Is Currency Trading Profitable? Exploiting Deviations from Uncovered Interest Parity

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where

$$Y^* = Y + M\Lambda_h Y + (M\Lambda_h)^2 Y + \ldots$$

Because all the elements of M and Λ_h take on values within the range [0, 1], the higher terms converge to zero. In estimating the true P/Es of Japanese firms, we can adjust the observed values of p* and Y* by:

Eq. 22

$$p = \Lambda_Y^{-1}(I_N\text{-}M)\Lambda_Y{}^*p^*$$

where

$$Y = (I_N - M\Lambda_h)Y^*.$$

Conclusion

The price/earnings ratios of Japanese firms are known to be higher than those in other countries. Some have tried to explain the difference by upward bias due to reciprocal ownership, assuming a model case of two identical firms engaging in reciprocal ownership.

This note has presented a general formula to adjust P/Es for the case of multiple firms with different levels of scale, earnings and payout ratios that are interconnected by different degrees of reciprocal ownership. Our analysis indicates that even in the simplest case of reciprocal ownership, it is not obvious whether P/Es are biased upward or downward.

Footnotes

1. *See H. Bierman, Jr., "Price/Earnings Ratios Restructured for Japan,"* Financial Analysts Journal, *March/April 1991.*
2. *We assume $Y_i \geqq 0$ for $\forall i$. If the firm issues debt, Y_i is defined as earnings net of interest payments, and the subsequent analysis is also valid.*
3. *See F. Brioschi, L. Buzzacchi and M. G. Columbo, "More on Stock Market Value with Reciprocal Ownership,"* Financial Analysts Journal, *May/June 1991. Also see H. Bierman, Jr., "Total Stock Market Value with Reciprocal Ownership: A Note on the Japanese Situation,"* Financial Analysts Journal, *January/February 1990. His two models are special cases in our general expression.*

Is Currency Trading Profitable? Exploiting Deviations from Uncovered Interest Parity

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Many participants in the foreign exchange market, especially interbank trading departments, are consistently able to generate large trading profits because they possess both superior information and superior processing skills relative to their counterparties. But many other market participants who lack these advantages also earn profits trading foreign exchange. These other participants take advantage of certain anomalies in the market, including the systematic bias of the forward rate.

Deviations from uncovered interest rate parity, also known as forward forecast errors, are a regular occurrence in the foreign exchange market. The forward forecast error is the difference between the forward rate and next period's spot rate. As yet, though, a key question remains unsolved. Namely, are the deviations from UIP random, hence unpredictable, or is there a systematic component that is predictable? If the latter is true, investors can *expect* to earn positive returns from investing in foreign exchange.

Empirical studies suggest the existence of systematic forward forecast errors. We argue that a portion of the forward forecast error should be predictable. Postulating that *ex ante* real rates are not equal across countries, we test whether differences in *ex ante* real interest rates explain a portion of the bias in the forward rate.

We develop a model to predict *ex ante* real rates and devise a simple trading strategy to test whether trading profits can be generated using predictions from the model. We conclude that *ex ante* real rates do explain a significant portion of the forward forecast error and that trading profits can be generated using simple models.

International Financial Theory

Modern international financial theory rests on two pillars—**purchasing power parity** (PPP) and **interest rate parity** (IRP). PPP relates movements in exchange rates to differences in inflation rates between countries. Formally, PPP states that

Eq. 1

$$E(S_t)/S = (1 + p)/(1 + p^*)$$

where

$E(S_t)$ = the expected spot rate at time t (dollars per foreign currency),
S = the spot exchange

rate (dollars per foreign currency),

p = expected domestic inflation rate and

p* = expected foreign inflation rate.

PPP is important because it ensures that easily transferable goods and services will be priced based upon global supply and demand. Consequently, arbitragers will be prevented from making a riskless profit by buying a basket of goods in one currency and selling them in another.

IRP has two forms—covered (CIP) and uncovered (UIP). Covered interest parity relates interest rate differentials to the pricing of foreign exchange forward contracts. A foreign exchange forward contract involves the commitment to buy or sell foreign exchange at a future date but at a rate agreed upon today. Formally, CIP states that:

Eq. 2

$$F/S = (1 + i)/(1 + i^*)$$

where

F = the forward exchange rate (dollars per foreign currency),

S = the spot exchange rate (dollars per foreign currency),

i = the domestic nominal interest rate and

i* = the foreign nominal interest rate.

CIP is important because it ensures that a riskless excess return cannot be generated by borrowing domestic currency, selling it for foreign currency, investing the foreign currency at the foreign interest rate and then selling the future proceeds of this investment forward into the domestic currency.

