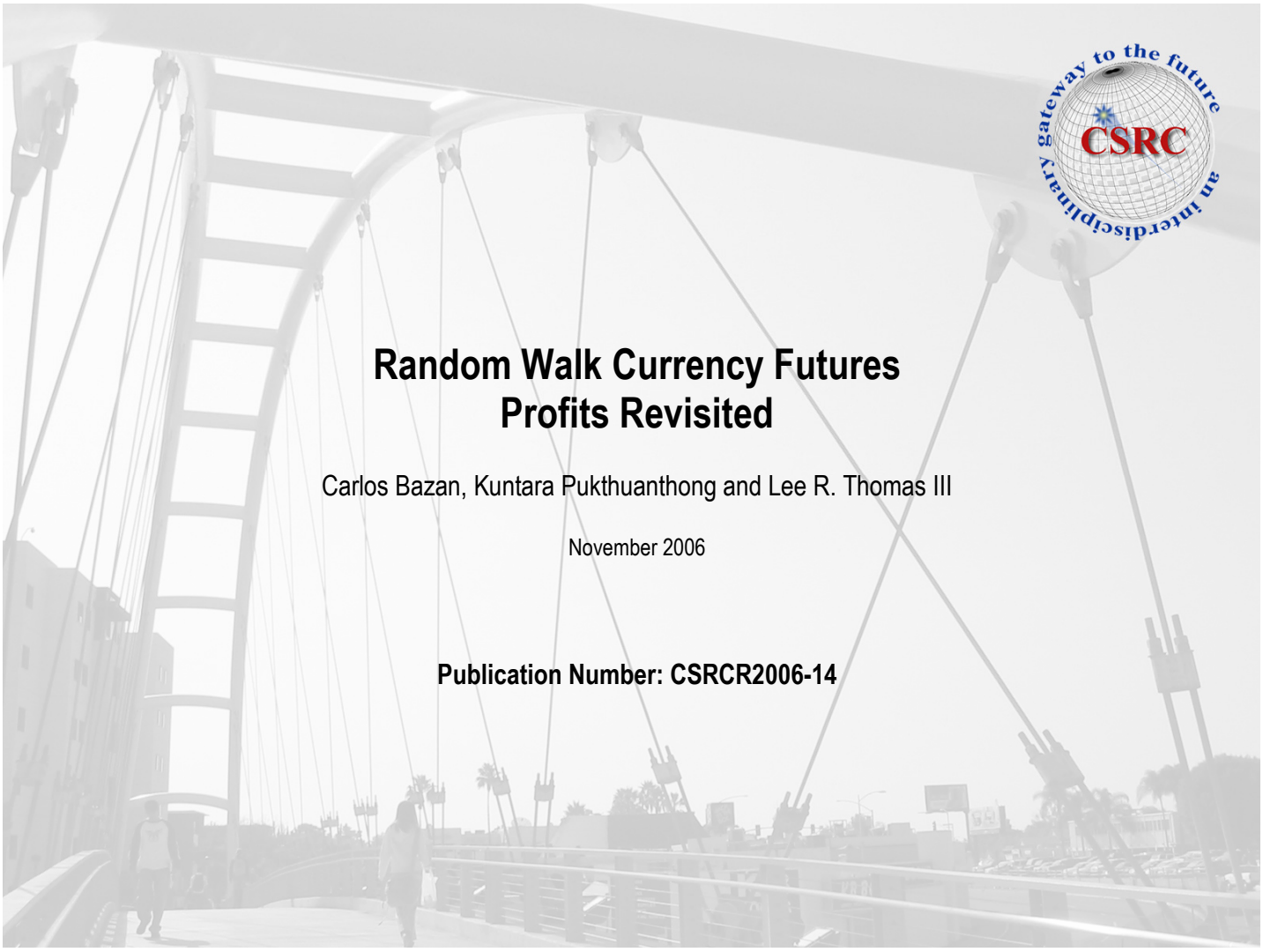

Random Walk Currency Futures Profits Revisited

Carlos Bazan, Kuntara Pukthuanthong and Lee R. Thomas III

November 2006

Publication Number: CSRCR2006-14

Computational Science & Engineering Faculty and Students Research Articles

Database Powered by the Computational Science Research Center Computing Group

COMPUTATIONAL SCIENCE & ENGINEERING

SAN DIEGO STATE UNIVERSITY

Computational Science Research Center
College of Sciences
5500 Campanile Drive
San Diego, CA 92182-1245
(619) 594-3430

Random Walk Currency Futures Profits Revisited

Carlos Bazan [a] , Kuntara Pukthuanthong [b,*] , Lee R. Thomas III [c]

[a] *San Diego State University, Computational Science Research Center*
San Diego, CA 92182-1245, USA

[b] *San Diego State University, College of Business Administration*
San Diego, CA 92182-8230, USA

[c] *Allianz Global Investors*
Newport Beach, CA 92660, USA

Authors' Coordinates

	Pukthuanthong	*Thomas*	*Bazan*
Address	*College of Business Administration* San Diego State University 5500 Campanile Drive San Diego, CA 92182-8236, USA	*Allianz Global Investors* 840 Newport Center Drive, Suite 100 Newport Beach, CA 92660, USA	*Computational Science Research Center* San Diego State University 5500 Campanile Drive San Diego, CA 92182-1245, USA
Voice	*1-619-594-5690*	*1- 949-219-2263*	*1-619-594-3430*
E-Mail	*kpukthua@mail.sdsu.edu*	*limaechoecho2000@yahoo.com*	*Carlos.Bazan@sdsu.edu*

I really appreciate the helpful comments and suggestions from Richard Roll, Ralf Zurbrugg (the editor), and the anonymous referee. * Corresponding author.

Random Walk Currency Futures Profits Revisited

Abstract

Recent research indicates that the Random Walk Hypothesis (RWH) approximately describes the behavior of major dollar exchange rates during the post-1973 float. The present analysis examines the profitability of currency futures trading rules that assume that spot exchange rates can be adequately modeled as driftless random walks. Two random walk currency futures trading rules are simulated over all available data from the period 1984-2003. In both cases, the investor buys currencies selling at a discount and sells those selling at a premium, as the RWH implies. The two rules differ only in the way they allocate the hypothetical investor's resources among long and short foreign currency positions. Results show that an investor who used these trading strategies over the past decade would have enjoyed large cumulative gains, although periods of profit were interrupted by periods of substantial loss. The findings encourage the hope that profitable random-walk-based strategies for currency futures trading can be devised.

Random Walk Currency Futures Profits Revisited

I. Introduction and Literature Review

A growing body of research indicates that the Random Walk Hypothesis (RWH) approximately describes the behavior of major dollar exchange rates during the post-1973 float.[1] This suggests that the RWH might be a useful foundation upon which to construct a currency futures trading program. Approximately twenty years ago, Thomas (1986) published an article in the Journal of Futures Markets describing a rule for trading foreign exchange futures contracts. The rule was simple: the only thing the speculator needed to do was to examine short term interest rates in two countries, then buy (respectively, sell) foreign currency if the foreign interest rate was above (respectively, below) the corresponding US rate. This strategy is equivalent to buying foreign currencies that sell at a discount in the futures market, and selling currencies that sell at a premium. In essence, the investor bets the futures market's implicit forecast of a change in the spot rate is incorrect, as it will be if spot rates evolve as random walks. When the price of a commodity describes a driftless random walk, the current spot price is an unbiased predictor of the future spot price. That is, the current spot rate systematically neither overestimates nor underestimates the future spot rate. If the futures market price of such a commodity equals the expected future spot price, then the spot and future prices should be equal. If they are not, either futures market prices contain risk premia, or future-market participants believe they can forecast the future spot price of a commodity better than the random walk model can. Despite its simplicity, the rule had been historically very profitable. As always, one explanation for these favorable results was implicit data mining. When many researchers look historically at many

[1] Taylor (1982) shows that there may be weak persistence in changes in the dollar/pound exchange rate. This is consistent with empirical evidence that simple filters are profitable in foreign exchange markets. See Dolley and Shafer (1983). Poole (1967) evaluates the evidence for pre-1973 floating rates, and draws a similar conclusion.

different trading rules, some are bound to work, at least work when applied to historical data. But post-sample, many such rules collapse. The purpose of this article is to see if the profits reported in 1983 persisted during the twenty years that have passed subsequent to publication of the trading rule in the Journal of Futures Markets.

Mounting evidence indicates that it is difficult for any exchange-rate forecasting model to significantly outperform the RWH.[2] Most importantly to our purpose, Bilson (1981), Bilson and Hseih (1983), Huang (1984), and others, have shown that the economic theory relating interest-rate differences among countries to subsequent exchange rate changes (uncovered interest-rate parity) seems to have broken down during the recent float. As a consequence, exchange-rate changes are no later governed by international interest differentials. Hacche and Townsend (1981) and Meese and Rogoff (1983 a and b) have demonstrated that other plausible economic theories, such as purchasing power parity and the monetary model, also add little to random walk forecasts of exchange rates, at least at horizons of less than a year. These studies all reported strong rejections of uncovered interest-rate parity. Subsequent studies have confirmed these results.[3] There is also an active theoretical literature, which attempts to determine if the failure of uncovered interest parity is due to risk aversion or market segmentation rather than market inefficiency.[4] In contrast, Roll and Yan (2000) suggest that forward exchange rates are unbiased predictors of subsequent spot rates and there is really no forward premium puzzle. The puzzle arises because the forward rate, the spot rate, and the forward premium follow nearly non-stationary time series processes. These theological issues will not be addressed in this paper.

[2] See Mussa (1979), Meese and Singleton (1982) or Meese and Rogoff (1983 a and b), Baillie and Bollerslev (2000), Flood and Rose (2002), MacDonald (2002), and Chinn and Meredith (2004).
[3] Lewis (1995) and Engel (1996) provide a review of the literature on this topic.
[4] Fama (1984), Hodrick and Srivastava (1986) and Bekaert and Hodrick (1992).

