Multiple Currency Investment Strategies

To Take Advantage of The Forward

Discount Bias

EXECUTIVE SUMMARY

Several published studies demonstrate the existence of a forward discount bias. However, as Froot and Thaler[1] have pointed out, single currency trading strategies designed to exploit this anomaly have not posted attractive returns. In fact, when one considers the increased volatility of returns generated by these strategies, the overall efficacy of such methods is open to question. This paper builds on previous research by examining the returns exhibited by multi-currency trading strategies based on the forward discount bias. In doing so, this study creates a six currency universe, where positions can be taken in the German Deutschmark, Japanese Yen, French Franc, British Pound, Swiss Franc, or U.S. Dollar. Four of the six strategies examined in this study attained Sharpe Ratios of 0.30 or better, which is on par with that of the S&P500. This paper concludes that multi-currency trading strategies offer better risk-reward tradeoffs than the single currency strategies discussed by Froot and Thaler.

→ Need to specify basis since not invariant to time horizon

FORWARD RATE BIASES

Froot and Thaler summarize the findings of numerous research projects investigating the presence of a forward rate bias. A review and application of their findings, however, first requires a discussion of both covered and uncovered interest parity. Briefly, covered interest parity (CIP) suggests that the forward rate / spot rate differential must reflect the prevailing interest rate differential between two countries. Expressed mathematically, $f_1/e_0 = (1+r_a)/(1+r_b)$. This relationship is certain to hold; if there were a deviation from this relationship, a true arbitrage opportunity would exist in the foreign exchange market. In such a case, investors would quickly "bid" the anomaly out of existence.

→ Where e_0 & f_1 express in (units A/units B)

Uncovered interest parity (UIP) expresses the relationship between the expected future spot rate, existing spot rate, and the interest rate differential between countries. In algebraic form, $e_1/e_0 =$

[1]Kenneth A. Froot and Richard H. Thaler, "Anomalies: Foreign Exchange," Journal of Economic Perspectives, Vol 4, No. 3, Summer 1990, pp. 179-192.

$(1+r_a)/(1+r_b)$.   Intuitively, this relationship expresses the concept of two countries' interest differential "offsetting" the expected change in the exchange rate. Therefore, the country with the higher interest rate would be expected to have a currency likely to *depreciate*. An investor's gains due to the higher interest rate in one country would thus be offset by that currency's weakening position relative to the second currency. While this too represents a "parity" condition, it is *not* a "riskless," or covered, opportunity. The future exchange rate is not determined through a forward contract, and therefore the position within a currency is subject to currency risk.

These two parity conditions suggest a third relationship. Substituting the CIP equation into the UIP equation yields $e_1 = f_1$. Given that UIP and CIP conditions hold, the forward rate should be an unbiased predictor of the expected spot rate. Froot and Thaler's summary, however, indicates that the forward rate is not an unbiased predictor of the future spot rate.   Indeed, when a regression is run on interest rates versus currency depreciation, a negative relationship is found. In short, *those currencies with a higher interest rate tend to appreciate*, while *those with a lower interest rate tend to depreciate*.

Such a finding hints at a straightforward scheme to capture returns on currency speculation. Anticipating this reaction, Froot and Thaler conclude their paper with humbling words to prospective investors:

> Whether or not there is really money to be made based on the apparent inefficiency of foreign exchange markets, it is worth emphasizing that the risk-return tradeoff for a single currency is not very attractive.... With transaction costs, the risk-return tradeoff becomes even less favorable. Although much of the risk in these strategies may be diversifiable in principle, more complex diversified strategies may be much more costly, unreliable, or difficult to execute.

The aim of this paper was to review various trading strategies based upon Froot and Thaler's findings for major traded currencies. First, a number of currencies were used to diversify the

"single currency risk." Second, a variety of strategies were tested to compare risk-return tradeoffs. Finally, an effort was made to "tally" the number of times full positions were turned over, in order to estimate likely transaction costs in the forex markets.

(Good)

DATA DESCRIPTION

The currencies used for this analysis included the Deutschmark, the French Franc, the Yen, the Swiss Franc, the Pound, and the U.S. Dollar. These currencies were chosen because of the deep foreign exchange markets which exist for their trades. Furthermore, much of the research on forward rate biases centers on the mark, yen, and dollar markets; this expanded basket of currencies was expected to behave similarly. ✓

Interest rates were collected from the 1996 dataset of the *International Financial Statistics*. Three month LIBOR values were used for each of these currencies. The *Datastream* service was the source of the exchange rates for these currencies. All data was collected on a quarterly basis from 1986 to present. While historical forward rate values were available, these values were instead calculated based on the covered interest parity relationship expressed earlier.

For each strategy reviewed, the quarterly return, the average quarterly return, the standard deviation of returns, and the overall Sharpe Ratio were calculated. The Sharpe Ratio represents a way of comparing the risk-return tradeoff across strategies. (The Sharpe Ratio = [rate of return - risk free rate] / standard deviation) The risk free rate used for Sharpe Ratio calculations was the return on 90 day U.S. Treasuries, also downloaded from *Datastream*.

INVESTMENT STRATEGIES

In each investment case, a $1000 investment was assumed to be made on the first trading day of the quarter. The return on this investment was then calculated at the end of the quarter. While it might be likely for an investor to roll over the investment from one quarter to the next, this was

not expressly carried out in the simulation; the calculated quarterly return and standard deviation provided the necessary information to compare the risk-return performances of various strategies.

A variety of strategies were implemented in order to determine how the risk-return tradeoff could be altered. While historical data was used for each strategy, please note that strategies were not optimized as if knowledge of future exchange and interest conditions existed. Instead, each strategy depended upon a quarterly review of the interest rates of the participating currencies. Admittedly, the resulting strategy performances for our survey reflect the interest rate / exchange rate conditions of the sample (1986-1996). The strategies used herein, however, all follow a readily implementable plan of quarterly decisions rather than "pre-knowledge" of exchange / interest rate changes to come.

> COULD BE CLEARER

Strategy 1: "All or Nothing"

The first investment strategy, "All or Nothing," held a long position in the currency with the highest interest rate at the beginning of the quarter. No additional long positions are taken, and no short positions are taken in currencies with relatively low interest rates. According to Froot and Thaler's summary, one would expect that the high interest rate currency would appreciate over the three month period, yielding additional gains to the investor with a long position in this currency.

The results of this strategy are summarized in Table IV. Please note that the investment returns represent a summation of both currency returns and returns from holding a three month LIBOR note. These returns were calculated with an implied "round trip" in the currency. For instance, the $1000 initially available was first converted to pounds in the second quarter of 1986. The LIBOR return was collected on this pound investment, and the final amount in pounds was then converted back to dollars at the new prevailing exchange rate (the third quarter, 1986 rate). This new dollar amount was then compared to the $1000 initial investment to calculate the investment

return. The average quarterly return over the ten year sample was found to be 3.3%, with a standard deviation of 5.9%. The Sharpe Ratio for this trial was 0.30. The four "clean-outs" outlined in the table represent the number of times a full position was cleared. While transaction costs were not explicitly evaluated for any strategy, this measure should provide some estimate of the likely costs associated with a particular trading strategy.

As explained above, the average return for this strategy includes both currency returns and LIBOR returns. In order to evaluate the currency portion of the investment strategy, the LIBOR returns were also subtracted for this case. The resulting currency returns are listed under the "LIBOR Adjusted Figures" heading. Note that the average currency return is 1.83%, with a standard deviation of 5.74%.