Uncovered interest parity relates the forward exchange rate to the expected future spot exchange rate. Formally, UIP states that

Eq. 3

$$F = E(S_t)$$

where

F = the forward exchange rate and

$E(S_t)$ = the expected spot rate at time t

UIP is important because it ensures that speculators cannot generate speculative profits trading forward rate contracts.

Cracks in the Pillars

Over the last decade, researchers have documented consistent violations of purchasing power parity. This finding has not surprised many people, given the well known frictions (including tariffs, quotas and home bias) involved in transferring goods and services globally. Other empirical research, however, has also documented persistent violations of uncovered interest parity.[1] This finding is extremely important; if UIP is violated consistently, market participants face the prospect of a transfer of wealth when dealing at the forward rate.

To date, a consensus has not materialized as to why UIP has failed to hold. Rather, two opposing camps have offered conflicting explanations. The first camp suggests that the foreign exchange market is, in fact, inefficient.[2] Adherents to the inefficiency doctrine usually substantiate their position with one of two observations. First, they point to the fact that speculative profits can be generated in the foreign exchange forward market by following simple trading rules. Second, they cite statistical tests that have rejected market efficiency when the forward rate is used as the market's expectation of the future spot rate.

The second explanation for deviations from UIP is based upon the existence of a **foreign exchange risk premium**. The notion that currency risk premiums explain deviations in UIP is supported by numerous empirical studies.[3] The currency risk premium comes into play as a slight modification to Equation (3). Instead of $F = E(S_t)$, the UIP equation expands to $F = E(S_t) + P$, where P represents a premium that compensates investors for bearing the

Glossary

▶***Purchasing Power Parity:*** The idea that, in equilibrium, an exchange rate should reflect inflation differentials between two countries.

▶***Interest Rate Parity:*** Covered IRP is an equilibrium condition that ensures that the forward rate reflects the spot rate and interest rates in two countries; uncovered IRP is the idea that, in equilibrium, the forward exchange rate is the expected future spot rate.

▶***Foreign Exchange Risk Premium:*** Incremental compensation, beyond the risk-free rate, an investor would be expected to receive for bearing systematic risk in the foreign exchange market.

▶***Out-of-Sample Test:*** A test of a model that uses a period that follows the period in which the model was estimated.

▶***Statistically Significant:*** A term used to indicate the confidence level a statistician would have in the explanatory power of a given variable or model.

▶***R-Squared:*** A statistical measure that reflects the explanatory power of a regression.

▶***Serial Correlation:*** A statistical measure that reflects the propensity of a time series to follow a trend.

uncertainty of unexpected currency price changes. If P = 0, then UIP reverts to its original form. Note that if $P \neq 0$, the market can still be efficient, even though UIP does not hold. The argument for market efficiency and the existence of a risk premium has been supported by a wealth of research performed over the last five years.[4]

Then why is the explanation of a risk premium not universally accepted? The reason is that the expected future spot rate is unobservable and, as a result, difficult to measure. Remember that, according to the UIP equation, the currency risk premium is the difference between the forward rate and the expected future spot rate. Researchers usually make assumptions about rational expectations and market efficiency when estimating future expectations. If you reject the notion of market efficiency, however, you will obviously reject any conclusions about risk premiums that assume market efficiency as a prior. Another alternative is to use survey data, but this does not provide a clear answer either, because survey data are fraught with problems of interpretation.[5]

Isn't it enough just to know that UIP is violated in order to make money? Do we really care if it is a result of market inefficiency, a risk premium or something else? Yes and no. In order to make money exploiting deviations from UIP, we need to know enough about how UIP is violated in order to place our bets. It would clearly be nice to know why violations occur, because that would give us a lot more comfort in our trading. Empirical research has shown that the current spot rate tends to be a better predictor of future spot rates than the forward rate. In general, forward rates tend to overestimate future movements in the spot rate.

Thus a very naive trading rule is to purchase currencies with relatively high interest rates and sell currencies with relatively low interest rates. The rationale for such a strategy is that CIP will ensure that currencies with high interest rates sell at discounts in the forward market relative to currencies with low interest rates. This process raises some key concerns, however. First, it is devoid of theory. Second, it ignores risk. Therefore, our next step is to build a model of the forward forecast error that is theoretically sound.

A Simple Model

Our simple model starts with the three parity conditions we discussed so far—PPP, CIP and UIP. In addition to these, we impose one more pillar of finance—Irving Fisher's equation for nominal interest rates. Fisher constructed a truism that relates the nominal interest rate to a real interest rate plus an inflation premium. Formally, the Fisher equation states that

Eq. 4

$$i = rr + p$$

where

i = the nominal interest rate,
rr = the real interest rate and
p = the expected inflation rate.