If dollar exchange rates evolve as approximate random walks, the mean absolute percentage deviations between spot and future exchange rates (Table I) also represent the expected rates of return from following a random walk trading strategy of buying futures contracts on currencies that are selling at a discount to the spot price, and selling currency futures that are priced at a premium.[5] We compare these predicted profits to the actual profitability of random walk trading and find that during the last two decades of floating rates, on average only about one-third of the observed difference between spot and futures exchange rates has been justified by subsequent exchange rates changes. In short, the trading rule has continued to produce profits that appear disproportionate to their associated risks.

In section II we review the trading rule, and its economic foundations. Section III contains data description and examines the historical data. Sections IV extend the original analysis, considering more sophisticated ways of implementing the basic strategy. The concluding section discusses the implementations for hedgers and traders.

II. Research Methodology

II.1 Predicted and Actual Profits from Random Walk Trading

The trading strategies described in Section I are all based on the RWH-derived assumption that the current exchange rate is an approximately unbiased estimate of the future spot rate. If this is so, the expected profit from buying/selling a currency using a futures contract equals its associated discount/premium. This section compares the expected and actual rates of return realized by an investor who followed such a RWH-based strategy, using each of the six major currencies that typically sell at a significant discount or premium from the spot.

[5] This could also be called a contrarian strategy for the currency futures market, since currencies apparently expected to appreciate are sold, and those expected to depreciate are bought.

II.2 Random Walk Trading

Suppose that starting at time t, a spot foreign currency exchange rate evolves independently of its previous values, or of any economic variables that were observable at time t. In common parlance (if somewhat inaccurately), the exchange rate evolves as a random walk. We can easily derive the expression describing the profits from currency futures speculation if exchange rates evolve this way.

The profit or loss on a foreign exchange position (R_{t+1}) depends on the domestic interest rate, i_t, and the foreign interest rate, i_t^*, and also on the change in the exchange rate. The return to holding foreign exchange R_{t+1}, can be written

$$R_{t+1} = \frac{FX_{t+1}}{FX_t}\left(1+i_t^*\right)-\left(1+i_t\right). \tag{1}$$

It is convenient to rewrite this as

$$R_{t+1} = \frac{FX_{t+1}-FX_t}{FX_t}\left(1+i_t^*\right)+\left(i_t^*-i_t\right), \tag{2}$$

where FX_{t+1} is the spot rate at next time period and FX_t is the spot rate at this time period. The spot rate is quoted as domestic currency per unit of foreign currency. The first term on the right hand side is the capital gain or loss associated with exchange rate changes and it depends on the percentage change in the exchange rate, and on the quantity of foreign exchange rate owned. The latter, in turn, depends on the foreign interest rate, i^*. The second sum on the right hand side, (i^*-i), is often called the *carry* on the trade. It represents the interest income or expense associated with (i) borrowing the domestic currency, and (ii) lending the foreign currency out. When the foreign rate exceeds the domestic rate, buying foreign currency is called a *positive*

carry trade. When the foreign currency interest rate is less than the domestic rate, buying foreign currency is a *negative carry*.

If exchange rates evolve as different random walks, the expected change in the exchange rate is zero. Then the expected return equals the carry. To put it succinctly, $E\left(R_{t+1}\right)=i^{*}-i$. There is an economic theory, the *uncovered interest parity* hypothesis that asserts you cannot treat the spot exchange rate as being a simple, driftless random walk. Instead, according to uncovered parity, on average, the capital gain or loss associated with foreign exchange rate changes will just offset the carry. Or, to put it more succinctly, $E\left(R_{t+1}\right)=0$, because $\left(1+i_t^{*}\right)\left(FX_{t+1}-FX_t\right)\big/FX_t$ equals $-\left(i^{*}-i\right)$. If this is correct, then a speculator who buys the higher interest currency and funds herself in the lower interest currency, will not earn profits (except by chance) even though the carry on her position is positive. We can test this by estimating b in the following regression equation,

$$R_{t+1}=a+b(i_t^{*}-i_t)+u_t, \tag{3}$$

where a and b are parameters and u_t is a normally distributed random error term. The left hand side represents the actual rate of return from the purchase of a currency futures contract. The right hand side variable represents the expected profit if the RWH is correct. Thus equation (3) compares the RWH-predicted profits from holding a currency contract during the quarter preceding its expiration, to the profit actually realized by following that strategy. According to the RWH, $b=1$ or exchange rate changes are unrelated to spreads; according to the uncovered interest parity condition, $b=0$ and then there are no profits to be made using the random walk trading rule, except by chance.

III. Data Description

We collected quarterly future and spot prices from Commodity Research Bureau (CRB) InfoTech CD. Our samples are from the first quarter of 1984 to the fourth quarter of 2003 and for British pound, Euro, Swiss franc, Canadian dollar, Australian dollar, and Japanese yen. All prices are quoted per US dollar. The French franc was dropped, as it vanished on Jan 1, 2000 when the Euro came into existence. The Euro is treated as the successor currency for the Deutsche mark. Despite ample empirical evidence advancing the random walk model as the best tool available for forecasting dollar exchange rates, for most currencies, IMM futures prices seldom equal the contemporaneous spot exchange rates. Table I shows the mean absolute percentage deviations between spot and the futures exchange rates, at a quarterly horizon, over the 1984-2003 periods. The differences have been substantial for all currencies.

The regression statistics, in each case estimated using all available data from 1984-2003, are summarized in Table II. As predicted, the estimated slope coefficients are generally close to zero. Unfortunately, the low coefficients of determination and the high standard errors of the estimated slope terms demonstrate that the Ordinary Least Squares (OLS) estimates are imprecise. For four of the six currencies the regression estimates are not powerful enough to decisively reject either hypothesis-random walk or unbiasness – in favor of the other. However, it is fair to say that the weight of the evidence presented in Table II favors the RWH. Uncovered interest parity can be rejected in favor of the RWH for one of the currencies, the Japanese yen. In contrast, RWH can be rejected in favor of uncovered interest parity for the Canadian dollar. The British pound, Euro, Swiss franc, and Australian dollar are not rejected for both hypotheses.

Zellner's Seemingly Unrelated Regression (SUR) procedure will yield more precise estimates of the parameter values if the u_t from Equation (1) are contemporaneously correlated

across different currencies. It is likely that the error terms for various currencies are related. First, changes in any dollar exchange rate can be imagined to result from real and monetary disturbances in either the US or the foreign country. Since all exchange rates are expressed here in terms of the dollar, disturbances originating in the US will influence them all.

Equation (1) was re-estimated using SUR over the 69 observations common to all of the six currencies, which yielded 414 pooled data points. The SUR results in Table III show that all of the beta coefficients are greater than unity and all are significantly greater than zero at standard levels of statistical significance. Uncovered interest parity can be rejected in favor of RWH. These results confirm the early studies of Hansen and Hodrick (1980), Bilson (1981), and Fama (1984) and the many subsequent studies of the uncovered interest rate parity condition. A joint test of the hypothesis that all of the regression coefficients are zero is firmly rejected with this data. The fact that the regression coefficient is greater than unity means that the expected return from this strategy exceeds the interest rate differential. In other words, the trader not only benefits from the higher foreign interest rate (dividend yield) but also from the appreciation of the exchange rate against the dollar (the capital gain.) When the foreign interest rate is below the US rate, the trader will borrow the foreign currency and invest in dollars. Since the regression coefficient is greater than unity, this strategy will also benefit from a dividend yield and the appreciation of the dollar against the foreign currency.

Unfortunately, even using SUR the estimates of slope remained imprecise. To secure a further gain in efficiency, Equation (1) was re-estimated using the SUR procedure while constraining the estimated slope terms to be equal for all six currencies. The result was

$$R_{t+1} = \underset{[0.0075]}{0.012} + \underset{[0.27]}{0.61}\ (i_t^* - i_t) + u_t, \tag{4}$$

where standard error of coefficient is reported in the bracket under each coefficient. As was the case twenty years ago, the regression result is inconsistent with uncovered interest rate parity ($b = 0$), but consistent with the random walk hypothesis ($b = 1$ and $a = 0$). The failure of the uncovered interest parity to hold is one of the great puzzles in international finance.[6] According to this regression, in an average quarter, exchange rates moved by approximately 39% of the amount indicated by the futures-market discount or premium; therefore, on average 61% of the quarterly discount or premium has not been justified by subsequent exchange-rate changes. This makes us optimistic that the random walk trading rule may have continued to work after it was published in 1986. To confirm this, we have examined the profitability of the trading rule.

IV. Simulated trading results

For many economists and for all investors, the profitability of trading rules is likely to be more persuasive than that of regression statistics. This section simulates two random walk currency future trading rules over all available data from the 1984-2003 period. The trading rule is simple: compare the spot exchange rate to the futures price of the same currency. If the foreign currency futures contract trades at a premium (respectively, a discount) to the spot exchange rate, then the trading rule sells (respectively, buys) it. This is equivalent to buying foreign currencies where the short-term interest rate is greater than the corresponding US short-term rate. All trades occur as close as possible to the Friday, 13 weeks prior to contract expiration, at the daily settlement price. Each position is held for the entire 13 weeks, with no intermediate trading permissible. Thus, for each currency, four positions are taken each year, except in the unusual case where the spot and futures prices are identical. In this event, no trade is made for that currency in the quarter in question.

[6] Lewis (1995) discusses the forward parity puzzle.

Two versions of the trading rule are compared, differing in how portfolios of positions are sized. Both approaches to portfolios construction are naïve. In the first strategy, "equal-weighted," the investor's resources are divided equally among the six currencies. The resulting portfolio may be risky if the trading rule calls for simultaneously buying/simultaneously selling all or almost all of the foreign currencies. Then a general dollar rise/dollar decline could produce large losses. We assume the investor has $1M in capital available, and posts $0.15M in margin for each contract bought or sold. This gross over margining is to preclude any margin calls.