Strategy 2: "It's All Relative"

This strategy had two features different than the previous. First, an average LIBOR interest rate across all six currencies was calculated each quarter. This average interest rate was then used as a "threshold" value for determining which currencies should be held long. Second, an *equal-weighted* investment was then made in each of the currencies with an interest rate above the average for the quarter. Again, no short positions were taken in any currency. The results for this strategy are outlined in Table V, attached. Please note that the investment returns represent the *sum* of currency and LIBOR returns in a quarter.

Strategy 3: "Xenocentric"

This strategy shared much in common with the previous. The U.S. interest rate, however, was used as the threshold interest rate to determine which currencies were to be held long. Equal-weighted positions were then taken in all of these currencies. Once more, short positions were excluded from the strategy. This strategy was viewed as perhaps a more appropriate modeling of

the typical U.S.-based investor, surveying the investment possibilities in countries other than the U.S. Table VI summarizes the results of this strategy.

Strategy 4: "U.S. Relative Weighting"

The *U.S. Relative Weighting* strategy represented a more sophisticated adaptation of the previous approach. Again, the U.S. three month LIBOR rate was used as the threshold to determine investment currencies. The long positions taken within these currencies, however, were *not* equal-weighted. Instead, the sum of the "distances" of high interest rate currencies from the U.S. Dollar LIBOR rate was calculated. The amount invested in an individual currency was then determined as a percentage of the $1000 investment by the distance from the U.S. Dollar rate. Essentially, those currencies with the highest interest rate differential compared to the U.S. were given the majority of the investment capital. Those with smaller differentials were awarded proportionately less capital. The outcomes of this portfolio strategy is described in Table VII.

Strategy 5: "The Long and Short of It"

The *Long and Short of It* strategy simply took the long position from strategy 1 and added a corresponding short in the lowest interest rate country. Only the highest and lowest interest rate countries were given a net position in this strategy. The short position was accounted for in the following manner. At the beginning of the quarter, an investor would take out a forward contract to deliver the foreign currency with the lowest interest rate. Delivery would take place at the end of the quarter. The amount of currency the investor would deliver would be $1000 times the current exchange rate. At the end of the quarter, the investor would buy the contractually required amount of foreign currency (with US dollars) at the prevailing exchange rate. In return, the investor would receive the forward rate times the US dollar amount of currency to be delivered. Thus, the return from this position would be determined by multiplying the initial $1000 by the difference of the forward rate and the end of quarter exchange rate. For the purpose of this model, an implied forward rate was calculated under the assumption of covered interest

CASH SETTLEMENT - WOULD HAVE EASED THE CALCULATIONS.

parity (CIP), where $f_1 = [(1+r_{us})/(1+r_{foreign})] e_0$. The results for this case can be found in Table VIII.

Strategy 6: "Shake Your Money Maker"

This final strategy represented the highest level of complexity. The approach used in the U.S. Relative Weighting strategy was applied here to both long and short positions. Again, the U.S. LIBOR rate was used as the threshold level for determining other currency positions. Furthermore, the magnitude of the difference between foreign and U.S. interest rates was used as a basis for determining the level of investment. By utilizing relative weighting and positions in all currencies, it was hoped that this strategy would yield the most favorable risk-return tradeoff. Table IX displays the performance of the strategy.

CONCLUSION

Various studies have investigated the returns of foreign currency trading strategies designed to exploit the forward discount bias. As Froot and Thaler have pointed out, however, single currency strategies post unattractive returns, especially considering the increased returns volatility they create. This study examined the multi-currency case, where strategies have multiple foreign currencies available for investment. This paper sought to determine what returns and volatilities would be associated with such strategies, and whether they offered attractive risk-return tradeoffs. The six investment strategies examined in this study posted average quarterly returns between 2.9% and 4.3%. These rates compare favorably with the average quarterly U.S. Treasury rate return of 1.49% (see Figure 1 and Figure 2). However, these methods resulted in a higher volatility of returns than was experienced by U.S. Treasuries. The standard deviations of the returns experienced by these trading strategies ranged from 4.9% to 8.2%. Meanwhile, the standard deviation of U.S. Treasury returns was only 1.96%. Clearly, a risk adjusted return is necessary in order to determine whether the

return on these strategies merits their volatility. Toward this end, Sharpe Ratios were calculated for each strategy (see Figure 3). A more detailed evaluation of each strategy follows.

Strategy 1, the "All or Nothing" strategy, was the benchmark case. The authors believed this strategy would produce moderately high returns, since the sole long position would be in the currency with the most favorable interest rate differential. Indeed, this strategy did well, achieving a 0.30 Sharpe Ratio. It should be noted that a Sharpe Ratio of 0.30 is generally accepted as an estimate of the risk-return profile of the S&P500. Therefore, it would appear that this strategy would at least keep pace with the market. However, this strategy did have four "Total Clean-Outs," meaning a position in one currency was completely cleaned-out to make room for a position in a different currency four times. Considering that the period from 1986 Q1 to 1995 Q4 covers 39 quarters, this implies that a position was closed-out only once every 10 quarters or so. This suggests that the interest rate differentials encountered during this period were persistent, and did not fluctuate wildly from quarter to quarter. As a result, this strategy would not result in high transaction costs (at least not during the time period observed).

[handwritten margin notes: "QUARTERLY BASIS?" and "→ PROVIDE ROUGH COST ESTIMATES? (E.G., THE 12 BP ESTIMATE IN THE FREE LUN ARTICLE)"]

Strategy 2, the "It's All Relative" strategy, was designed to create a more international perspective, and so used the average interest rate of the six currencies to determine the base rate for calculating interest rate differentials. Interestingly, this strategy generated a Sharpe Ratio of 0.27, and therefore performed worse than the simpler "All or Nothing" strategy. This may have been due to the fact that the "It's All Relative" strategy softened its returns somewhat by requiring that a position to be taken in any currency with a positive interest rate differential, while the "All or Nothing" strategy only invested in the currency with the greatest interest rate differential. An additional drawback of this strategy might have been that by computing interest rate differentials on the basis of an average interest rate of all the currencies, rather than comparing their interest rates one to one, that the true interest rate differentials between

countries were incorrectly stated. As a final point, this strategy cleaned-out seven positions during the study, which implies it would have almost double the transaction costs of the "All or Nothing" strategy.

Strategy 3, the "Xenocentric" strategy, was very similar to the aforementioned "It's All Relative" strategy. However, instead of using an average interest rate, the U.S. interest rate was used as the base in calculating interest rate differentials. Since this change corrects one of the possible problems with the second strategy, it is not surprising that this strategy provided a higher average return and a more favorable Sharpe Index of 0.31. This strategy also resulted in one less "clean-out" than the second strategy.

Strategy 4, the "U.S. Relative Weighting" strategy, was similar to the "Xenocentric" strategy except that it employed a weighting system to determine what proportion of the overall portfolio would be devoted to a specific currency position. This weighting system was based on the magnitude of the interest rate differential. As a result, it was anticipated that this strategy would generate higher returns than the third strategy, yet returns were unchanged. Furthermore, the standard deviation increased from 4.9% to 5.3%, and the Sharpe Ratio fell to 0.28. It is possible that the currencies with the higher interest rate differentials also had higher standard deviations of their returns, which led to these results.

