The Hedging Performance of Foreign Currency Options and Foreign Currency Futures: A Comparison

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Abstract

This paper is concerned with an empirical comparison of the hedging effectiveness of currency options and currency futures contracts, when each instrument is used to hedge against variations in the exchange rate of the spot currency. The results of the paper indicate that if the hedger were interested in minimising risk alone, futures contracts performed better than the corresponding options contracts. However, if the hedger were interested in minimizing the risk of a portfolio of the spot currency and the hedging instrument for a given level of expected return, then the currency option performed better than the corresponding currency futures contract.

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Comments appreciated
Not to be quoted

Errata

1. On Pages 8, 9, 11, 12

In place of	Substitute
Swiss franc	Japanese yen
West German mark	Swiss franc
Japanese yen	West German mark

2. On Pages 11 & 12, Tables 3 & 4, column 2 pertaining to option exercise price:

In place of	Substitute
0.40	0.0040
0.42	0.0042
0.0037	0.37
0.0038	0.38

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I. Introduction

This paper is concerned with a comparitive evaluation of the performances of options and futures contracts on foreign currency, when each instrument is combined with the foreign currency in an investment portfolio.

Foreign currency options began trading on the International Options Market division of the Montreal Exchange and on the Philadelphia Stock Exchange late in 1982. Table 1 shows the typical option contract size for various options.

The basic features common to currency options are: An initial investment in a call option would entitle the holder to purchase a certain number of units of the foreign currency within a given number of days at a certain excercise price. The excercise price is fixed and is generally a few units above or below the current spot price of the currency at the time the option is written. The options expiry dates are in March, June, September and December of the year or subsequent years. The investor is under no obligation to excercise the option, it may simply expire. The down-payment is the option price or option premium.

Foreign currency futures have been trading in the International Monetary Market of the Chicago Mercantile Exchange since 1972. The futures contract calls for delivery of a certain amount of the foreign currency at a future date, generally March, June, September, December. The futures market deals with standardized contracts in terms of size and delivery dates. The futures market is open to anyone who can put up a security deposit or margin. Typical contract sizes and current margin requirements are given in Table 2. Futures contracts are subject to daily settlement. Each day, the previous day's contract is settled. Gains and losses are calculated and the margin put up is

adjusted to reflect the gain or loss. If the adjusted margin falls below the minimum margin requirement, the investor will have to make up the difference. The investor is under no obligation to make or take delivery of the currency, he/she can close out his/her position in the futures contract. For instance, an investor who sold a futures contract that called for delivery of the foreign currency can always close out his/her position by buying a futures contract that promises delivery of the foreign currency.

Currency options offer the investor several advantages over currency futures. First, the currency option can be excercised at any time before the delivery date or allowed to expire. The futures contract, on the other hand, obliges the investor to either make or take delivery of the foreign currency or close out his position. Second, the maximum loss that the investor in a call option can sustain is his initial investment. The investor in the futures contract has to pay a margin and if the price moves against him, he may lose not only his original investment in the margin, but more. The currency option protects the investor against downside risk. The literature oft cites the difference in investor groups who would make use of the two types of instruments. Foreign currency options could be used by investors who may or may not receive money from abroad in the future and want to hedge against adverse shifts in exchange rates. An example would be a U.S. based corporation submitting bids to a plant in a foreign country where the bid would have to be denominated in the foreign country's currency (1,11). If the bid is successful, the corporation would not need the currency protection and would allow the option to expire. Currency futures could be used by firms who know with certainty they will receive foreign currency (or have to pay foreign currency) in the future and want to lock in today's exchange rate (12).

A comparison of Table 1 and Table 2 shows that the currency option contracts offered by the Montreal Exchange are much smaller than the currency

futures contracts offered by the Chicago Mercantile Exchange. A disadvantage caused by the fixed size of the option and futures contract is that this may prevent the hedger from achieving the optimal proportion of the hedging instrument in his portfolio. The smaller size of the options contract may offer less of a constraint than when hedging is accomplished using the futures contract.

There seems no overriding argument as to why the second group of firms mentioned above cannot use currency options to hedge against exchange rate risk, since all the characteristics of currency options are in their favor. The first question therefore posed here is: Is there any difference between the hedging performance of currency options and currency futures, when each instrument is held along with the particular currency in a portfolio? The second question posed here is: Do portfolios of the spot currency and the option dominate portfolios of the spot currency and the futures contract by Markowitz's (17) mean-variance rule?