In the second trading rule, "square-dollar," the investor divides her resources equally between buying and selling foreign currencies. This is an attempt to insulate the portfolio's return from the general movement of dollar exchange rates. In each period, the total dollar value of currency the investor purchases for future delivery equals the dollar value of foreign currency she sells for future delivery. Accordingly, $0.5M is deployed to sell currency futures that are offered at a premium to spot, and $0.5M is allocated to buying foreign currency futures. If both buy and sell candidates are not available, then no position is taken. As before, margin of $0.15M is allocated to each contract. We assume the investor can buy or sell fractional currency futures contracts, and the brokerage fee is assumed to be $10 per contract bought or sold, or $20 per round trip. This strategy helps to show if the profits associated with random walk currency trading are exclusively associated with US dollar exchange rate change. Moreover, because dollar exchange rates have generally been more volatile over the past decade than cross exchange rates have, the second rule reduces the risk of currency futures trading from the perspective of a dollar-based investor.

The trading simulations that follow are based on the following assumptions:

(i) Each simulated position is opened 13 weeks before the final Friday on which the contract trades. Whenever possible, simulated foreign currency positions are opened and closed at Friday settlement prices. If these data are unavailable, settlement prices from the nearest available trading day are used. Each futures position is closed on the last Friday on which the contract trades. No mid-quarter trading is permitted.

(ii) In each quarter, futures contracts on a total of $1,000,000 of foreign currency are bought or sold, valued at the futures prices on the date the option is opened. This generally requires assuming that fractional contracts can be purchased. The rate of return computations assume that an investor posts $150,000, or 15%, of the initial dollar value of her position as margin. This represents approximately three times the required initial margin, and approximately five times the required maintenance margin, for the typical portfolio simulated. This relatively conservative strategy is chosen to avoid margin calls.

(iii) Normally, large account holders will satisfy 70-90% of their margin requirements by posting Treasury bills. The interest income they will earn is not generally accounted for in what follows; that is, the reported rates of return are based on trading profits only. Therefore, to find the approximate total return to capital invested in trading strategy, about 70-90% of the three month Treasury bill rate should be added to the reported trading profit.

(iv) Transaction costs are assumed to be $20 per round trip, per contract. This probably exaggerates their drag on trading profits. Currently, discount brokers typically charge retail customers as little as $8 for a round-trip trade.

In the first simulation, imaginary equal-dollar-valued positions are taken in each of the six currencies. The random walk strategy adopts a contrarian stance, selling “strong” and purchasing “weak” currencies. Foreign currency futures selling at discounts are always purchased, and those

selling at a premium are always sold. The resulting portfolio positions are shown for each quarter, 1984-2003, in Table IV. Often, Euro, Swiss franc, and Japanese yen are sold, while Australian dollar, Canadian dollars, and British pounds are purchased. That is, the futures markets often predicted that the Euro, Swiss franc, and Japanese yen will appreciate and the pound, Canadian dollar, and Australian dollar will depreciate, against the US dollar. A total of 465 trades are simulated; 274 or 59% are profitable. Each currency produces a cumulative profit over the twenty-year period. Table V shows the summary of the profit data. Gross trading profits total $622,060. After commission of $101,046, net profit is estimated to have been $521,014 or $6,513 per quarter. Based on an investment of $150,000, this represents an average annualized rate of return of 18.53%, exclusive of the interest earned on Treasury bills posted as margin.

Table VI shows the quarterly profits and losses earned in each currency and the portfolio's profit or loss. It is immediately obvious that the random walk strategy earned large profit after 1995, but that it sustained substantial losses during the mid to late 1980s. This pattern corresponds to the major US dollar movements in recent years; the dollar generally declined in the late 1980s and recovered from 1990 to 2000 and then has declined from 2000 until recently. This suggests that the trading rule may be sensitive to general dollar trends.

The second random walk trading rule is designed to show whether the profitability of the first resulted only from capturing the dollar "bull market" of 1990-1998. It accomplished this by constructing "square dollar" positions[7] – the investor's resources are equally divided between long and short dollar positions. The "square dollar" portfolio is both long and short of foreign currencies, so that the net dollar value of the portfolio is zero. In essence, the investor places a

[7] In a square dollar strategy an attempt is made to minimize risk. Half of the resources are invested in long contracts and half in short contracts. In theory, if something dramatic happens, this strategy would minimize any ill effects of a large move in either direction. Using a square dollar approach should theoretically be safer and reduce the chances for a margin call. This probably will be at the cost of a lower return. See Atkins and Basu (2003).

series of bets on how cross exchange rates – for example, the Euro/Swiss franc or British pound/Japanese yen rates – will evolve, rather than betting on the course of dollar exchange rates. This should substantially insulate the portfolio's return from general dollar exchange rate trends. Incidentally, it also should reduce the risk of random walk trading from a dollar-based investor's perspective.

The quarterly positions taken by the "square dollar" portfolio are also documented in Table IV. If a currency was bought and sold according to the first trading rule, then it was also bought and sold during the corresponding period by the "square dollar" rule. The scale of the overall portfolio – $1,000,000 worth of currency bought or sold – was also the same. Thus, the second trading rule differed from the first only in the division of resources among currency positions.

Table VII summarizes the "square dollar" trading results; the quarterly performance is presented in Table VIII. The "square dollar" portfolio simulated 465 trades involving 872 futures contracts. The portfolio produced a gross, twenty-year profit of $316,066 before estimated commissions of $87,203, or a net trading profit of $228,863. The average quarterly profit of $2,861 corresponds to an annualized rate of return of 7.85% (above Treasury bill interest rate). This is roughly less than half the rate of return registered by the equally-weighted portfolio (18.53%).[8] This suggests that the random walk strategy benefits from taking outright dollar positions, but that dollar exchange rate trends do not explain all of the observed profits. Betting against discounts or premia in futures-market cross exchange rates is also profitable from 1984-2003.

[8] The standard deviation of the square dollar strategy's profits was also three-fourth of that registered by the equally-weighted portfolio.

As can be seen, both trading rules produce cumulative profits during the approximately 20-year period that has elapsed since the trading rules were published. The first trading rule produces an information ratio (profit divided by standard deviation) of 26.0%. The second produced an information ratio of 17.6%. During the same period, a buy and hold position in the US stock market (the S&P 500 futures contracts) produced an information ratio of 16.0%, after allowing for $20 round trip commissions each quarter ($80/year per contract).

The final topic considered is the risk of the currency futures trading strategies. The discussion is complicated by two factors. First, the gross variability of the profit streams simulated above depends on the degree of leverage employed. The apparent risk of the strategies can be reduced by posting more than $150,000 per period in margin. More substantially, the analysis of the strategies is plagued by the difficulty of partitioning risking into their systematic and non-systematic components. Measuring systematic risk requires first identifying the market portfolio. US equity prices are commonly used in the finance literature as a proxy for the market portfolio. Despite the theoretical inadequacies of this approach, that practice is adopted in the followings:

Total returns to currency portfolios have been computed by adding 80% of the 30-day Treasury bill yield (applied to the assumed investment of $150,000 per period) to the trading profits. The return to holding US common stocks is measured by changes in the Standard and Poor's Index of 500 stock prices plus dividend yield. All returns are before taxes.

Table IX compares summary statistics on the returns and risks of four investments – the equally-weighted and square-dollar currency futures portfolios, common stocks, and the 30-day US Treasury bills, from the first quarter of 1984 through the fourth quarter of 2003. The equally-weighted currency futures portfolio is the riskiest investment of those considered, registering a

standard deviation of quarterly returns of almost 20%. The square dollar procedure reduces risk to 15%, approximately twice that of common stock. However, as the Table and accompanying Figure show, the investor is amply rewarded for bearing these risks. A line connecting the return/risk realization for investments in 30-days Treasury bills and the Standard and Poor's 500 stock index intersect a line connecting the return/risk for both currency portfolios at point A (Figure 1), which has the mean of 6.1% and standard deviation of 20.12%. At this point, the amount of investing capital is 103.87% in equally-weighted and –3.87% in square-dollar currency portfolios. The return/risk for both currency portfolios lies above the extension of a line connecting the return/risk realization for investments in 30-day Treasury bills and the Standard and Poor's 500 stock index after point A, or when we invest more than 103.87% in equally-weighted currency portfolio and the rest in square-dollar currency portfolio.[9] In conclusion, the return of S&P 500 and 30-day T-Bill combination falls below the portfolio of currency futures strategies when the investor shorts a little of the safer strategy (square dollar currency) and go long more than 100% of the riskier strategy (equally-weighted currency). Potentially more important than the gross variability of the currency portfolio' return streams are their correlations with returns to US common stock. The estimated correlation coefficients between the equally-weighted and the square-dollar returns and those to common stock investments are, respectively 16.75% and 18.09%. These low figures indicate that investors who hold US equity portfolios will have enjoyed substantial gains from diversifying using the currency portfolio simulated here.[10] (The trading rules themselves are correlated at 89.35%).

[9] Treasury bills and the Standard and Poor's index proxy for the risk-free rate and the rate of return on the market portfolio, respectively.

[10] The betas of the currency portfolios are estimated as 0.46 and 0.37 for the equally-weighted and square-dollar portfolios, respectively, with standard errors of 0.397 and 0.299. Accordingly, neither estimated beta is statistically significantly different from zero.

Suppose you have known in advance these means, volatilities and correlations; how will you have allocated your capital and risk efficiently between the three strategies to minimize variance of the portfolio? The minimal variance portfolio will allocate 79.69% to the stock market, –1.82% to equally-weighted currency trading, and 22.13% of its capital to square-dollar currency trading and the expected return of this portfolio will be equal to the mean quarterly return of S&P 500, which is 3.42%. Even though the stock market enjoyed a bull market of historic proportions, and even though these currency trading rules are simple and have been published within the futures trading community, currency trading is more attractive than investing in equities!

V. Conclusions

The simulations show that purchasing futures contracts on currencies priced at a discount and selling futures contracts priced at a premium has generally been a profitable trading strategy during the last two decades of floating exchange rates.