Strategy 5, "The Long and Short of It" strategy, simply consisted of one long and one short position. It was expected that this approach would provide superior returns to the "All or Nothing" strategy, since this method adds a short position as another way of taking advantage of the forward discount bias. As was expected, this strategy provided a high return of 4.31%, but also generated the highest standard deviation of all the strategies, at 8.20%. The net result, however, was quite favorable: this strategy attained a Sharpe Ratio of 0.33, the second highest of all the strategies tested. Comparing this strategy with the "All or Nothing" approach would

Table I. Exchange Rates

	DM to $	¥ to $	FFr to $	£ to $	Sw Fr to $
1986 Q2	2.3205	177.90	7.3250	0.6745	1.7958
1986 Q3	2.0275	158.50	6.9400	0.6636	1.6382
1986 Q4	1.9640	154.15	6.4625	0.6957	1.6235
1987 Q1	1.8373	153.30	6.1200	0.6642	1.506
1987 Q2	1.8310	141.70	6.0150	0.6126	1.52
1987 Q3	1.8102	148.55	6.0870	0.6109	1.529
1987 Q4	1.6535	142.35	6.0135	0.6017	1.278
1988 Q1	1.6862	130.70	5.6825	0.5643	1.3685
1988 Q2	1.7290	123.82	5.6310	0.5291	1.5095
1988 Q3	1.8750	135.45	6.3435	0.6022	1.5895
1988 Q4	1.7292	126.65	6.1660	0.5681	1.504
1989 Q1	1.8375	126.95	6.2560	0.5632	1.66
1989 Q2	1.9820	131.99	6.3050	0.5864	1.673
1989 Q3	1.9780	140.75	6.4850	0.6223	1.618
1989 Q4	1.7855	142.90	6.3960	0.6371	1.5465
1990 Q1	1.7200	145.60	5.7130	0.5993	1.4965
1990 Q2	1.6995	157.97	5.6250	0.6088	1.4175
1990 Q3	1.5780	148.10	5.5350	0.5549	1.299
1990 Q4	1.5140	127.80	5.1110	0.5130	1.2955
1991 Q1	1.5385	135.65	5.2432	0.5240	1.46
1991 Q2	1.7475	134.15	5.6245	0.5573	1.56
1991 Q3	1.7470	136.90	6.0745	0.6050	1.4495
1991 Q4	1.6130	129.90	5.8250	0.5874	1.3555
1992 Q1	1.6430	128.90	5.5560	0.5721	1.4985
1992 Q2	1.6040	133.37	5.6210	0.5698	1.3775
1992 Q3	1.3900	125.10	5.0050	0.5203	1.2295
1992 Q4	1.5735	120.20	4.9320	0.5901	1.456
1993 Q1	1.6555	126.08	5.5250	0.6531	1.495
1993 Q2	1.5905	113.15	5.4315	0.6489	1.5095
1993 Q3	1.6594	108.35	5.8900	0.6718	1.4175
1993 Q4	1.7222	107.08	5.7260	0.6609	1.4795
1994 Q1	1.7079	110.95	5.9390	0.6693	1.41
1994 Q2	1.6455	103.44	5.8613	0.6798	1.3445
1994 Q3	1.5755	97.85	5.3310	0.6407	1.286
1994 Q4	1.5735	98.18	5.2120	0.6274	1.3115
1995 Q1	1.4632	98.55	5.2953	0.6378	1.1391
1995 Q2	1.4083	83.30	4.8545	0.6234	1.151
1995 Q3	1.4630	87.78	4.8460	0.6268	1.1438
1995 Q4	1.4463	100.98	4.9620	0.6352	1.1505
1996 Q1	1.4765	105.30	4.9635	0.6475	1.3628

Table II. Three Month Libor Rates

	German	Japanese	French	UK	Swiss	US
1986 Q2	4.59%	4.84%	7.79%	10.23%	4.60%	7.11%
1986 Q3	4.58%	4.84%	7.44%	10.03%	4.54%	6.27%
1986 Q4	4.78%	4.74%	8.71%	11.09%	4.13%	6.14%
1987 Q1	4.25%	4.31%	8.89%	10.66%	3.87%	6.38%
1987 Q2	3.82%	3.98%	8.38%	9.40%	3.89%	7.15%
1987 Q3	4.00%	4.17%	8.21%	9.85%	3.82%	7.22%
1987 Q4	4.16%	4.58%	9.07%	9.29%	4.03%	7.96%
1988 Q1	3.44%	4.31%	8.27%	9.07%	1.99%	6.98%
1988 Q2	3.65%	4.23%	7.97%	8.48%	2.62%	7.48%
1988 Q3	5.07%	4.92%	7.82%	11.37%	3.79%	8.42%
1988 Q4	5.15%	4.59%	8.29%	12.53%	4.40%	9.02%
1989 Q1	6.28%	4.67%	8.90%	13.12%	5.82%	9.81%
1989 Q2	6.77%	5.05%	8.87%	13.55%	7.06%	9.78%
1989 Q3	7.12%	5.55%	9.18%	13.99%	7.33%	8.93%
1989 Q4	8.19%	6.58%	10.44%	15.13%	8.07%	8.62%
1990 Q1	8.40%	7.28%	10.99%	15.25%	9.44%	8.40%
1990 Q2	8.25%	7.41%	9.92%	15.17%	9.09%	8.46%
1990 Q3	8.41%	8.04%	10.14%	15.03%	8.76%	8.17%
1990 Q4	8.99%	8.32%	10.09%	13.69%	8.58%	8.22%
1991 Q1	9.21%	8.15%	9.84%	13.34%	8.39%	6.87%
1991 Q2	9.26%	7.89%	9.41%	11.72%	8.31%	6.17%
1991 Q3	9.26%	7.24%	9.53%	11.01%	8.03%	5.84%
1991 Q4	9.51%	6.25%	9.65%	10.63%	8.27%	5.05%
1992 Q1	9.63%	5.17%	10.07%	10.63%	7.93%	4.25%
1992 Q2	9.82%	4.71%	10.03%	10.42%	8.91%	4.08%
1992 Q3	9.67%	4.12%	10.45%	10.23%	8.20%	3.47%
1992 Q4	8.95%	3.85%	10.94%	7.51%	6.48%	3.63%
1993 Q1	8.30%	3.46%	11.84%	6.46%	5.47%	3.26%
1993 Q2	7.68%	3.23%	8.01%	6.08%	5.12%	3.22%
1993 Q3	6.83%	2.99%	7.69%	5.98%	4.77%	3.26%
1993 Q4	6.39%	2.32%	6.74%	5.70%	4.47%	3.42%
1994 Q1	5.90%	2.27%	6.33%	5.30%	4.11%	3.56%
1994 Q2	5.28%	2.25%	5.76%	5.22%	4.17%	4.47%
1994 Q3	5.01%	2.31%	5.65%	5.46%	4.26%	4.97%
1994 Q4	5.28%	2.39%	5.76%	6.17%	4.12%	5.96%
1995 Q1	5.08%	2.28%	6.70%	6.67%	3.90%	6.29%
1995 Q2	4.57%	1.38%	7.58%	6.74%	3.38%	6.12%
1995 Q3	4.41%	0.82%	6.15%	6.83%	2.88%	5.89%
1995 Q4	4.08%	0.60%	6.29%	6.68%	2.20%	5.85%
1996 Q1	3.64%	0.60%	4.71%	6.64%	5.60%	5.18%
1996 Q2	3.36%	0.65%	4.03%	6.00%	5.11%	5.06%

Table III. Interest Rate Differentials (vs. U.S.)