Now for a little algebraic fun. Substituting the right-hand side of Equations (4) and (3) into Equation (2), we arrive at:

Eq. 5

$$\frac{E(S_t)}{S} = \frac{(1 + rr + p)}{(1 + rr^* + p^*)}$$

where

S = the spot exchange rate,
$E(S_t)$ = the expected spot rate at time t,
p = the expected domestic inflation rate,
p* = the expected foreign inflation rate,
rr = the real domestic interest rate and
rr* = the real foreign interest rate.

Equation (5) should look familiar because it is very much like the equation for PPP. Furthermore, if we (a) substitute the right-hand side of Equation (5) into Equation (1), (b) make the simplifying assumption that, in general, $1 + x - y$ is approximately equal to $(1 + x)/(1 + y)$, and (c) subtract $(p - p^*)$ from each side, then we are left with:

Eq. 6

$$rr - rr^* = 0.$$

In brief, Equation (6) suggests that if our four aforementioned pillars of finance are to hold simultaneously, real interest rates must be the same across countries. Since we know that at least two of the pillars do not hold (UIP and PPP), it is a fairly safe bet to assume that real interest rates are probably not the same across countries. We can again point to the efforts of academic researchers for direct support of this contention.[6] All of this raises the following question: Can real interest rate differentials across countries explain the forward forecast error? Our answer is yes.

Testing our hypothesis is actually a bit tricky. Any test of our hypothesis is predicated on a model for *ex ante* real interest rates. So, in fact, we are forced to test a joint hypothesis—(1) do differences in real rates explain the forward forecast error and (2) is our model for predicting *ex ante* real rates any good? After considering the complexities and pitfalls inherent in modeling, we decided to impose several conditions on our model. First, our model had to be simple. Second, our model had to make intuitive sense. Third, our model had to rely as much as possible on market prices for predictor variables. Our third condition emanates from our belief that asset markets are, for the most part, efficient. As

Table I Regression Results, 1976–1987

	Coefficient Estimates				*Standard Errors*					
Country	*b0*	*b1*	*b2*	*b3*	*s(b0)*	*s(b1)*	*s(b2)*	*s(b3)*	*SSR*	*DW*
Japan	0.009	0.466	−0.090	0.034	0.005	0.174	0.198	0.132	0.095	1.988
U.K.	−0.007	0.458	0.214	−0.220	0.004	0.124	0.168	0.103	0.132	2.125
Germany	0.019	0.134	0.521	0.093	0.007	0.195	0.245	0.135	0.052	2.290
Italy	−0.007	0.428	0.505	−0.555	0.007	0.125	0.244	0.140	0.126	2.151
France	0.003	0.484	−0.223	−0.451	0.004	0.158	0.330	0.150	0.149	2.284
Netherlands	0.007	0.238	0.215	0.013	0.004	0.125	0.207	0.100	0.054	2.146
Switzerland	0.037	0.274	0.456	0.063	0.011	0.208	0.221	0.130	0.092	2.195
Canada	−0.008	0.192	0.182	−0.018	0.003	0.066	0.215	0.058	0.075	2.278

a result, we feel that the best estimates of *ex ante* real interest rates are embedded in observable asset prices.

Our model is comprised of three predictor variables—short-term interest rate differences, long-term interest rate differences and *ex post* inflation differences. Given their relationship in the Fisher equation, predicting *ex ante* real interest rates is analogous to predicting expected inflation. It should thus not be surprising that two of our predictor variables are observable prices of money. Nominal interest rates reflect *ex ante* real interest rates. Our decision to use *ex post* inflation as a predictor variable follows from our desire to anchor our forecasts on recent history.

To estimate the coefficients of the model, we chose to use monthly periods from January 1975 through December 1987. This horizon includes both weak and strong dollar environments as well as weak and strong economic environments. We saved the last three years (1988–90) for an **out-of-sample test** period. We examined eight currencies relative to the U.S. dollar—Japan, U.K., Germany, Italy, France, Netherlands, Switzerland and Canada. These currencies were chosen because of data availability. Our data source was DRI. Formally, our regression is:

Eq. 7

$$\text{FFE} = x(0) + x(1)\,\text{DIFST} + x(2)\,\text{DIFGL} + x(3)\,\text{DIFINF} + e$$

where

$$\begin{aligned}
\text{FFE} &= \log\left(1 + [S(t) - F]/S\right) \\
\text{DIFST} &= \log\left[1 + ST(i^*)\right] - \log\left[1 + ST(i)\right] \\
\text{DIFGL} &= \log\left[1 + LT(i^*)\right] - \log\left[1 + LT(i)\right] \\
\text{DIFINF} &= \log\left(1 + p^*\right) - \log\left(1 + p\right)
\end{aligned}$$

Does It Work?