There are at least three reasonable interpretations of this result. First, futures market participants may have overestimated their ability to forecast exchange changes, producing unreasonable discounts and premia. A major objection to this interpretation is that it must assume that the currency futures markets were inefficient for an extended period. Violation of market efficiency is not necessary to explain the simulated trading results.

A second explanation postulates that, in equilibrium, the futures markets do not price currency for future delivery at the expected future spot exchange rate. Thus a portion of observed differences between spot and future exchange rates represents a risk premium. The major difficulty with this view is that it is unclear what factors are priced into this risk premium. Future

developments in international asset pricing models may confirm or deny this interpretation of these empirical results.

A third possibility is that the results reported are due only to chance, and that the random walk trading strategy profits will evaporate in the future. Given that the strategies in this paper were tested once before, two decades ago, and that they continue to work well, such an explanation seems unlikely; but unfortunately, it cannot be entirely ruled out.

The simulation results have important implications for those willing to suspend disbelief, and tentatively conclude that the currency futures markets may be inefficient. Hedgers – economic agents with natural foreign currency exposures – are one group that may find the simulation useful. Hedgers, who are naturally long "strong" currencies (i.e., those selling at premia), or naturally short "weak" currencies can have their cake and eat it too. Hedging, in this instance, involves selling currencies priced at a futures-market premium and buying those priced at a futures-market discount – a strategy that has been shown above to generally yield profits. Hence, the hedger is compensated, in an expected return sense, for reducing his foreign exchange risk.

Borrowers can also benefit. It has been demonstrated elsewhere that these currency-futures results can be interpreted as showing that borrowing in low-interest-rate countries and lending in high-interest-rate countries has generally been profitable over 1974-2003 period (Thomas, 1986 section 2-3). Borrowers have done better to borrow in "strong" (i.e., low interest rate) currencies; they have been well compensated for bearing the resulting exchange risk. Lenders did better favoring "weak" (high interest rate) currencies.

The results are of obvious interest to speculators. The trading rules described in the body of the article were deliberately naïve, since they were designed to demonstrate that the

foundation for a random walk trading strategy is secure. This would have been less clear if more complicated trading tactics were simulated. But even these simple strategies were profitable. More sophisticated trading rules are certainly conceivable. For example, there is evidence that the spectrum of exchange-rate changes is not quite white noise. Exchange rates do not evolve as true random walks. Instead, there are weak positive correlations among current and lagged historical exchange rate changes (Taylor, 1982). This suggests that local-trend following models may be useful devices for forecasting exchange rates. Such models can easily be grafted onto the basic trading strategy. In addition, risk-return efficient combinations of currency-futures positions can be constructed by using modern portfolio theory.

References

- Atkins, A.B., & Basu, S. (2003) "Profits from Currency Futures Based on The Random Walk Hypothesis", Working Paper, Northern Arizona University.
- Baillie, R.T., & Bollerslev, T. (2000) "The forward premium anomaly is not as bad as you think", Journal of International Money and Finance, Vol 19 No 4, pp. 471-488.
- Bekaert, G. & Hodrick, R. (1992) "Characterizing predictable components in excess returns on equity and foreign exchange markets", Journal of Political Economy, Vol 47 No 2, pp. 467-509.
- Bilson, J. (1981) "The speculative efficiency hypotheses", The Journal of Business, Vol 54 No 3, pp. 435-451.
- Bilson, J., & Hseih, D. (1983) "The profitability of currency speculation", Working paper, University of Chicago.
- Chinn, M., & Meredith, G. (2002), "Uncovered interest parity in crisis", IMF Staff Papers 49, pp. 252-266.
- Dooley, M.D. & Shafer, J.R. (1983), "Analysis of short run-exchange rate behaviors", International Financial Paper 123, Board of Governors of Federal Reserve System.
- Engel, C. (1996) "The Forward Discount Anomaly and the Risk Premium: A Survey of Recent Evidence", Journal of Empirical Finance, Vol 3 No 2, pp. 123-192.
- Fama, E. (1984) "Forward and spot exchange rates", Journal of Monetary and Economics, Vol 14 No 3, pp. 319-338.
- Flood, R. P. & Rose, A. (2002) "Uncovered Interest Parity in Crisis", IMF Staff Papers, No 49, pp. 252-266.

- Hacche, G. & Townsend, J. (1981) "Exchange rates and monetary policy: Modeling Sterling's effective exchange rate, 1972-1980", in Eltis, W. and Sinclair, P. (Eds.), The Money Supply and the Exchange Rate, Oxford University Press, Oxford.
- Hansen, L.P. & Hodrick, R. (1980) "Forward Exchange Rates as Optimal Predictors of Future Spot Rates: An Econometric Analysis", Journal of Political Economy, Vol 88 Issue 5, pp. 829-853.
- Hodrick, R. & Srivastava, S. (1986) "The covariation of risk premiums and expected future spot rates", Journal of International Money and Finance, Vol 5 Supplement, pp. 5-21.
- Huang, R.D. (1984) "Some alternate tests of foreign exchange rates as predictors of future spot rates", Journal of International Money and Finance, Vol 3 No 2, pp. 153-167.
- Lewis, K. (1995) "Puzzles in international finance", in Grossman, G. and Rogoff, K. (Eds.), Handbook of International Economics, pp. 1913-1949.
- MacDonald, R. (2000) "Expectations Formation and Risk in Three Financial Markets: Surveying What the Surveys Say", Journal of Economic Surveys, Vol 14 No 1, pp. 69-100.
- Meese, R.M., & Rogoff, K. (1983) "Empirical exchange rate models of the Seventies: Do they fit out of sample?", Journal of International Economics, Vol 14 No 1-2, pp. 3-24.
- Meese, R.M., & Rogoff, K. (1983) "The out-of-sample failure of empirical exchange rate models: Sampling error or misspecification?", in Frenkel, J.A. (Ed.), Exchange Rates and International Macroeconomics, University of Chicago Press, Chicago, Illinois.
- Meese, R.A., & Singleton, K.J. (1982) "On Unit Roots and the Empirical Modeling of Exchange Rates", Journal of Finance, Vol 37 No 4, pp. 1029-1035.
- Mussa, M. (1979) "Empirical regularities in the behavior of exchange rates and theories of the foreign exchange market", in Brunner, K. and Meltzer, A.H. (Eds.), Policies for Employment,

Prices, and Exchange Rates, pp. 9-57. Carnegie-Rochester Conference Series on Public Policy, II.

- Poole, W. (1967) "Speculative prices as random walks: An analysis of ten time series of flexible exchange rates", Southern Economic Journal, Vol 33 No 2, pp. 468-478.
- Roll, R. & Yan, S. (2000) "An explanation of the forward premium puzzle", European Financial Management, Vol 6 No 2, pp. 121-248.
- Samuelson, P. (1973) "A proof that properly anticipated prices vibrate randomly", Bell Journal of Economics, Vol 4 No 2, pp. 369-374.
- Taylor, S. (1982) "Tests of the random walk hypothesis against a price trend hypothesis", Journal of Financial and Quantitative Analysis, Vol 17, pp. 37-61.
- Thomas, L.R. (1986) "Random walk profits in currency futures trading", Journal of Futures Markets, Vol 6 No 1, pp. 109-126.

Table I

Mean Absolute Percent Differences between Spot and Futures Market Exchange Rates (Annualized, 1984-2003)

This Table reports mean absolute percent differences between spot and futures market exchange rate. There are 465 samples from the first quarter of 1984 to the fourth quarter of 2003 for Euro, British pound, Australian Dollar, Swiss franc, Japanese yen, and Canadian Dollar. All prices are quoted as US dollar per one unit of foreign currency. Standard deviations are reported under mean absolute differences between spot and future exchange rates.

Currency	Mean Absolute Differences between Spot and Future Exchange Rates (%)	Number of Observations
Euro	2.69	79
	-0.76	
British Pound	2.46	80
	-0.99	
Australian Dollar	2.26	67
	-1.16	
Swiss Franc	2.92	80
	-0.82	
Japanese Yen	3.23	80
	-1.01	
Canadian Dollar	1.62	79
	-0.6	

Table II

OLS Regression Statistics Testing for Random Walk Hypothesis

This table reports OLS regressions of returns of holding foreign exchange on the difference between foreign interest rate (i^*) and US interest rate (i). Return of holding foreign exchange is

$$R_{t+1} = \frac{FX_{t+1} - FX_t}{FX_t}\left(1 + i_t^*\right) + \left(i_t^* - i_t\right),$$

where FX_{t+1} is spot rate at next time period and FX_t is spot rate at this time period. There are 465 samples from the first quarter of 1984 to the fourth quarter of 2003 for Euro, British pound, Australian Dollar, Swiss franc, Japanese yen, and Canadian Dollar. All prices are quoted as US dollar per one unit of foreign currency. The regression model is

$$R_{t+1} = a + b(i_t^* - i_t) + u_t,$$

where R_{t+1} is the dependent variable for foreign currency at quarter $t+1$, a and b are intercept and slope respectively, and u_t is a normally-distributed random error term. Hansen's heteroscadasticity consistent estimator of the covariance matrix is shown under each coefficient. Asymptotic Standard errors are presented beneath coefficients. *** Indicates statistical significance at the 1% level. ** Indicates statistical significance at the 5% level. * Indicates statistical significance at the 10% level.