	German	Japanese	French	UK	Swiss
1986 Q2	-2.52%	-2.27%	0.68%	3.12%	-2.51%
1986 Q3	-1.70%	-1.43%	1.17%	3.76%	-1.74%
1986 Q4	-1.36%	-1.40%	2.57%	4.95%	-2.02%
1987 Q1	-2.13%	-2.07%	2.52%	4.29%	-2.50%
1987 Q2	-3.33%	-3.17%	1.23%	2.25%	-3.26%
1987 Q3	-3.22%	-3.05%	0.98%	2.63%	-3.40%
1987 Q4	-3.80%	-3.39%	1.11%	1.33%	-3.93%
1988 Q1	-3.55%	-2.68%	1.29%	2.09%	-5.00%
1988 Q2	-3.83%	-3.25%	0.49%	1.00%	-4.86%
1988 Q3	-3.35%	-3.50%	-0.60%	2.95%	-4.63%
1988 Q4	-3.87%	-4.43%	-0.73%	3.51%	-4.62%
1989 Q1	-3.53%	-5.14%	-0.91%	3.30%	-3.99%
1989 Q2	-3.01%	-4.73%	-0.91%	3.77%	-2.72%
1989 Q3	-1.81%	-3.38%	0.25%	5.06%	-1.60%
1989 Q4	-0.43%	-2.04%	1.82%	6.51%	-0.55%
1990 Q1	-0.01%	-1.12%	2.59%	6.84%	1.03%
1990 Q2	-0.21%	-1.05%	1.46%	6.71%	0.62%
1990 Q3	0.24%	-0.13%	1.98%	6.87%	0.59%
1990 Q4	0.77%	0.10%	1.86%	5.47%	0.36%
1991 Q1	2.33%	1.28%	2.96%	6.47%	1.52%
1991 Q2	3.09%	1.72%	3.24%	5.55%	2.13%
1991 Q3	3.42%	1.40%	3.69%	5.17%	2.18%
1991 Q4	4.45%	1.20%	4.60%	5.57%	3.21%
1992 Q1	5.39%	0.93%	5.82%	6.39%	3.68%
1992 Q2	5.74%	0.62%	5.95%	6.34%	4.83%
1992 Q3	6.21%	0.65%	6.98%	6.76%	4.73%
1992 Q4	5.33%	0.23%	7.32%	3.88%	2.86%
1993 Q1	5.04%	0.20%	8.58%	3.20%	2.21%
1993 Q2	4.46%	0.02%	4.80%	2.87%	1.90%
1993 Q3	3.58%	-0.26%	4.44%	2.73%	1.52%
1993 Q4	2.97%	-1.10%	3.32%	2.28%	1.05%
1994 Q1	2.34%	-1.29%	2.76%	1.74%	0.55%
1994 Q2	0.80%	-2.22%	1.29%	0.75%	-0.31%
1994 Q3	0.04%	-2.66%	0.68%	0.49%	-0.71%
1994 Q4	-0.69%	-3.57%	-0.20%	0.20%	-1.84%
1995 Q1	-1.21%	-4.01%	0.41%	0.38%	-2.39%
1995 Q2	-1.55%	-4.74%	1.45%	0.61%	-2.75%
1995 Q3	-1.48%	-5.07%	0.26%	0.94%	-3.02%
1995 Q4	-1.77%	-5.26%	0.44%	0.82%	-3.66%
1996 Q1	-1.54%	-4.58%	-0.47%	1.46%	0.42%

Table IV. "All or Nothing Strategy"

	Beg. of Qtr. Inv. Position	End of Qtr. Inv. Position	Investment Return
1986 Q2	£675	£692	4.24%
1986 Q3	£664	£680	-2.22%
1986 Q4	£696	£715	7.65%
1987 Q1	£664	£682	11.31%
1987 Q2	£613	£627	2.63%
1987 Q3	£611	£626	4.03%
1987 Q4	£602	£616	9.10%
1988 Q1	£564	£577	9.07%
1988 Q2	£529	£540	-10.28%
1988 Q3	£602	£619	9.02%
1988 Q4	£568	£586	4.03%
1989 Q1	£563	£582	-0.81%
1989 Q2	£586	£606	-2.58%
1989 Q3	£622	£644	1.09%
1989 Q4	£637	£661	10.33%
1990 Q1	£599	£622	2.19%
1990 Q2	£609	£632	13.88%
1990 Q3	£555	£576	12.23%
1990 Q4	£513	£531	1.25%
1991 Q1	£524	£541	-2.84%
1991 Q2	£557	£574	-5.19%
1991 Q3	£605	£622	5.83%
1991 Q4	£587	£603	5.40%
1992 Q1	£572	£587	3.07%
1992 Q2	£570	£585	12.37%
1992 Q3	¥5,005	¥5,136	4.13%
1992 Q4	¥4,932	¥5,067	-8.29%
1993 Q1	¥5,525	¥5,689	4.73%
1993 Q2	¥5,432	¥5,540	-5.94%
1993 Q3	¥5,890	¥6,003	4.84%
1993 Q4	¥5,726	¥5,822	-1.96%
1994 Q1	¥5,939	¥6,033	2.93%
1994 Q2	¥5,861	¥5,946	11.53%
1994 Q3	¥5,331	¥5,406	3.73%
1994 Q4	£627	£637	-0.11%
1995 Q1	¥5,295	¥5,384	10.91%
1995 Q2	¥4,855	¥4,946	2.07%
1995 Q3	£627	£638	0.36%
1995 Q4	£635	£646	-0.26%

Average Return	3.29%
Std. Dev	5.85%
Total Clean-outs	4
Sharpe Ratio	0.30
Libor Adjusted Figures:	
Average Return	1.83%
Std. Dev	5.74%
Total Clean-outs	4
Sharpe Ratio	0.06

suggest·that adding a short position to the portfolio generates modest returns but high volatility. Furthermore, the twelve total close-outs in this strategy are three times that of the first strategy, implying much higher transaction costs.

Strategy 6, the "Shake Your Money Maker" strategy, was expected to provide the best risk-reward tradeoff of all (thus the name). This strategy implied holding a position in each currency, which would allow an investor to diversify the portfolio of currencies, which could decrease its standard deviation. Indeed, this happened, as standard deviation was 6.0%, much less than the fifth strategy, which is the only other strategy to employ short positions. This effect was more than enough to offset the lower average return of this strategy, which may have resulted from long positions in any currency with a positive interest rate differential, rather than placing the entire $1000 in the currency with the highest differential. A similar argument might be made of the short positions as well. At any rate, the Sharpe Ratio of this strategy was the best of those studied, at 0.39.