Section II applies a theoretical model developed by Ederington (10) to measure the effectiveness of currency options and currency futures in hedging against exchange rate risk. Section III describes the data and methodology employed. Section IV is a description of the results.

II. A measure of portfolio hedging effectiveness

The model described in this section was first developed by Ederington (10) to measure the effectiveness of financial futures contracts in hedging against interest rate risk. It is applied here to hedging against exchange rate risk.

Let X_S represent the holdings of the spot currency. This is assumed to be fixed. The decision is how much of this is to be hedged. Letting U represent the return on an unhedged position,

$$E(U) = X_S E(P_S^2 - P_S^1) \qquad (1)$$

$$V(U) = X_s^2 \sigma_s^2 \tag{2}$$

where

P_s^2 = price of currency at time 2

P_s^1 = price of currency at time 1

σ_s^2 = variance of the possible spot currency price changes from time 1 to time 2

Let R represent the return on a portfolio which includes both the spot currency holding X_s and the holdings X_h of the hedging instrument (either a futures contract or an option). Ignoring transactions costs of hedging,

$$E(R) = X_s E(P_s^2 - P_s^1) + X_h E(P_h^2 - P_h^1) \tag{3}$$

$$V(R) = X_s^2 \sigma_s^2 + X_h^2 \sigma_h^2 + 2X_s X_h \sigma_{sh} \tag{4}$$

where

P_h^2 = price of the hedging instrument at time 2

P_h^1 = price of the hedging instrument at time 1

σ_h^2 = variance of the possible price changes of the hedging instrument from time 1 to time 2

σ_{sh} = covariance between the possible price changes of the spot currency and the hedging instrument from time 1 to time 2

The objective is to find $b = \frac{-X_h}{X_s}$ which represents the proportion of the spot position to be hedged.

Minimizing V(R) with respect to b leads to the following equation:-

$$b^* = \frac{\sigma_{sh}}{\sigma_h^2} \tag{5}$$

The optimum value of b which minimizes the variance of the portfolio is given by equation 5. The measure of hedging effectiveness e is the percent reduction in variance or

$$e = 1 - \frac{V(R^*)}{V(U)} \tag{6}$$

where

$V(R^*)$ = minimum variance of a portfolio of the spot currency and the hedging instrument

Using equations 4 and 5, equation 6 can be simplified to:-

$$e = \frac{\sigma_{sh}^2}{\sigma_s^2 \sigma_h^2} = \rho^2 \tag{7}$$

where

ρ = correlation between the price changes on the spot currency and the hedging instrument.

The measure of hedging effectiveness used in this paper, therefore, is given by equation 7.

The costs of hedging include a reduction in the expected return of the portfolio and transactions costs incurred in hedging. Transactions costs are ignored here; though they could differ considerably between currency options and currency futures.

III. Data and methodology

Weekly price data were collected on the spot exchange rate between the US $ and the following foreign currencies: the British pound, the Canadian $, the Japanese Yen, the Swiss franc and the West German mark, from data made available by the Banker's Trust Company. Weekly price data was also collected for the futures contracts on the corresponding foreign currencies, traded on the International Monetary Market of the Chicago Mercantile Exchange. Weekly price data on the options on the same foreign currencies was obtained from data provided by the International Options Market division of the Montreal Exchange. A limitation of the study was due to the comparative newness of the currency options as a financial instrument. The price data on currency options

was available at most for a year, over 1982. The options and futures price data were collected for the March, June, September and December 1983 and the March and June 1984 instruments. (The dates refer to the expiry dates of options and delivery dates of the futures contracts). A second limitation of this study is caused by the fact that data available on the spot exchange rate, the futures contract price and option premium may not necessarily be synchronized as to time, due to the different daily closing times or the concerned exchanges. However, this is not of very serious concern, since the study is concerned with weekly returns on the spot currency or the hedging instrument.

Weekly returns on the spot currency, the futures contract and the option were calculated for each week as:-

$$r_t = \frac{P_t - P_{t-1}}{P_{t-1}} \times 100 \qquad (8)$$

where

P_t = price of the spot currency, the futures contract or the option in period t

r_t = return on the spot currency, the futures contract or the option in period t

Using equation 7, the hedging effectiveness of each of the currency options and the futures contract were calculated. The results are tabulated in Table 3.