Currency	Estimated Value of the intercept *a*	Estimated Value of the slope *b*	Adjusted R-Square	Number of Observations
Euro	0.0125	0.33	0.04	79
	-0.0123	-1		
British Pound	0.0234	0.71	0.06	80
	-0.0139	-1.35		
Australian Dollar	0.0271*	1.72*	0.02	67
	-0.0137	-0.96		
Swiss Franc	-0.0142	2.39*	0.14	80
	-0.0175	-1.33		
Japanese Yen	-0.0036	2.93**	0.07	80
	-0.0023	-1.26		
Canadian Dollar	0.0086	0.68	0.08	79
	-0.0064	-0.52		

Table III

Seemingly Unrelated Regression Statistics Testing for Random Walk Hypothesis

This table reports Seemingly Unrelated Regressions of returns of holding foreign exchange on the difference between foreign interest rate (i^*) and US interest rate (i). Return of holding foreign exchange is

$$R_{t+1} = \frac{FX_{t+1} - FX_t}{FX_t}\left(1 + i_t^*\right) + \left(i_t^* - i_t\right),$$

where FX_{t+1} is spot rate at next time period and FX_t is spot rate at this time period. There are 465 samples from the first quarter of 1984 to the fourth quarter of 2003 and for British pound, Euro, Swiss franc, Canadian dollar, Australian dollar, and Japanese yen. All prices are quoted as US dollar per one unit of foreign currency. The regression model is

$$R_{t+1} = a + b(i_t^* - i_t) + u_t,$$

where R_{t+1} is the dependent variable for foreign currency at quarter $t+1$, a and b are intercept and slope respectively, and u_t is a normally-distributed random error term. Hansen's heteroscadasticity consistent estimator of the covariance matrix is shown under each coefficient. Asymptotic Standard errors are presented beneath coefficients. *** Indicates statistical significance at the 1% level. ** Indicates statistical significance at the 5% level. * Indicates statistical significance at the 10% level.

Currency	Estimated Value of the intercept *a*	Estimated Value of the slope *b*	Adjusted R-Square	Number of Observations
Euro	0.0123	1.92***	0.02	79
	-0.0119	-0.41		
British Pound	0.0194	2.19**	0.06	80
	-0.0135	-0.99		
Australian Dollar	0.0191*	1.05*	0.05	67
	-0.0102	-0.56		
Swiss Franc	-0.0192	2.07**	0.19	80
	-0.0143	-0.89		
Japanese Yen	-0.0226	1.87*	0.07	80
	-0.0177	-1.04		
Canadian Dollar	0.0083	1.46**	0.15	79
	-0.0054	-0.55		

Table IV
Positions Taken

This table shows the number of future contracts traded based on equally-weighted currency and square-dollar positions in each of the six currencies. The random walk strategy adopts a contrarian stance, selling "strong" and purchasing "weak" currencies. Foreign currency futures selling at discounts were always purchased, and those selling at a premium were always sold. Equal presents equally-weighted currency strategy, which is implemented by investing equally in all six currencies and Square presents square-dollar strategy, which is implemented by investing resources equally divided between long and short dollar positions. The resulting portfolio positions are shown for each quarter, 1984-2003.

Contract	British Pound		Euro		Canadian Dollar		Australian Dollar		Japanese Yen		Swiss Franc	
	Equal	Square	Equal	Square	Equal	Square	Equal	Square	Equal	Square	Equal	Square
03/16/84	-2.26	-1.13	-4.44	-2.22	-2.50	-1.25			-3.77	-1.88	-3.54	-1.77
06/15/84	-2.21	-1.38	-4.20	-2.63	2.54	6.35			-3.62	-2.26	-3.45	-2.16
09/14/84	-2.32	-1.16	-4.39	-2.20	-2.60	-1.30			-3.73	-1.86	-3.65	-1.83
12/14/84	-3.17	-1.58	-6.08	-3.04					-4.92	-2.46	-5.02	-2.51
03/15/85	2.68	3.35	-4.94	-4.12	2.64	3.30			-3.96	-3.30	-4.07	-3.39
06/14/85	2.95	3.69	-5.41	-4.50	2.77	3.47			-4.18	-3.48	-4.61	-3.84
09/13/85	2.50	3.13	-4.90	-4.08	2.74	3.42			-3.98	-3.32	-4.12	-3.43
12/13/85	2.41	3.01	-4.65	-3.87	2.75	3.43			-3.86	-3.22	-3.84	-3.20
03/14/86	2.23	2.79	-4.04	-3.36	2.78	3.48			-3.25	-2.71	-3.37	-2.81
06/13/86	2.18	2.72	-3.63	-3.02	2.78	3.48			-2.83	-2.36	-3.05	-2.54
09/12/86	2.10	2.63	-3.54	-2.95	2.77	3.46			-2.64	-2.20	-2.92	-2.43
12/12/86	2.17	2.71	-3.30	-2.75	2.77	3.47			-2.49	-2.07	-2.67	-2.23
03/13/87	2.24	2.80	-3.22	-2.68	2.76	3.45			-2.61	-2.17	-2.71	-2.26
06/12/87	1.69	1.69	-2.47	-2.47	2.20	2.20	2.46	2.46	-2.03	-2.03	-2.07	-2.07
09/11/87	1.61	1.61	-2.41	-2.41	2.24	2.24	2.32	2.32	-1.92	-1.92	-2.00	-2.00
12/11/87	1.62	1.62	-2.41	-2.41	2.20	2.20	2.29	2.29	-1.92	-1.92	-2.00	-2.00
03/11/88	1.45	1.45	-2.18	-2.18	2.18	2.18	2.34	2.34	-1.71	-1.71	-1.77	-1.77
06/10/88	1.44	1.44	-2.21	-2.21	2.10	2.10	2.28	2.28	-1.70	-1.70	-1.83	-1.83
09/16/88	1.47	1.47	-2.29	-2.29	2.03	2.03	2.07	2.07	-1.67	-1.67	-1.92	-1.92
12/16/88	1.59	1.59	-2.49	-2.49	2.04	2.04	2.10	2.10	-1.79	-1.79	-2.11	-2.11
03/10/89	1.47	1.47	-2.34	-2.34	2.01	2.01	1.97	1.97	-1.65	-1.65	-1.98	-1.98
06/16/89	1.55	1.55	-2.48	-2.48	2.00	2.00	2.03	2.03	-1.73	-1.73	-2.12	-2.12
09/15/89	1.73	1.73	-2.64	-2.64	2.00	2.00	2.22	2.22	-1.93	-1.93	-2.28	-2.28
12/15/89	1.70	1.70	-2.62	-2.62	1.97	1.97	2.15	2.15	-1.95	-1.95	-2.26	-2.26
03/16/90	2.00	1.25			2.32	1.45	2.55	1.60	-2.31	-5.76	2.48	1.55
06/15/90	1.65	1.24	-2.27	-3.40	1.97	1.48	2.21	1.66	-2.04	-3.05	2.01	1.51
09/14/90	1.56	1.56	-2.25	-2.25	1.95	1.95	2.15	2.15	-2.05	-2.05	-1.91	-1.91
12/14/90	1.41	0.84	-2.09	-6.28	1.94	1.16	2.02	1.21	1.82	1.09	1.73	1.04
03/15/91	1.38	0.69	1.98	0.99	1.93	0.97	2.17	1.09	1.77	0.89	1.70	0.85
06/14/91	1.46	0.73	2.14	1.07	1.93	0.96	2.17	1.08	1.84	0.92	1.86	0.93
09/13/91	1.63	0.82	2.39	1.20	1.91	0.95	2.21	1.10	1.88	0.94	2.05	1.03
12/13/91	1.54	0.77	2.25	1.13	1.89	0.95	2.09	1.05	1.79	0.89	1.97	0.99
03/11/92	1.47	0.74	2.12	1.06	1.90	0.95	2.16	1.08	1.72	0.86	1.87	0.94
06/12/92	1.56	0.78	2.23	1.11	2.00	1.00	2.21	1.10	1.78	0.89	2.01	1.01
09/11/92	1.44	0.72	2.10	1.05	1.98	0.99	2.20	1.10	1.69	0.84	1.90	0.95
12/11/92	1.39	0.69	1.94	0.97	2.03	1.01	2.29	1.15	1.66	0.83	1.72	0.86
03/12/93	1.71	1.03	2.11	1.26	2.12	1.27	2.42	1.45	-1.65	-4.96	1.88	1.13
06/11/93	1.86	0.93	2.22	1.11	2.07	1.04	2.34	1.17	1.57	0.79	2.03	1.01
09/10/93	1.75	1.05	2.18	1.31	2.13	1.28	2.47	1.48	-1.42	-4.25	1.94	1.16
12/10/93	1.72	0.86	2.13	1.06	2.19	1.10	2.57	1.28	1.41	0.71	1.86	0.93
03/11/94	1.78	1.07	2.26	1.36	2.22	1.33	2.48	1.49	-1.46	-4.37	1.94	1.16
06/10/94	1.78	1.07	2.24	1.35	2.27	1.36	2.33	1.40	-1.40	-4.20	1.90	1.14
09/16/94	1.77	1.33	2.22	1.67	2.29	1.72	2.27	1.70	-1.38	-2.07	-1.88	-2.81
12/16/94	1.69	1.69	-2.06	-2.06	2.25	2.25	2.24	2.24	-1.32	-1.32	-1.71	-1.71
03/10/95	-1.71	-1.28	-2.10	-1.57	2.32	3.48	2.15	3.23	-1.34	-1.00	-1.78	-1.33
06/16/95	1.70	1.70	-1.89	-1.89	2.35	2.35	2.24	2.24	-1.21	-1.21	-1.58	-1.58

Table IV (Continued)