This study suggests that multi-currency trading strategies designed to exploit the forward discount bias provide a better risk-return tradeoff than the single currency strategies discussed by Froot and Thaler. However, at least two areas of study remain. The findings of this study could be further refined by a thorough examination of the transaction costs implied by these strategies. This study made an attempt to monitor the magnitude of these costs and compare this across strategies, but no effort was made to determine the specific transaction costs involved. Furthermore, an effort to break down the average returns from each investment strategy into the returns form currency appreciation/depreciation and interest rate changes would more accurately state the value of trading predicated on the forward discount bias. For instance, in the "All or Nothing" strategy, the overall average return was 3.29%. But this return includes not only the currency appreciation, but also the 3 month LIBOR interest earned by the long position. Once the LIBOR returns are eliminated from the overall returns, the currency

appreciation returns are only 1.83%, and the Sharpe Ratio drops to 0.06. Clearly, it would be important to adjust all the returns from these and any other forward discount bias trading strategies to differentiate between changes to the exchange rate and to the interest rate.

Table V
"It's All Relative" Investment Strategy

	Average Interest Rate	DM	Yen	Local Currency Investment Positions, Start of Quarter FFr	Pound	Sw Fr	U.S. $	Investment Return
1986 Q2	6.52	-	-	2,441.67	224.83	-	333.33	4.5%
1986 Q3	6.28	-	-	3,470.00	331.80	-	-	3.6%
1986 Q4	6.60	-	-	3,231.25	347.85	-	-	7.8%
1987 Q1	6.39	-	-	3,060.00	332.10	-	-	7.7%
1987 Q2	6.10	-	-	2,005.00	204.20	-	333.33	1.8%
1987 Q3	6.21	-	-	2,029.00	203.63	-	333.33	3.0%
1987 Q4	6.52	-	-	2,004.50	200.57	-	333.33	6.4%
1988 Q1	5.68	-	-	1,894.17	188.10	-	333.33	4.6%
1988 Q2	5.74	-	-	1,877.00	176.37	-	333.33	-6.0%
1988 Q3	6.90	-	-	2,114.50	200.73	-	333.33	5.3%
1988 Q4	7.33	-	-	2,055.33	189.37	-	333.33	2.3%
1989 Q1	8.10	-	-	2,085.33	187.73	-	333.33	1.0%
1989 Q2	8.51	-	-	2,101.67	195.47	-	333.33	-0.3%
1989 Q3	8.68	-	-	2,161.67	207.43	-	333.33	2.3%
1989 Q4	9.50	-	-	3,198.00	318.55	-	-	12.6%
1990 Q1	9.96	-	-	2,856.50	299.65	-	-	3.3%
1990 Q2	9.72	-	-	2,812.50	304.40	-	-	9.0%
1990 Q3	9.76	-	-	2,767.50	277.45	-	-	11.6%
1990 Q4	9.65	-	-	2,555.50	256.50	-	-	0.6%
1991 Q1	9.30	-	-	2,621.60	262.00	-	-	-3.7%
1991 Q2	8.79	582.50	-	1,874.83	185.77	-	-	-2.7%
1991 Q3	8.49	582.33	-	2,024.83	201.67	-	-	7.8%
1991 Q4	8.22	403.25	-	1,456.25	146.85	338.88	-	1.4%
1992 Q1	7.95	547.67	-	1,852.00	190.70	-	-	3.1%
1992 Q2	8.00	401.00	-	1,405.25	142.45	344.38	-	15.1%
1992 Q3	7.69	347.50	-	1,251.25	130.08	307.38	-	-7.2%
1992 Q4	6.89	524.50	-	1,644.00	196.70	-	-	-6.4%
1993 Q1	6.46	827.75	-	2,762.50	-	-	-	5.5%
1993 Q2	5.56	530.17	-	1,810.50	216.30	-	-	-3.4%
1993 Q3	5.25	553.13	-	1,963.33	223.93	-	-	2.0%
1993 Q4	4.84	574.07	-	1,908.67	220.30	-	-	0.2%
1994 Q1	4.58	569.30	-	1,979.67	223.10	-	-	2.7%
1994 Q2	4.53	548.50	-	1,953.77	226.60	-	-	8.3%
1994 Q3	4.61	393.88	-	1,332.75	160.18	-	250.00	2.5%
1994 Q4	4.95	393.38	-	1,303.00	156.85	-	250.00	2.5%
1995 Q1	5.15	-	-	1,765.10	212.60	-	333.33	5.5%
1995 Q2	4.96	-	-	1,618.17	207.80	-	333.33	1.6%
1995 Q3	4.50	-	-	1,615.33	208.93	-	333.33	0.3%
1995 Q4	4.28	-	-	1,654.00	211.73	-	333.33	0.9%

Average Return	2.9%
Std. Dev	4.9%
Total Clean-outs	7
Sharp Index	0.27

Table VI
"Xenocentric" Investment Strategy
Local Currency

	DM	Yen	FFr	Pound	Sw Fr	Investment Return
			Investment Positions, Start of Quarter			
1986 Q2	-	-	3,662.50	337.25	-	5.9%
1986 Q3	-	-	3,470.00	331.80	-	3.6%
1986 Q4	-	-	3,231.25	347.85	-	7.8%
1987 Q1	-	-	3,060.00	332.10	-	7.7%
1987 Q2	-	-	3,007.50	306.30	-	1.8%
1987 Q3	-	-	3,043.50	305.45	-	3.7%
1987 Q4	-	-	3,006.75	300.85	-	8.7%
1988 Q1	-	-	2,841.25	282.15	-	6.0%
1988 Q2	-	-	2,815.50	264.55	-	-9.9%
1988 Q3	-	-	-	602.20	-	9.0%
1988 Q4	-	-	-	568.10	-	4.0%
1989 Q1	-	-	-	563.20	-	-0.8%
1989 Q2	-	-	-	586.40	-	-2.6%
1989 Q3	-	-	3,242.50	311.15	-	2.4%
1989 Q4	-	-	3,198.00	318.55	-	12.6%
1990 Q1	-	-	1,904.33	199.77	498.83	4.9%
1990 Q2	-	-	1,875.00	202.93	472.50	9.9%
1990 Q3	394.50	-	1,383.75	138.73	324.75	8.0%
1990 Q4	302.80	25,560.00	1,022.20	102.60	259.10	-2.3%
1991 Q1	307.70	27,130.00	1,048.64	104.80	292.00	-3.7%
1991 Q2	349.50	26,830.00	1,124.90	111.46	312.00	0.3%
1991 Q3	349.40	27,380.00	1,214.90	121.00	289.90	8.0%
1991 Q4	322.60	25,980.00	1,165.00	117.48	271.10	1.6%
1992 Q1	328.60	25,780.00	1,111.20	114.42	299.70	3.6%
1992 Q2	320.80	26,674.00	1,124.20	113.96	275.50	13.6%
1992 Q3	278.00	25,020.00	1,001.00	104.06	245.90	-4.7%
1992 Q4	314.70	24,040.00	986.40	118.02	291.20	-4.8%
1993 Q1	331.10	25,216.00	1,105.00	130.62	299.00	5.2%
1993 Q2	318.10	22,630.00	1,086.30	129.78	301.90	0.6%
1993 Q3	414.85	-	1,472.50	167.95	354.38	0.7%
1993 Q4	430.55	-	1,431.50	165.23	369.88	1.7%
1994 Q1	426.98	-	1,484.75	167.33	352.50	3.5%
1994 Q2	548.50	-	1,953.77	226.60	-	8.3%
1994 Q3	525.17	-	1,777.00	213.57	-	2.9%
1994 Q4	-	-	-	627.40	-	-0.1%
1995 Q1	-	-	2,647.65	318.90	-	7.5%
1995 Q2	-	-	2,427.25	311.70	-	1.6%
1995 Q3	-	-	2,423.00	313.40	-	-0.2%
1995 Q4	-	-	2,481.00	317.60	-	0.6%

