rate parity theorem, in actuality, the magnitude of any observed deviations must be compared with realistic transaction costs that are necessarily incurred in covered-interest arbitrage operations. That is, the existence of transaction costs implies that deviations of acual futures prices from predicted prices may be unimportant, if such deviations are circumscribed within the dimensions of the transactions "band" about the interest rate parity theorem predictions.

It is difficult to be precise with regard to the magnitude of total transaction costs in currency futures trading. However, commission costs (approximately $45 for a round trip) plus foregone interest on security deposit funds may justify a transaction costs band of approximately 85 percent of the spot value of currency represented in the futures contract.[10]

As shown in Table 2, we observed several points which lay outside this band. In fact, a few contract prices deviated from the interest rate parity line by nearly 5 percent of the monetary value of the contract unit. Clearly, these deviations are not consistent with the pure interest rate parity theorem, modified only by the introduction of transaction costs. We are not certain of the exact cause of observed points outside the transaction costs band. Extreme deviations from the interest rate parity line could result from many factors: differential tax treatment, governmental controls, time differential between observing a profit opportunity

[10] This calculation assumes an interest rate of 8 percent per year, a security deposit of 10 percent of the spot value of the contract unit, and a dollar value of approximately $80,000 for the contract unit. At best, the transaction costs estimates are extremely crude, not only because of the explicit assumptions about interest rate levels and dollar value of the contract, but also because the spot prices used are only "asked" prices, and because we implicitly presume that transactions can be achieved at the stated spot price, which is a 3:00 P.M. Eastern time zone price.

TABLE 2

FREQUENCY DISTRIBUTION FOR ABSOLUTE VALUES OF DEVIATIONS OF OBSERVED FUTURES EXCHANGE RATES [$AF_{i,k}$] FROM PREDICTED FUTURES EXCHANGE RATES [$PF_{i,k}$], EXPRESSED AS PERCENTAGES OF CURRENCY SPOT PRICES [SP_i]

$$\gamma_{i,k} = |[AF_{i,k} - PF_{i,k}]/SP_i|$$

Currency		Number of Observations	Percentages γ <1	1-3	>3
British pound	12 month	12	4	6	2
	9 month	13	6	7	
	6 month	15	6	9	
	3 month	14	10	4	
Canadian dollar	12 month	10	7	3	
	9 month	13	10	3	
	6 month	13	13		
	3 month	14	14		
German mark	12 month	11	7	4	
	9 month	16	10	4	2
	6 month	15	10	4	1
	3 month	14	10	4	
French franc	12 month	5	2	3	
	9 month	6	1	4	1
	6 month	6	1	4	1
	3 month	6	2	3	1
Japanese yen	12 month	7		1	6
	9 month	8		3	5
	6 month	10	1	4	5
	3 month	12	5	5	2
Dutch guilder	12 month	7	2	4	1
	9 month	10	4	5	1
	6 month	9	6	3	
	3 month	10	8	2	

and executing the appropriate arbitrage activity, and inexact interest rate and spot-exchange rate data. Of course, the deviations may also be a product of measurement errors associated with our data, as discussed earlier.

Our conclusions for this portion of the study are mixed. In most cases, the means of deviations from the interest rate parity line are not significantly different from zero; however, some individual futures prices deviate from the interest rate parity line by more than can be explained with the presence of crudely estimated transaction costs.

Characteristic Biases

A characteristic bias is said to exist if futures prices are systematically higher or lower than the prices of the contract immediately before expiration.

In the case of seasonal products, several researchers[11] have concluded that a bias exists in favor of the long side of futures contracts. This bias is sometimes "explained" as necessary inducement to speculators who are relieving hedgers of burdensome risk. However, in the case of currency futures, the assumption that relates the dichotomous classifications (hedger-speculator and long side-short side) is less easily justified. American importers of Swiss watches need hedge protection; so do Swiss importers of American machine tools.

If international trade were not in perfect balance, some countries could have net demands for speculators' services. Any effects upon futures prices (via a discount or premium), however, would necessarily be limited to the extent permitted by deviations from the assumptions of the interest rate parity theorem.