Contract	British Pound		Euro		Canadian Dollar		Australian Dollar		Japanese Yen		Swiss Franc	
	Equal	Square	Equal	Square	Equal	Square		Equal	Square	Equal	Square	Equal
09/15/95	1.66	1.66	-1.87	-1.87	2.30	2.30	2.29	2.29	-1.13	-1.13	-1.55	-1.55
12/15/95	1.72	1.72	-1.96	-1.96	2.24	2.24	2.21	2.21	-1.39	-1.39	-1.61	-1.61
03/15/96	1.74	1.74	-1.92	-1.92	2.29	2.29	2.24	2.24	-1.36	-1.36	-1.55	-1.55
06/14/96	1.74	2.62	-1.96	-1.47	-2.27	-1.71	2.15	3.23	-1.41	-1.06	-1.58	-1.19
09/13/96	1.74	2.60	-2.04	-1.53	-2.28	-1.71	2.10	3.15	-1.46	-1.09	-1.68	-1.26
12/13/96	1.71	2.57	-2.02	-1.51	-2.28	-1.71	2.11	3.16	-1.47	-1.10	-1.66	-1.24
03/14/97	1.61	2.42	-2.07	-1.55	-2.27	-1.70	2.11	3.16	-1.52	-1.14	-1.77	-1.32
06/13/97	1.67	2.50	-2.26	-1.70	-2.28	-1.71	2.08	3.12	-1.65	-1.23	-1.94	-1.46
09/12/97	1.63	4.89	-2.32	-1.39	-2.30	-1.38	-2.22	-1.33	-1.53	-0.92	-1.93	-1.16
12/12/97	1.66	4.98	-2.36	-1.42	-2.32	-1.39	-2.31	-1.39	-1.61	-0.97	-1.95	-1.17
03/13/98	1.62	4.85	-2.37	-1.42	-2.37	-1.42	-2.52	-1.51	-1.74	-1.04	-1.92	-1.15
06/12/98	1.60	4.79	-2.43	-1.46	-2.36	-1.41	-2.47	-1.48	-1.71	-1.02	-1.96	-1.18
09/11/98	1.63	4.90	-2.41	-1.45	-2.45	-1.47	-2.84	-1.70	-1.93	-1.16	-2.00	-1.20
12/11/98	1.59	4.78	-2.26	-1.36	-2.52	-1.51	-2.78	-1.67	-1.74	-1.05	-1.85	-1.11
03/12/99	1.58	4.74	-2.20	-1.32	-2.57	-1.54	-2.69	-1.61	-1.55	-0.93	-1.77	-1.06
06/11/99	1.63	4.90	-1.22	-0.73	-2.54	-1.52	-2.62	-1.57	-1.58	-0.95	-1.95	-1.17
09/10/99	-1.65	-0.82	-1.27	-0.63	-2.44	-1.22	-2.51	-1.25	-1.57	-0.79	-2.02	-1.01
12/10/99	-1.65	-0.82	-1.29	-0.64	-2.46	-1.23	-2.56	-1.28	-1.45	-0.73	-2.07	-1.03
03/10/00	-1.65	-0.82	-1.32	-0.66	-2.46	-1.23	-2.62	-1.31	-1.36	-0.68	-2.11	-1.05
06/16/00	-1.69	-0.85	-1.38	-0.69	-2.43	-1.22	-2.71	-1.36	-1.42	-0.71	-2.23	-1.11
09/15/00	-1.76	-0.88	-1.38	-0.69	-2.44	-1.22	-2.75	-1.38	-1.42	-0.71	-2.16	-1.08
12/15/00	-1.91	-0.95	-1.56	-0.78	-2.47	-1.24	-3.06	-1.53	-1.43	-0.71	-2.38	-1.19
03/16/01	-1.81	-1.08	-1.49	-0.89	-2.53	-1.52	3.06	9.17	-1.50	-0.90	-2.24	-1.35
06/15/01	1.86	1.86	1.49	1.49	-2.61	-2.61	3.37	3.37	-1.64	-1.64	-2.28	-2.28
09/14/01	1.90	1.90	1.55	1.55	2.54	-2.54	-3.18	-3.18	-1.64	-1.64	-2.37	-2.37
12/14/01	1.81	1.81	-1.45	-1.45	2.61	-2.61	3.24	3.24	-1.57	-1.57	-2.16	-2.16
03/15/02	1.83	1.38	1.47	1.11	2.60	-1.95	3.21	2.41	-1.70	-2.55	-2.17	-3.26
06/14/02	1.87	1.40	1.51	1.13	2.64	-1.98	3.17	2.38	-1.72	-2.58	-2.21	-3.32
09/13/02	1.81	1.35	1.41	1.06	2.58	-1.93	2.97	2.23	-1.65	-2.48	-2.08	-3.12
12/13/02	1.72	1.29	1.37	1.03	2.63	-1.97	3.03	2.27	-1.62	-2.44	-2.01	-3.02
03/14/03	1.68	1.26	1.30	0.98	2.60	-1.95	2.95	2.21	-1.61	-2.41	-1.92	-2.89
06/13/03	1.68	1.26	1.24	0.93	2.46	-1.84	2.78	2.09	-1.58	-2.37	-1.82	-2.73
09/12/03	1.60	1.20	1.12	0.84	2.22	-1.67	2.49	1.87	-1.57	-2.35	-1.73	-2.60
12/12/03	1.66	1.25	1.18	0.89	2.27	-1.71	2.52	1.89	-1.56	-2.35	-1.84	-2.76
Total Contracts	**142.79**	**151.10**	**186.91**	**144.62**	**183.99**	**152.48**	**164.09**	**136.51**	**155.13**	**144.34**	**177.54**	**142.97**

Table V

Equally-Weighted Portfolio Profit Summary

This table presents the number of trades, number of profitable trades, number of futures contracts traded, and cumulative profits in each of the six currencies from 1984-2003 based on equal-dollar-valued. The random walk strategy adopts a contrarian stance, selling "strong" and purchasing "weak" currencies. Foreign currency futures selling at discounts were always purchased, and those selling at a premium were always sold. Equally-weighted currency strategy is implemented by investing equally in all six currencies.

Currency	Number of Trades	Number of Profitable Trades	Number of Futures Contracts Traded	Cumulative Profits
British Pound	80	49	142.79	235,559.67
Euro	79	45	186.91	87,207.08
Canadian Dollar	79	53	183.99	91,222.65
Australian Dollar	67	42	164.09	214,902.68
Japanese Yen	80	42	155.13	10,379.29
Swiss Franc	80	43	177.54	-17,211.08
All	465	274	1,010.46	622,060.29

Table VI
Quarterly Profits
Equally-Weighted Portfolio Strategy

This table shows the quarterly profits in each of the six currencies based on equal-dollar-valued positions. The random walk strategy adopts a contrarian stance, selling "strong" and purchasing "weak" currencies. Foreign currency futures selling at discounts were always purchased, and those selling at a premium were always sold. Equally-weighted currency strategy is implemented by investing equally in all six currencies. The resulting portfolio positions are shown for each quarter, 1984-2003. Cumulative profit and loss is profit and loss accumulated over time.

Contract Month	British Pound	Euro	Canadian Dollar	Australian Dollar	Japanese Yen	Swiss Fran	Portfolio Profit/Loss	Cumulative Profit/Loss
03/16/84	230	-7,374	2,769	0	-5,014	-1,527	-10,916	-10,916
06/15/84	8,497	8,881	-3,832	0	6,535	11,515	31,597	20,681
09/14/84	14,725	18,268	1,669	0	10,589	17,904	63,155	83,836
12/14/84	9,278	5,138	0	0	3,396	5,230	23,042	106,879
03/15/85	-15,577	16,116	-7,334	0	9,674	21,033	23,912	130,791
06/14/85	33,006	-16,124	3,113	0	-6,824	-18,847	-5,675	125,116
09/13/85	8,412	-8,323	160	0	-4,091	-11,205	-15,047	110,069
12/13/85	14,378	-23,071	-1,743	0	-31,135	-20,888	-62,459	47,610
03/14/86	5,331	-17,935	558	0	-24,755	-16,649	-53,450	-5,840
06/13/86	8,084	-2,428	2,290	0	-10,444	-5,398	-7,897	-13,737
09/12/86	-3,963	-11,087	93	0	-9,577	-14,602	-39,136	-52,873
12/12/86	-3,929	-3,417	2,140	0	8,180	2,824	5,798	-47,075
03/13/87	19,313	-13,689	7,966	0	-10,945	-13,870	-11,225	-58,300
06/12/87	9,716	-2,636	-2,052	13,881	-8,777	-4,939	5,192	-53,109
09/11/87	-456	2,784	3,251	5,212	1,640	1,437	13,868	-39,240
12/11/87	20,987	-16,359	2,318	-1,847	-18,852	-19,698	-33,451	-72,691
03/11/88	1,770	4,837	6,783	6,356	318	6,835	26,898	-45,793
06/10/88	-2,618	7,244	5,786	18,952	-2,003	9,884	37,245	-8,547
09/16/88	-12,502	15,017	306	-272	12,859	17,053	32,461	23,913
12/16/88	15,646	-9,190	3,647	13,160	-12,112	-9,145	2,005	25,918
03/10/89	-7,907	10,437	1,127	-3,182	8,710	12,698	21,882	47,801
06/16/89	-16,149	11,521	1,065	-11,945	19,784	13,767	18,042	65,843
09/15/89	5,755	-984	2,977	9,583	2,577	-1,503	18,405	84,248
12/15/89	5,074	-22,222	5,101	4,712	-144	-14,097	-21,577	62,671
03/16/90	4,243	0	-1,658	-2,333	10,066	4,443	14,761	77,432
06/15/90	12,174	-990	3,609	7,940	1,702	9,195	33,629	111,061
09/14/90	21,192	-12,825	2,966	13,529	-20,245	-18,003	-13,386	97,675
12/14/90	5,983	-9,252	2,808	-10,178	4,864	2,482	-3,293	94,383
03/15/91	-7,261	-11,939	2,087	2,376	-5,350	-13,590	-33,677	60,706
06/14/91	-15,229	-16,297	3,322	-768	-2,972	-14,926	-46,871	13,835
09/13/91	12,401	12,019	2,012	10,756	9,162	7,863	54,214	68,049
12/13/91	9,941	11,682	324	-4,162	6,826	9,864	34,475	102,523
03/13/92	-7,509	-5,849	-6,555	-1,551	-5,243	-10,223	-36,931	65,592
06/12/92	16,704	12,032	2,212	2,133	9,409	11,386	53,876	119,468
09/11/92	8,956	17,547	-2,632	-6,199	3,382	20,716	41,768	161,237
12/11/92	-29,065	-11,307	-6,742	-7,243	768	-12,582	-66,172	95,065
03/12/93	-11,960	-6,271	5,796	6,016	-8,224	-11,037	-25,680	69,385
06/11/93	11,544	4,713	-3,546	-6,704	18,862	8,289	33,157	102,542
09/10/93	4,453	6,039	-3,305	-5,720	336	8,345	10,148	112,690
12/10/93	-5,123	-8,455	-1,232	6,464	-4,477	-6,654	-19,476	93,213
03/11/94	1,457	2,420	-3,618	10,821	-5,837	4,080	9,324	102,537
06/10/94	1,516	2,624	-1,454	5,314	-1,640	2,206	8,566	111,104
09/16/94	8,229	13,599	3,750	2,474	-6,847	-16,213	4,993	116,097
12/16/94	-1,921	3,035	-4,932	7,083	3,226	6,827	13,316	129,413
03/10/95	-619	-17,937	-1,441	-5,912	-14,923	-20,022	-60,854	68,559
06/16/95	4,474	-1,318	3,651	-2,744	-10,783	-1,899	-8,618	59,941