Average Return	3.1%
Std. Dev	4.9%
Total Clean-outs	6
Sharp Index	0.31

Table VII
"U.S. Relative Weighting" Investment Strategy
Local Currency

| | Investment Positions, Start of Quarter | | | | | Investment |
	DM	Yen	FFr	Pound	Sw Fr	Return
1986 Q2	-	-	1,315.19	553.39	-	4.8%
1986 Q3	-	-	1,647.69	506.05	-	0.5%
1986 Q4	-	-	2,208.62	457.94	-	7.7%
1987 Q1	-	-	2,264.87	418.40	-	8.6%
1987 Q2	-	-	2,127.83	395.89	-	2.0%
1987 Q3	-	-	1,659.17	444.38	-	3.8%
1987 Q4	-	-	2,734.98	328.04	-	8.7%
1988 Q1	-	-	2,164.84	349.32	-	6.8%
1988 Q2	-	-	1,844.18	355.82	-	-10.0%
1988 Q3	-	-	-	602.20	-	9.0%
1988 Q4	-	-	-	568.10	-	4.0%
1989 Q1	-	-	-	563.20	-	-0.8%
1989 Q2	-	-	-	586.40	-	-2.6%
1989 Q3	-	-	311.31	592.43	-	1.2%
1989 Q4	-	-	1,398.81	497.77	-	11.3%
1990 Q1	-	-	1,413.37	391.94	147.58	3.3%
1990 Q2	-	-	932.17	464.70	100.61	12.1%
1990 Q3	39.79	-	1,130.22	393.83	79.06	11.2%
1990 Q4	135.50	1,493.17	1,113.09	327.85	54.34	0.4%
1991 Q1	246.57	11,890.46	1,067.59	232.72	152.35	-4.0%
1991 Q2	343.50	14,660.13	1,158.15	196.49	211.64	-1.1%
1991 Q3	376.57	12,069.51	1,412.42	197.29	199.55	7.7%
1991 Q4	377.54	8,157.58	1,406.58	172.00	228.87	2.3%
1992 Q1	398.74	5,376.40	1,456.51	164.61	248.32	4.1%
1992 Q2	392.05	3,545.02	1,424.17	153.81	283.35	14.8%
1992 Q3	340.50	3,215.16	1,378.99	138.94	229.64	-6.2%
1992 Q4	427.58	1,391.33	1,840.41	116.75	212.12	-5.6%
1993 Q1	433.99	1,337.02	2,464.24	108.71	171.59	4.3%
1993 Q2	505.18	153.07	1,854.72	132.51	204.31	-2.1%
1993 Q3	484.25	-	2,132.20	149.39	175.48	1.5%
1993 Q4	531.26	-	1,977.15	156.44	162.03	0.8%
1994 Q1	540.80	-	2,220.49	157.50	104.56	3.2%
1994 Q2	464.68	-	2,664.41	178.81	-	8.9%
1994 Q3	48.02	-	3,003.63	260.19	-	3.6%
1994 Q4	-	-	-	627.40	-	-0.1%
1995 Q1	-	-	2,737.80	308.04	-	7.6%
1995 Q2	-	-	3,416.48	184.67	-	1.8%
1995 Q3	-	-	1,056.80	490.11	-	0.1%
1995 Q4	-	-	1,732.57	413.41	-	0.4%

Average Return	3.1%
Std. Dev	5.3%
Total Clean-outs	6
Sharp Index	0.28

Table VIII. "The Long and Short of It."

| | Beg. of Qtr. Inv. Pos.: | | Investment |
	Long	Short	Return
1986 Q2	£675	DM 2,321	-7.80%
1986 Q3	£664	SFr 1,638	-1.46%
1986 Q4	£696	SFr 1,624	1.78%
1987 Q1	£664	SFr 1,506	14.64%
1987 Q2	£613	DM 1,831	4.69%
1987 Q3	£611	SFr 1,529	-12.34%
1987 Q4	£602	SFr 1,278	19.50%
1988 Q1	£564	SFr 1,369	23.31%
1988 Q2	£529	SFr 1,510	-0.51%
1988 Q3	£602	SFr 1,590	7.79%
1988 Q4	£568	SFr 1,504	17.85%
1989 Q1	£563	¥126,950	7.92%
1989 Q2	£586	¥131,990	8.15%
1989 Q3	£622	¥140,750	5.80%
1989 Q4	£637	¥142,900	14.09%
1990 Q1	£599	¥145,600	11.07%
1990 Q2	£609	¥157,970	8.19%
1990 Q3	£555	¥148,100	-3.54%
1990 Q4	£513	¥127,800	6.95%
1991 Q1	£524	¥135,650	-5.14%
1991 Q2	£557	¥134,150	-4.77%
1991 Q3	£605	¥136,900	-0.86%
1991 Q4	£587	¥129,900	3.50%
1992 Q1	£572	¥128,900	5.54%
1992 Q2	£570	¥133,370	5.16%
1992 Q3	FFr 5,005	¥125,100	-0.57%
1992 Q4	FFr 4,932	¥120,200	-3.85%
1993 Q1	FFr 5,525	¥126,080	-6.89%
1993 Q2	FFr 5,432	¥113,150	-10.39%
1993 Q3	FFr 5,890	¥108,350	3.91%
1993 Q4	FFr 5,726	¥107,080	2.60%
1994 Q1	FFr 5,939	¥110,950	-3.07%
1994 Q2	FFr 5,861	¥103,440	7.99%
1994 Q3	FFr 5,331	¥97,850	6.66%
1994 Q4	£627	¥98,180	3.75%
1995 Q1	FFr 5,295	¥98,550	-3.48%
1995 Q2	FFr 4,855	¥83,300	11.86%
1995 Q3	£627	¥87,780	18.46%
1995 Q4	£635	¥100,980	9.06%