The next question that is to be asked is: Do efficient portfolios of the spot currency and the option dominate efficient portfolios of the spot currency and the futures contract by Markowitz's (17) mean-variance rule? The mean return, variance of return and covariance of return of the spot currency, the option and the futures contract were calculated. The expected return E and the variance of return V of an efficient portfolio of the currency and the

currency option and of an efficient portfolio of the currency and the futures contract was calculated as:-

$$E = X_1 E_1 + (1-X_1) E_2 \quad (9)$$

$$V = X_1^2 \sigma_1^2 + (1-X_1)^2 \sigma_2^2 + 2X_1(1-X_1) \rho_{12} \sigma_1 \sigma_2 \quad (10)$$

where

E_1 = expected return on the currency

E_2 = expected return from holding either the option or the futures contract in the portfolio as the hedging instrument

σ_1^2 = variance of return on the currency

σ_2^2 = variance of return from holding either the option or the futures contract in the portfolio as the hedging instrument

ρ_{12} = correlation between the return on the spot currency and the return on the hedging instrument used.

X_1 = proportion of the portfolio invested in the spot currency

$1-X_1$ = proportion of the portfolio invested in the hedging instrument.

The expected return E and the variance of return V were calculated for both the spot currency-option portfolio and the spot currency-futures contract portfolio for values of the annualised E ranging from 5% to 20%. Figure 1 graphs the expected return of the portfolio versus the variance of return of the portfolio for portfolios of the spot currency-option contract and of the spot currency-futures contract for the British pound, when the call option considered had an excercise price of $1.50 and the option expiry date and futures delivery date considered was March 1984.[1]

IV. RESULTS

Table 3 shows the measure of hedging effectiveness calculated for five

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[1]Similar graphs are available, which compare the expected return-variance of portfolios of the spot currency-option and spot currency-futures contract portfolios for all the currencies and expiry dates/delivery dates considered in this study. These graphs will be made available by the authors on request.

currencies, the British pound, the Canadian dollar, the Swiss franc, the West German mark and the Japanese yen, when the hedging instrument used was the currency futures contract or the put or call option on the currency. For the British pound, Canadian dollar and the West German mark, the measure of hedging effectiveness of the futures contract is higher than the corresponding measure for both the call and put options for the various excercise prices. As far as the Swiss franc and Japanese yen are concerned, some options on the currency can be found whose measure of hedging effectiveness is greater than the measure of hedging effectiveness for the futures contract on the currency.

The evidence indicates that the reduction in portfolio risk that could be achieved using the futures contract as the hedging instrument is greater than the reduction in portfolio risk that could be achieved by using an option (either put or call) along with the spot currency in a portfolio.

The hedging effectiveness e determines the reduction in risk that could be obtained by combining the spot currency with the hedging instrument. The expected return of the portfolio is also a matter of interest to the hedger. This would be considered explicitly by determining which set of portfolios (of the currency and a particular hedging instrument) dominate the other set (of the currency and the other hedging instrument) by the mean-variance rule. Figure 1 is a graph of one such comparison for the British pound. The call option expiry date and futures delivery date of the instruments compared are both March 1984. The excercise price of the option is $1.50. It is seen that in this figure, the efficient portfolios of the currency and the option lie to the left of the efficient portfolios of the currency and the futures contract. Therefore portfolios composed of the currency and the option dominate portfolios of the currency and the futures contract by the mean-variance rule. The comparison was repeated for all the currencies, option excercise prices, put and call options and the various expiry/delivery dates. Table 4 condenses

the results. It is seen that for the British pound, West German mark and the Japanese yen, portfolios of the spot currency - option contract dominated portfolios of the spot currency-futures contract for a large majority of the comparisons. Excluding those comparisons in which neither portfolio dominated the other, the spot currency-option portfolio dominated the spot currency-futures portfolio 15 of 16 comparisons for the British pound, 14 of 17 comparisons for the West German mark and 12 of 14 comparisons for the Japanese yen. For the Canadian dollar, the spot currency-options portfolios dominated the spot currency-futures portfolio for 12 out of 22 comparisons. The spot currency-option portfolios performed poorly in comparison with the spot currency-futures contract portfolio for the Swiss franc, being dominated 8 out of 9 comparisons.

V. Conclusion

If reduction in risk alone is considered, the futures contract could have offered a higher reduction in risk of the portfolio than the option contract. However when the expected return and variance of the portfolio are both considered, the conclusion clearly is that the option contract would have proved of more value to the investor than the futures contract when held in a portfolio along with the foreign currency.