Table VI (Continued)

Contract Month	British Pound	Euro	Canadian Dollar	Australian Dollar	Japanese Yen	Swiss Fran	Portfolio Profit/Loss	Cumulative Profit/Loss
09/15/95	-5,713	8,744	2,426	7,688	32,625	7,400	53,170	113,111
12/15/95	-970	-2,689	-3,320	-1,801	-786	-4,972	-14,539	98,572
03/15/96	-413	3,927	1,237	7,876	8,008	4,763	25,398	123,970
06/14/96	742	6,857	91	5,068	7,003	10,700	30,461	154,430
09/13/96	2,281	-633	999	359	4,112	-541	6,578	161,008
12/13/96	10,894	5,315	-250	676	7,107	11,440	35,181	196,190
03/14/97	-5,184	14,627	1,332	1,391	14,749	16,509	43,424	239,614
06/13/97	3,920	5,193	2,849	-9,664	-10,047	48	-7,702	231,912
09/12/97	-2,756	4,030	2,583	6,588	10,374	3,878	24,697	256,609
12/12/97	5,230	1,613	4,135	14,257	14,124	-1,085	38,275	294,884
03/13/98	2,638	4,624	-449	-3,494	-557	6,231	8,992	303,876
06/12/98	-2,929	-90	6,766	22,117	20,720	4,428	51,012	354,889
09/11/98	4,904	-10,096	4,988	-3,401	-15,128	-11,316	-30,049	324,840
12/11/98	2,623	-3,906	3,176	-5,493	-18,401	-6,337	-28,338	296,502
03/12/99	-5,496	14,292	-1,849	-3,970	5,513	17,282	25,773	322,275
06/11/99	-1,166	6,635	-7,112	-7,383	939	6,732	-1,355	320,920
09/10/99	-62	3,959	1,728	3,433	-11,827	5,794	3,025	323,945
12/10/99	-165	4,905	638	4,241	-8,230	4,836	6,226	330,171
03/10/00	4,644	9,126	-1,719	5,733	8,400	10,689	36,872	367,043
06/16/00	6,553	584	1,140	2,302	2,733	-4,083	9,229	376,273
09/15/00	13,003	19,823	2,732	16,998	4,404	17,006	73,966	450,239
12/15/00	-8,826	-7,151	5,084	793	10,192	-8,787	-8,695	441,544
03/16/01	5,550	408	5,238	-15,377	16,262	4,363	16,444	457,988
06/15/01	-2,524	-6,359	-3,340	10,868	2,247	6,768	7,660	465,648
09/14/01	8,477	12,594	-4,605	3,304	-6,972	-15,835	-3,036	462,612
12/14/01	-1,251	3,377	366	2,179	14,558	810	20,039	482,651
03/15/02	-2,696	-3,532	-2,602	3,034	3,041	2,877	122	482,774
06/14/02	7,133	12,590	3,988	12,089	-5,843	-10,211	19,746	502,520
09/13/02	9,534	5,469	-3,255	-1,619	-2,470	-5,375	2,284	504,804
12/13/02	4,900	9,326	2,966	5,491	-888	-6,973	14,823	519,627
03/14/03	485	9,129	9,684	11,405	-2,521	-9,251	18,931	538,558
06/13/03	10,329	18,152	17,807	21,223	-825	-8,313	58,373	596,931
09/12/03	-5,778	-7,675	-2,840	-176	429	10,041	-5,998	590,933
12/12/03	15,966	15,368	7,030	22,161	-14,311	-15,087	31,127	622,060
Total	**235,560**	**87,207**	**91,223**	**214,903**	**10,379**	**-17,211**	**622,060**	**14,869,684**

Table VII

Square-Dollar Portfolio Profit Summary

This table shows the number of trades, number of profitable trades, number of contracts traded, and cumulative profits in Euro, British Pound, Canadian Dollar, Swiss Franc, Japanese Yen, and Australian Dollar from 1984-2003 based on square-dollar strategy. The random walk strategy adopts a contrarian stance, selling "strong" and purchasing "weak" currencies. Foreign currency futures selling at discounts were always purchased, and those selling at a premium were always sold. Square-dollar strategy is implemented by investing resources equally divided between long and short dollar positions.

Currency	Number of Trades	Number of Profitable Trades	Number of Contracts Traded	Cumulative Profits
Euro	80	49	151.10	246,054.60
British Pound	79	45	144.62	12,259.81
Canadian Dollar	79	53	152.48	67,301.61
Swiss Franc	67	42	136.51	135,194.58
Japanese Yen	80	42	144.34	-54,701.46
Australian Dollar	80	43	142.97	-90,042.92
All	**465**	**274**	**872.03**	**316,066.22**

Table VIII
Quarterly Profits
Square-Dollar Portfolio Strategy

This table shows the quarterly profits in each of the six currencies based on square-dollar-valued positions. The random walk strategy adopts a contrarian stance, selling "strong" and purchasing "weak" currencies. Foreign currency futures selling at discounts were always purchased, and those selling at a premium were always sold. Square-dollar strategy is implemented by investing resources equally divided between long and short dollar positions. The resulting portfolio positions are shown for each quarter, 1984-2003. Cumulative profit and loss is profit and loss accumulated over time.

Contract Month	British Pound	Euro Dollar	Canadian Dollar	Australian Dollar	Japanese Yen	Swiss Fran	Portfolio Profit/Loss	Cumulative Profit/Loss
03/16/84	138	-4,424	1,661	0	-3,008	-916	-6,549	-6,549
06/15/84	6,373	6,661	-11,495	0	4,901	8,636	15,076	8,527
09/14/84	8,835	10,961	1,001	0	6,354	10,742	37,893	46,420
12/14/84	6,958	3,854	0	0	2,547	3,923	17,282	63,702
03/15/85	-23,365	16,116	-11,001	0	9,674	21,033	12,457	76,159
06/14/85	49,510	-16,124	4,670	0	-6,824	-18,847	12,385	88,543
09/13/85	12,618	-8,323	241	0	-4,091	-11,205	-10,760	77,783
12/13/85	21,566	-23,071	-2,615	0	-31,135	-20,888	-56,142	21,641
03/14/86	7,996	-17,935	837	0	-24,755	-16,649	-50,505	-28,865
06/13/86	12,126	-2,428	3,434	0	-10,444	-5,398	-2,710	-31,575
09/12/86	-5,945	-11,087	139	0	-9,577	-14,602	-41,071	-72,646
12/12/86	-5,893	-3,417	3,210	0	8,180	2,824	4,904	-67,742
03/13/87	28,969	-13,689	11,949	0	-10,945	-13,870	2,414	-65,328
06/12/87	9,716	-2,636	-2,052	13,881	-8,777	-4,939	5,192	-60,136
09/11/87	-456	2,784	3,251	5,212	1,640	1,437	13,868	-46,268
12/11/87	20,987	-16,359	2,318	-1,847	-18,852	-19,698	-33,451	-79,719
03/11/88	1,770	4,837	6,783	6,356	318	6,835	26,898	-52,821
06/10/88	-2,618	7,244	5,786	18,952	-2,003	9,884	37,245	-15,575
09/16/88	-12,502	15,017	306	-272	12,859	17,053	32,461	16,886
12/16/88	15,646	-9,190	3,647	13,160	-12,112	-9,145	2,005	18,890
03/10/89	-7,907	10,437	1,127	-3,182	8,710	12,698	21,882	40,773
06/16/89	-16,149	11,521	1,065	-11,945	19,784	13,767	18,042	58,815
09/15/89	5,755	-984	2,977	9,583	2,577	-1,503	18,405	77,220
12/15/89	5,074	-22,222	5,101	4,712	-144	-14,097	-21,577	55,643
03/16/90	3,182	0	-1,244	-1,750	30,197	3,332	33,718	89,361
06/15/90	9,130	-1,485	2,707	5,955	2,553	6,896	25,755	115,116
09/14/90	21,192	-12,825	2,966	13,529	-20,245	-18,003	-13,386	101,731
12/14/90	3,590	-27,756	1,685	-6,107	2,918	1,489	-24,180	77,550
03/15/91	-3,630	-5,969	1,044	1,188	-2,675	-6,795	-16,838	60,712
06/14/91	-7,615	-8,149	1,661	-384	-1,486	-7,463	-23,435	37,277
09/13/91	6,200	6,009	1,006	5,378	4,581	3,931	27,107	64,383
12/13/91	4,971	5,841	162	-2,081	3,413	4,932	17,237	81,621
03/13/92	-3,754	-2,924	-3,278	-775	-2,622	-5,112	-18,465	63,155
06/12/92	8,352	6,016	1,106	1,067	4,705	5,693	26,938	90,093
09/11/92	4,478	8,773	-1,316	-3,099	1,691	10,358	20,884	110,977
12/11/92	-14,532	-5,654	-3,371	-3,622	384	-6,291	-33,086	77,892
03/12/93	-7,176	-3,762	3,478	3,609	-24,671	-6,622	-35,145	42,746