Although we would like to address the question, "Are futures prices systematically less than or greater than expected future spot prices?", our data do not permit us to do so. The expectations theory deals with ex ante future spot prices, whereas our empirical test has been applied to ex post data. Anticipated and realized future spot prices will not necessarily be equal except in a world of perfect certainty. Since we do not possess expectational data, our examination must be confined to addressing the question, "During the period covered have futures prices been systematically less than or greater than realized spot prices at contract maturity?"[12] Thus, we do not directly examine the expectations hypothesis.

Let $AF_{i,0}$ = settlement price for currency i contract on the day the contract expires. If there is no characteristic bias, then

$$E[\delta_{i,k}] = 0$$

where $\delta_{i,k} = AF_{i,k} - AF_{i,0}$.

Evidence related to the characteristic bias issue is presented in Table 3. Mean differences and standard deviations of mean differences are shown for three-month futures in all eight currencies.[13] As before, the t

[11] See Gray (1960, 1961) and Houthakker (1957), and Cootner (1960) for examples of discussions regarding bias in grain futures.

[12] Kohlhagen (1975), and Giddy and Dufey (1975) addressed this question using bank forward data. Kohlhagen's data represented the period 1973-1974; Giddy and Dufey's data covered two periods: 1919-1925 and 1971-1974. Neither study found the forward rate to be a biased predictor of the future spot rate.

[13] See Footnotes 8 and 9.

statistic provides an indication of any departure from zero characteristic bias. In only one instance — the Mexican peso — is the mean difference significantly different from zero at the 5-percent level of significance. The peso result is inconsistent with the view that there were no important characteristic biases in the eight exchange rates during the period studied. It appears that the traders in peso futures may have expected a devaluation against the dollar during the period covered by our data. The devaluation, however, did not come until September, 1976.

Rates of Return on Futures

The last issue we address concerns the realized rates of return that investors would have experienced from "buying" futures contracts in currency i with k months remaining life and then "selling" the contract on maturity. In Equation 2, we define this observed annualized return as $RR_{i,k}$. The required security deposit was assumed to be 10 percent of the monetary value of the contract trading unit, based upon the current futures price:

Let[14,15,16] $$RR_{i,k} = \frac{AF_{i,0} - AF_{i\ k}}{.10\ AF_{i,k}}\left(\frac{12}{k}\right)\left(100\right) \qquad (2)$$

Results from Equation 2 are shown in Table 4.

We shall not attempt to explain or ex post rationalize the return distribution statistics given in Table 4; rather, we will attempt only to identify a few salient factors. In the cases of the French franc, the Japanese yen, the Canadian dollar, and the Dutch guilder, the signs of mean returns are mixed; none of these mean returns was significantly different from zero. Returns to the holders of long sides in futures contracts on Mexican pesos, German marks, and Swiss francs were positive; however, only the mean return on three-month peso contracts was significantly different from zero. Returns to the holders of long sides in British pounds were negative, but not significantly different from zero.

Whether the distributions of returns in futures contracts are temporarily stable is not known. The summary statistics in Table 4 are, for the most part, offered only as an early look at historical returns to market participants, and as a basis for comparisons with future investigations of ex post returns.

[14] In July, 1976, the initial security deposit varied from $1,500 for the Canadian dollar (approximately 1.5 percent of the value of the contract unit) to $8,000 for the Mexican peso (approximately 10 percent of the value of the contract unit).

[15] Grubel (1965) also assumed a 10-percent margin.

[16] Multiplying by (12/k) approximately annualizes the rate of return, and multiplying by 100 puts the result in percent units.