Success or failure can be judged at two levels:

1. Is the model **statistically significant**?
2. Is the model economically significant—that is, does it make money?

Table I depicts our statistical results. In general, our model explained a respectable portion of the variance in the forward forecast error. Our **R-squares** range from a low of 0.05 to a high of 0.15. A value between 0.1 and 0.2 is pretty good for a simple three-factor model such as ours, especially given the fact we did not attempt to massage the data. Our Durbin-Watson values range from 1.99 to 2.29, indicating that there is not much evidence of **serial correlation** in the error terms.

As far as individual factors go, our DIFST factor generated a t-statistic that exceeds 2.6 (significance level of 99%) in five of the eight

Table II Monthly Trading Results, 1988–1990

Country	*Average Return (%)*	*Standard Deviation (%)*	*Sharpe Ratio*	*Maximum Return (%)*	*Minimum Return (%)*
Japan	0.47	3.67	0.13	7.50	−7.19
U.K.	0.78	3.69	0.21	8.13	−7.44
Germany	0.92	3.16	0.29	6.60	−5.80
Italy	0.67	2.93	0.23	7.36	−5.12
France	0.54	3.12	0.17	6.44	−5.87
Netherlands	1.68	2.77	0.61	6.38	−6.12
Switzerland	0.26	3.49	0.07	7.18	−6.69
Canada	0.24	1.31	0.18	2.52	−2.87
Average	0.70	3.02	0.23	6.51	−5.89
S&P 500	0.58	4.02	0.14	9.07	−9.69
LT Government	0.32	2.57	0.12	6.37	−4.84

regressions. In two of the remaining three regressions, the t-statistic for our DIFGL factor exceeds 2.0 (significance level of 95%). Clearly, differences in term structures across countries play a large role in explaining the forward forecast error.

Our third factor, DIFINF (past inflation differences), had a significant t-statistic in only three regressions, but these were the regressions that had the best fit (U.K., Italy, France). Not coincidentally, these countries also possess dismal records for controlling inflation. This is in line with our expectations, because a country with a poor track record on inflation would need to have relatively high real rates in order to attract investor capital. If our contention that the forward forecast error is a function of differences in real rates is correct, then we would expect to see larger deviations from UIP in countries with historically high inflation rates.

So how does an investor stand to gain? To answer this question, we devised a naive trading strategy to test our model's ability to make money. At the beginning of each month, we generated a prediction of the one-month-forward forecast error. If our model predicted a positive forward forecast error, we purchased a one-month-forward contract that committed us to purchase the foreign currency against the U.S. dollar. If our prediction was negative, we sold the foreign currency vis-a-vis the U.S. dollar.

Table II shows our trading profits and losses. (Returns are calculated using the U.S. dollar value of the forward contract as the denominator.) Because many investors do not need to commit capital to trade forward contracts, return on capital can be vastly higher (up to and including infinity).

In general, our naive trading strategy was enormously successful. Average monthly returns ranged from a low of 0.24% for Canada to a high of 1.68% for the Netherlands. An equally weighted portfolio would have earned over 0.70% per month. Though risk was also high, the return-to-risk ratio (Sharpe Ratio) ranged from 0.07 to 0.61, averaging a respectable 0.23. By comparison, the S&P 500 over the same period experienced a ratio of 0.14, while long-term government bonds had a value of 0.12.

Note that our naive trading strategy was not overly concerned with risk. Clearly, though, controlling for risk is a key component of any investment strategy. One way of incorporating risk into the portfolio construction process is to employ mean-variance optimization. An optimization uses estimates of return, risk and correlation to create a portfolio that maximizes return for any level of risk. Our live trading record suggests that the return-to-risk ratio of trading currencies can be improved significantly by the use of optimization techniques.

Footnotes

1. *See R. Levich, "On the Efficiency of Markets for Foreign Exchange," in R. Dornbusch and J. Frenkel, eds.,* International Economic Policy: Theory and Evidence *(Baltimore: Johns Hopkins University Press, 1979) and J. F. Bilson, "The Speculative Efficiency Hypothesis,"* Journal of Business, *1981.*
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6. *See, for example, N.C. Mark, "Some Evidence on the International Inequality of Real Interest Rates,"* Journal of International Money and Finance, *1985.*