Table VIII (Continued)

Contract Month	British Pound	Euro Dollar	Canadian Dollar	Australian Dollar	Japanese Yen	Swiss Fran	Portfolio Profit/Loss	Cumulative Profit/Loss
06/11/93	5,772	2,357	-1,773	-3,352	9,431	4,144	16,579	59,325
09/10/93	2,672	3,623	-1,983	-3,432	1,008	5,007	6,895	66,220
12/10/93	-2,561	-4,228	-616	3,232	-2,238	-3,327	-9,738	56,482
03/11/94	874	1,452	-2,171	6,493	-17,510	2,448	-8,413	48,068
06/10/94	909	1,574	-872	3,189	-4,919	1,324	1,204	49,273
09/16/94	6,172	10,199	2,813	1,856	-10,271	-24,319	-13,550	35,723
12/16/94	-1,921	3,035	-4,932	7,083	3,226	6,827	13,316	49,039
03/10/95	-465	-13,453	-2,161	-8,867	-11,192	-15,017	-51,155	-2,116
06/16/95	4,474	-1,318	3,651	-2,744	-10,783	-1,899	-8,618	-10,734
09/15/95	-5,713	8,744	2,426	7,688	32,625	7,400	53,170	42,436
12/15/95	-970	-2,689	-3,320	-1,801	-786	-4,972	-14,539	27,897
03/15/96	-413	3,927	1,237	7,876	8,008	4,763	25,398	53,295
06/14/96	1,112	5,143	68	7,602	5,252	8,025	27,203	80,498
09/13/96	3,422	-475	749	539	3,084	-405	6,914	87,411
12/13/96	16,341	3,986	-188	1,015	5,330	8,580	35,064	122,475
03/14/97	-7,776	10,970	999	2,086	11,062	12,382	29,723	152,198
06/13/97	5,879	3,894	2,137	-14,495	-7,536	36	-10,084	142,114
09/12/97	-8,268	2,418	1,550	3,953	6,224	2,327	8,204	150,318
12/12/97	15,689	968	2,481	8,554	8,475	-651	35,516	185,834
03/13/98	7,913	2,774	-269	-2,097	-334	3,738	11,726	197,560
06/12/98	-8,787	-54	4,060	13,270	12,432	2,657	23,578	221,139
09/11/98	14,711	-6,058	2,993	-2,040	-9,077	-6,789	-6,260	214,878
12/11/98	7,870	-2,344	1,905	-3,296	-11,041	-3,802	-10,707	204,171
03/12/99	-16,487	8,575	-1,109	-2,382	3,308	10,369	2,274	206,446
06/11/99	-3,499	3,981	-4,267	-4,430	563	4,039	-3,612	202,833
09/10/99	-31	1,979	864	1,716	-5,914	2,897	1,513	204,346
12/10/99	-82	2,453	319	2,121	-4,115	2,418	3,113	207,459
03/10/00	2,322	4,563	-859	2,866	4,200	5,344	18,436	225,895
06/16/00	3,276	292	570	1,151	1,367	-2,041	4,615	230,510
09/15/00	6,501	9,911	1,366	8,499	2,202	8,503	36,983	267,493
12/15/00	-4,413	-3,576	2,542	397	5,096	-4,394	-4,347	263,146
03/16/01	3,330	245	3,143	-46,131	9,757	2,618	-27,039	236,107
06/15/01	-2,524	-6,359	-3,340	10,868	2,247	6,768	7,660	243,767
09/14/01	8,477	12,594	-4,605	3,304	-6,972	-15,835	-3,036	240,731
12/14/01	-1,251	3,377	366	2,179	14,558	810	20,039	260,770
03/15/02	-2,022	-2,649	-1,952	2,276	4,561	4,316	4,530	265,300
06/14/02	5,350	9,443	2,991	9,067	-8,765	-15,317	2,769	268,069
09/13/02	7,151	4,102	-2,441	-1,214	-3,705	-8,062	-4,170	263,899
12/13/02	3,675	6,995	2,225	4,119	-1,333	-10,459	5,221	269,120
03/14/03	364	6,847	7,263	8,554	-3,782	-13,877	5,369	274,489
06/13/03	7,747	13,614	13,355	15,918	-1,238	-12,469	36,926	311,415
09/12/03	-4,333	-5,756	-2,130	-132	644	15,062	3,354	314,769
12/12/03	11,975	11,526	5,273	16,621	-21,467	-22,630	1,297	316,066
Total	**246,055**	**12,260**	**67,302**	**135,195**	**-54,701**	**-90,043**	**316,066**	**8,442,525**

Table IX
Summary Return Statistics

This table shows the number of quarters, mean quarterly returns, and standard deviation of quarterly returns of 30-day treasury bills, common stock, equally-weighted currency, and square-dollar currency portfolios in British Pound, Swiss Franc, Euro, Canadian Dollar, Australian Dollar, and Japanese Yen from 1984 to 2003. To compute equally-weighted and square-dollar portfolios, the random walk strategy is adopted as a contrarian stance, selling "strong" and purchasing "weak" currencies. Foreign currency futures selling at discounts were always purchased, and those selling at a premium were always sold. Equally-weighted currency strategy is implemented by investing equally in all six currencies and square-dollar currency strategy is implemented by investing resources equally divided between long and short dollar positions. Total returns to currency portfolios have been computed by adding 80% of the three-month Treasury-Bill yield (applied to the assumed investment of $150,000 per period) to the trading profits. The return to holding US common stocks is measured by changes in the Standard and Poor's Index of 500 stock prices plus dividend yield. All returns are before taxes.

Investment	Number of Quarters	Mean Quarterly Return (%)	Standard Deviation of Quarterly Return (%)
Treasury Bills	80	1.27	0.53
Common Stock	80	3.29	8.72
Equally-weighted Currency Portfolio	80	6.01	19.87
Square-Dollar Currency Portfolio	80	3.62	14.97

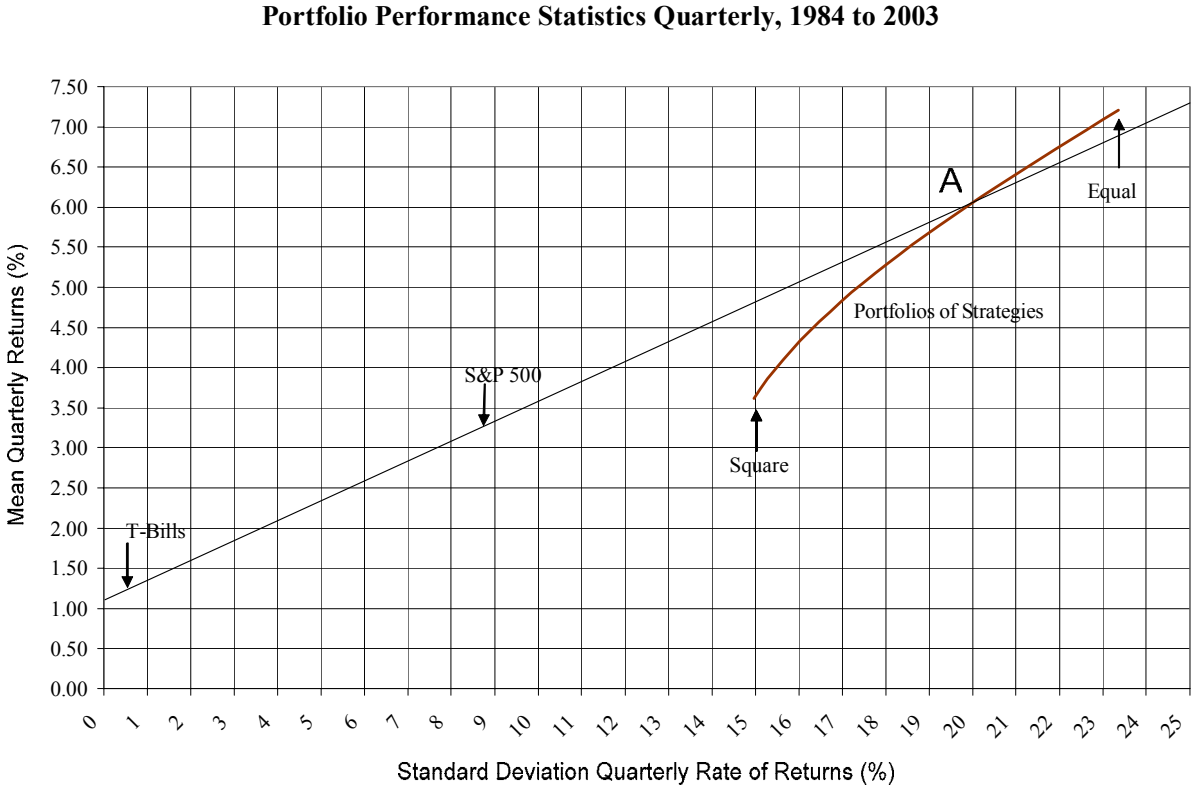

Figure 1: Portfolio Performance Statistics. Quarterly 1984 to 2003

This table shows mean quarterly returns and standard deviation of quarterly returns of 30-day treasury bills, common stock, equally-weighted currency, and square-dollar currency portfolios in British Pound, Swiss Franc, Euro, Canadian Dollar, Australian Dollar, and Japanese Yen from 1984 to 2003. To compute equally-weighted and square-dollar portfolios, the random walk strategy is adopted as a contrarian stance, selling "strong" and purchasing "weak" currencies. Foreign currency futures selling at discounts were always purchased, and those selling at a premium were always sold. Equally-weighted currency strategy is implemented by investing equally in all six currencies and square-dollar currency strategy is implemented by investing resources equally divided between long and short dollar positions. Total returns to currency portfolios have been computed by adding 80% of the three-month Treasury-Bill yield (applied to the assumed investment of $150,000 per period) to the trading profits. The return to holding US common stocks is measured by changes in the Standard and Poor's Index of 500 stock prices plus dividend yield. All returns are before taxes.