Average Return	4.31%
Std. Dev	8.20%
Total Clean-outs	12
Sharpe Index	0.33

Table IX
"Shake Your Money Maker" Investment Strategy

Quarter	Local Currency — Long Investment Positions, Start of Quarter					Local Currency — Short Investment Positions, Start of Quarter					Investment Returns
	DM	Yen	FFr	Pound	Sw Fr	DM	Yen	FFr	Pound	Sw Fr	
1986 Q2			1,315.19	553.39		800.62	55,336.38			617.62	-4.9%
1986 Q3			1,847.69	508.05		707.08	46,611.90			585.12	-0.2%
1986 Q4			2,208.62	457.94		560.20	45,226.36			684.10	3.9%
1987 Q1			2,284.87	418.40		584.18	47,324.14			562.25	8.5%
1987 Q2			2,127.83	395.89		624.66	45,888.95			508.12	6.4%
1987 Q3			1,659.17	444.38		602.78	46,852.28			537.62	-4.5%
1987 Q4			2,734.98	328.04		565.69	43,336.16			451.71	12.6%
1988 Q1			2,164.84	349.32		533.01	31,181.17			609.43	14.3%
1988 Q2			1,844.18	355.82		554.95	33,695.55			614.22	0.8%
1988 Q3				602.20		520.01	39,281.51	313.53		609.14	5.9%
1988 Q4				568.10		490.49	41,075.17	328.93		509.38	13.0%
1989 Q1				563.20		477.72	48,066.99	420.91		488.21	6.7%
1989 Q2				586.40		525.07	54,851.78	504.87		400.57	2.7%
1989 Q3			311.31	592.43		527.00	70,022.40			381.97	0.4%
1989 Q4			1,398.81	497.77	147.58	253.21	96,874.63			280.95	12.9%
1990 Q1			1,413.37	391.94	100.61	12.19	144,568.29				12.1%
1990 Q2			932.17	464.70	79.06	285.49	131,433.04				6.1%
1990 Q3	39.79		1,130.22	383.83	54.34		148,100.00				-4.5%
1990 Q4	135.50	1,493.17	1,113.09	327.85	152.35						0.4%
1991 Q1	246.57	11,890.46	1,067.59	232.72	211.64						-4.0%
1991 Q2	343.50	14,680.13	1,158.15	196.49	199.55						-1.1%
1991 Q3	376.57	12,069.51	1,412.42	197.29	228.87						7.7%
1991 Q4	377.54	8,157.58	1,406.58	172.00	248.32						2.3%
1992 Q1	398.74	5,376.40	1,456.51	164.61	283.35						4.1%
1992 Q2	392.05	3,545.02	1,424.17	153.81	229.64						14.8%
1992 Q3	340.50	3,215.16	1,378.99	138.94	212.12						-6.2%
1992 Q4	427.58	1,391.33	1,840.41	116.75	171.59						-5.6%
1993 Q1	433.99	1,337.02	2,464.24	108.71	204.31						4.3%
1993 Q2	505.18	153.07	1,854.72	132.51	175.48						-2.1%
1993 Q3	484.25		2,132.20	149.39	162.03		108,350.00				0.6%
1993 Q4	531.26		1,977.15	158.44	104.56		107,080.00				5.3%
1994 Q1	540.80		2,220.49	157.50			110,950.00				-2.8%
1994 Q2	484.88		2,684.41	178.81			90,919.18			162.74	5.2%
1994 Q3	48.02		3,003.63	280.19			77,320.40	166.23		269.81	6.4%
1994 Q4				627.40		171.53	55,817.68			383.75	-2.5%
1995 Q1			2,737.80	308.04		232.74	51,924.33			357.74	0.6%
1995 Q2			3,418.48	184.87		241.31	43,704.86			349.88	8.4%
1995 Q3			1,058.80	490.11		226.86	46,513.31			360.35	10.8%
1995 Q4			1,732.57	413.41		239.88	49,667.72			393.80	12.1%

Average Return	3.9%
Std. Dev	6.0%
Total Clean-ou	12
Sharpe Ratio	0.39

Figure 1

"All or Nothing" and U.S. Treasury Returns
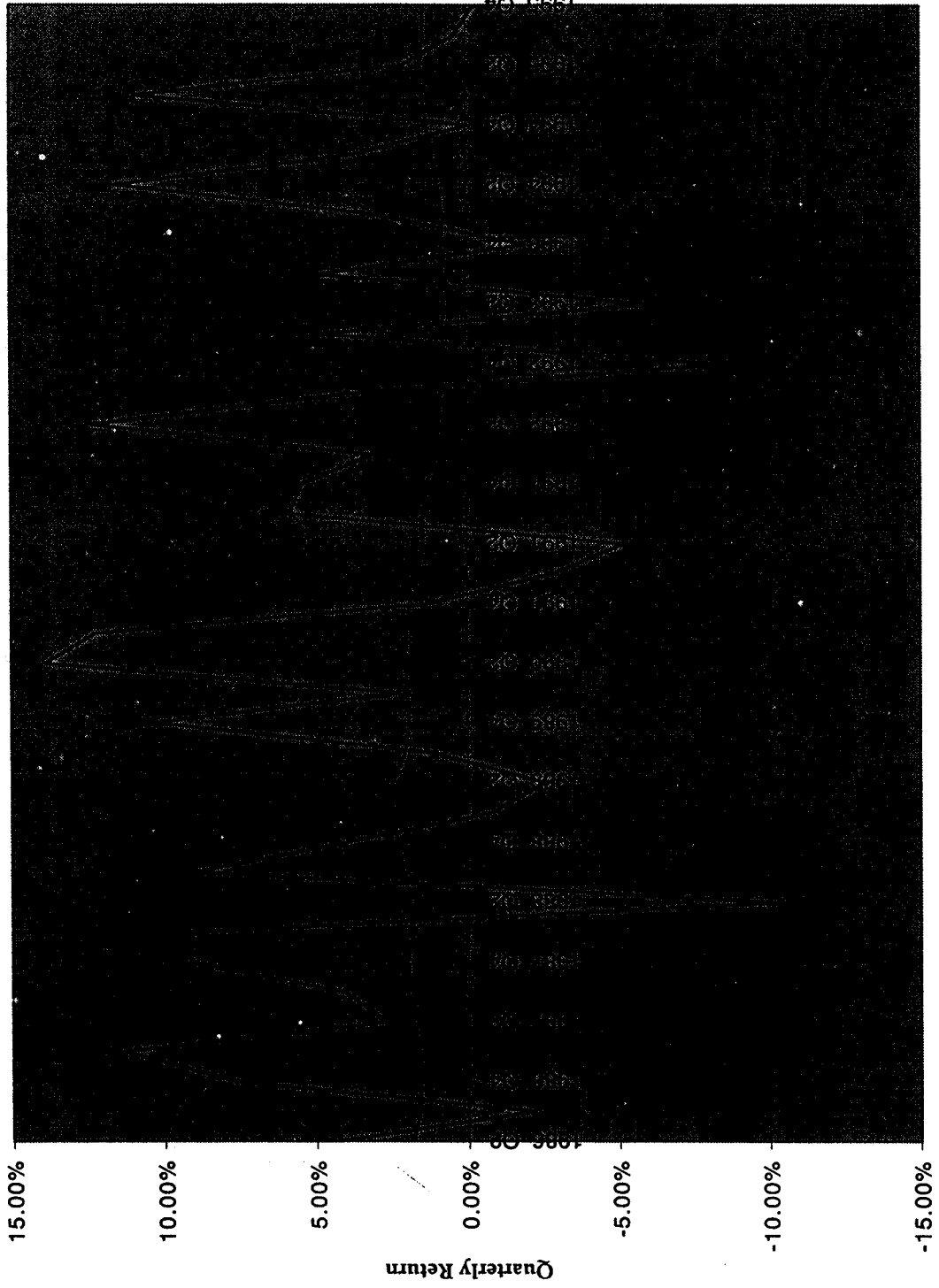
Figure 2