TABLE 3
DEVIATIONS OF OBSERVED FUTURES EXCHANGE RATES $[AF_{i,k}]$ FROM REALIZED SPOT RATES AT MATURITY $[AF_{i,0}]$

$$\delta_{i,k} = AF_{i,k} - AF_{i,0}$$

Currency		Number of Observations	Mean Difference ($)	Standard Deviation of Mean Difference ($)	t
British pound	12 month	12	.0471	.0528	
	9 month	13	.0486	.0482	
	6 month	15	.0207	.0422	
	3 month	14	.0082	.0296	.28
Canadian dollar	12 month	10	.0168	.0086	
	9 month	13	.0128	.0055	
	6 month	13	.0029	.0083	
	3 month	14	−.0008	.0053	−.15
German mark	12 month	11	−.0001	.0144	
	9 month	16	−.0096	.0112	
	6 month	15	−.0062	.0100	
	3 month	14	−.0029	.0070	−.41
French franc	12 month	5	.0080	.0119	
	9 month	6	.0083	.0086	
	6 month	6	.0026	.0105	
	3 month	6	−.0027	.0071	−.38
Japanese yen	12 month	7	.0001	.00011	
	9 month	8	.0001	.00011	
	6 month	10	.0000	.00006	
	3 month	12	−.0000	.00006	−.00
Mexican peso	12 month	12	−.0024	.0006	
	9 month	12	−.0023	.0006	
	6 month	13	−.0018	.0005	
	3 month	13	−.0011	.0003	−3.67
Swiss franc	12 month	13	−.0274	.0103	
	9 month	14	−.0215	.0100	
	6 month	14	−.0144	.0086	
	3 month	14	−.0073	.0060	−1.22
Dutch guilder	12 month	7	−.0037	.0137	
	9 month	10	.0043	.0103	
	6 month	9	.0037	.0117	
	3 month	10	.0028	.0062	.45

TABLE 4

RETURNS TO LONG SIDES OF CURRENCY FUTURES CONTRACTS, COVERING THE PERIOD JUNE 18, 1972 TO MARCH 16, 1976

$$RR_{i,k} = \left[\frac{AF_{i,0} - AF_{i,k}}{(.1)\ AF_{i,k}}\right]\left(\frac{12}{k}\right)(100)$$

Currency		Number of Observations	Mean Percent	Standard Deviation Percent	t
British pound	12 month	12	−21.22	24.05	
	9 month	13	−28.73	28.48	
	6 month	15	−19.91	38.40	
	3 month	14	−17.91	51.85	.35
Canadian dollar	12 month	10	−16.39	8.43	
	9 month	13	−16.36	10.51	
	6 month	13	−4.80	16.67	
	3 month	14	3.71	21.15	.18
German mark	12 month	11	10.38	40.07	
	9 month	16	48.18	44.93	
	6 month	15	47.89	55.87	
	3 month	14	44.73	73.04	.61
French franc	12 month	5	−28.34	68.36	
	9 month	6	−42.56	62.12	
	6 month	6	−12.88	106.04	
	3 month	6	57.78	125.54	.46
Japanese yen	12 month	7	−35.38	33.00	
	9 month	8	−24.51	32.46	
	6 month	10	−0.50	41.89	
	3 month	12	19.48	59.22	.33
Mexican peso	12 month	12	31.69	8.44	
	9 month	12	39.58	10.54	
	6 month	13	47.92	13.50	
	3 month	13	57.29	17.08	3.35
Swiss franc	12 month	13	94.29	32.97	
	9 month	14	100.87	42.16	
	6 month	14	100.53	53.87	
	3 month	14	100.89	73.24	1.37
Dutch guilder	12 month	7	13.35	35.90	
	9 month	10	−10.82	34.52	
	6 month	9	−12.15	59.59	
	3 month	10	−24.22	62.34	.39

SUMMARY

We have addressed three separate issues in this paper. First, we compared observed IMM futures prices with prices predicted by the interest rate parity theorem. In the case of the British pound, we found a systematic tendency for observed futures prices to be less than futures prices predicted via the interest rate parity theorem. Also, some individual contract prices for the German mark, the French franc, and the Japanese yen deviated from the interest rate parity line by much more than could be explained by the presence of transaction costs alone. Second, we investigated the question of any characteristic bias in futures prices. Three-month contracts on the Mexican peso exhibited a significant difference between futures price and spot price at contract maturity. We attribute this peso bias to expectations of a devaluation, which, in fact, occurred soon after the time period represented in our data base. Last, we presented some preliminary rate of return data on IMM futures contracts.

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