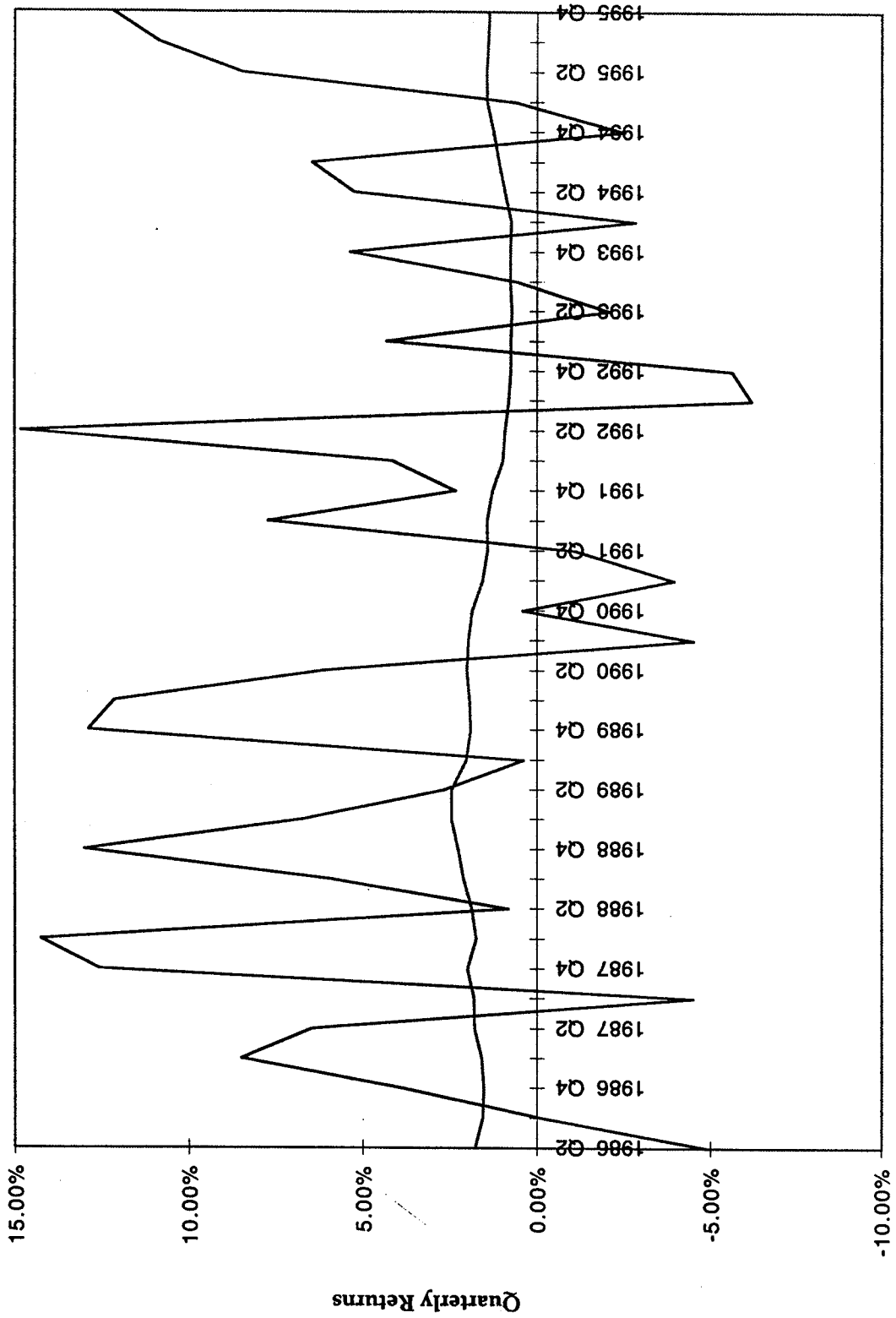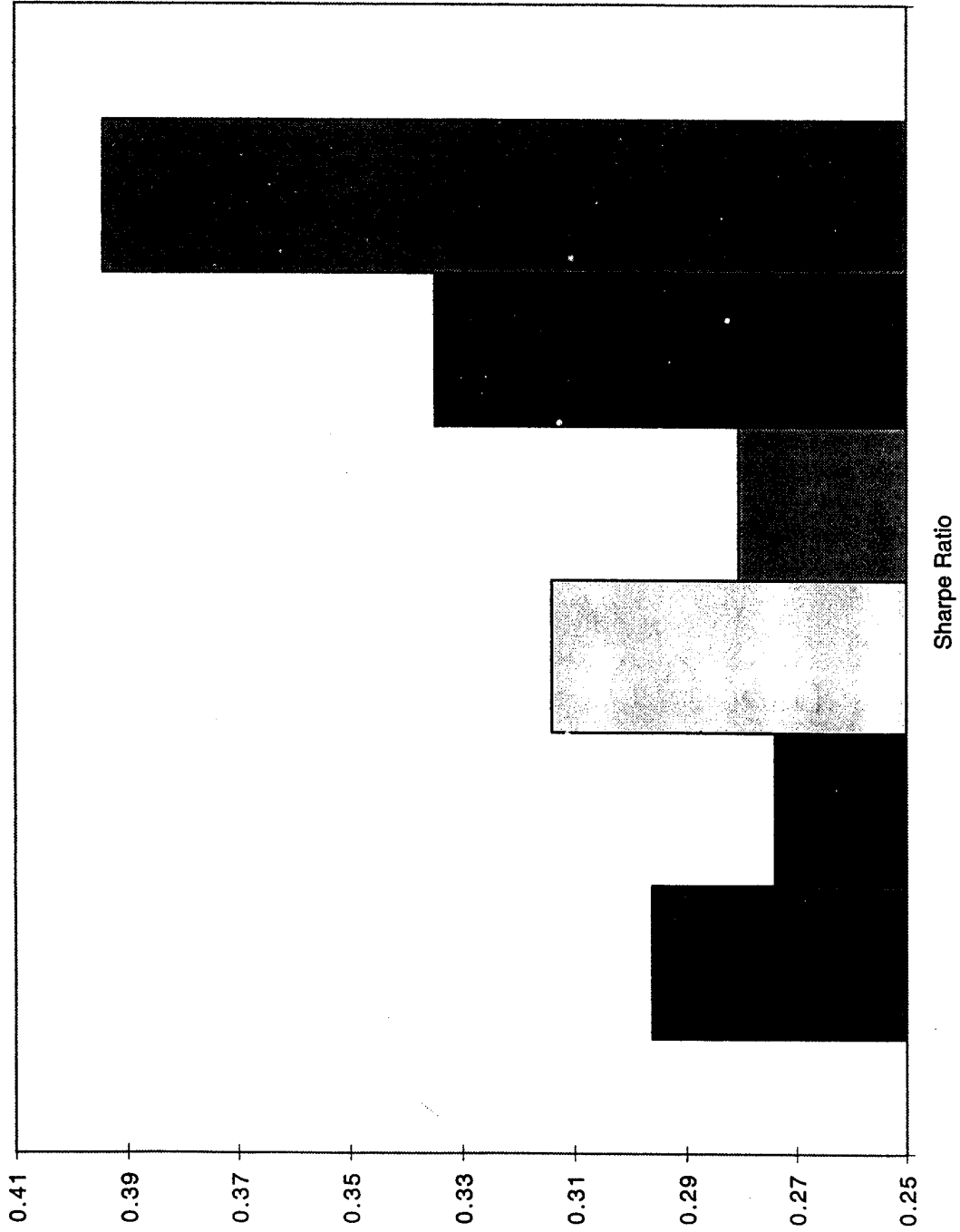## "Shake Your Money Maker" & U.S. Treasury Returns

Figure 3

Comparison of Strategies: Sharpe Ratios

Legend:
- All or Nothing
- It's All Relative
- Xenocentric
- U.S. Relative Weighting
- The Long and Short of It
- Shake Your Money Maker

Sharpe Ratio

0.41 0.39 0.37 0.35 0.33 0.31 0.29 0.27 0.25