As remarked earlier, a limitation of this paper is that the transactions costs associated with hedging using the futures contract and the option were not considered. The hedger who opts to use the futures contract has to maintain a margin. The cost of hedging using futures contracts would include the opportunity cost of the margin plus any broker's fees. The costs of hedging using the option would be the option premium plus broker's fees. In order to obtain a riskless hedge with an option contract, the hedge ratio would have to be adjusted often and this would give rise to large transactions costs. This is a matter that is to be investigated in future research.

Table 1

Characteristics of foreign currency options

Currency	Size of option contract
British pound	£ 5,000
Canadian dollar	CAN $ 50,000
Swiss franc	SF 25,000
West German mark	DM 25,000
Japanese Yen	Y 2,500,000

Data Source: The Montreal Exchange

Table 2

Characteristics of foreign currency futures

Currency	Size of futures contract	Minimum margin requirement US $
British pound	£ 25,000	1,500
Canadian $	CAN $100,000	900
Swiss franc	SF 125,000	2,000
West German mark	DM 125,000	1,500
Japanese yen	Y 12.5 million	1,500

Data Source: The Chicago Mercantile Exchange

Table 3

Hedging effectiveness of foreign currency options and foreign currency futures

Currency	Option Excercise Price $	Hedging Instrument	Hedging effectiveness e — Expiry date/delivery date					
			March 1983	June 1983	September 1983	December 1983	March 1984	June 1984
British pound		Futures	0.94	0.98	0.96	0.96	0.96	0.88
	1.50	Call option	-*	-*	0.92	0.81	0.94	0.55
	1.50	Put option	-*	-*	0.94	0.72	0.79	0.88
	1.55	Call option	-*	-*	0.86	0.72	0.90	-*
	1.55	Put option	-*	-*	0.98	0.85	0.83	-*
Canadian dollar		Futures	0.98	0.98	0.98	0.98	0.88	0.85
	0.80	Call option	0.92	0.79	0.79	0.85	0.67	0.69
	0.80	Put option	0.59	0.58	0.53	0.61	0.20	0.12
	0.81	Call option	0.72	0.74	0.76	0.79	0.67	0.58
	0.81	Put option	0.59	0.74	0.71	0.76	0.34	0.02
Swiss franc		Futures	0.90	0.86	0.67	0.88	0.94	0.92
	0.40	Call option	-*	-*	-*	0.86	0.85	0.85
	0.40	Put option	-*	-*	-*	0.46	0.53	0.50
	0.42	Call option	-*	-*	0.64	0.48	0.62	0.90
	0.42	Put option	-*	-*	0.96	0.71	0.85	0.83
West German mark		Futures	0.96	0.92	0.92	0.90	0.90	0.90
	0.47	Call option	-*	-*	0.85	0.88	0.83	0.53
	0.47	Put option	-*	-*	0.85	0.90	0.92	0.94
	0.48	Call option	-*	0.76	0.67	0.83	0.86	0.94
	0.48	Put option	-*	0.52	0.79	0.77	0.86	0.86
Japanese yen		Futures	0.98	0.98	0.88	0.85	0.66	0.74
	0.0037	Call option	-*	-*	-*	0.92	0.92	0.81
	0.0037	Put option	-*	-*	-*	0.86	0.81	0.69
	0.0038	Call option	-*	-*	0.61	0.76	0.77	0.85
	0.0038	Put option	-*	-*	0.77	0.76	0.71	0.69

*Unable to calculate the hedging effectiveness due to lack of observations.

Table 4

Comparison of expected return and variance of return of currency-options portfolio and currency-futures portfolios

Currency	Type of Option/ Excercise price $	Hedging instrument in mean-variance dominating portfolios					
		March 1983	June 1983	September 1983	December 1983	March 1984	June 1984
British pound	Call/1.50	-*	-*	Option	Option	Option	Option
	Put/1.50	-*	-*	Option	Option	Option	Option
	Call/1.55	-*	-*	Futures	Option	Option	Option
	Put/1.55	-*	-*	Option	Option	Option	Option
Canadian dollar	Call/0.80	Futures	Option	Futures	Futures	Option	Option
	Put/0.80	Option	Option	Option	-[1]	Futures	Futures
	Call/0.81	Futures	Option	-[1]	Option	Option	Option
	Put/0.81	Option	Option	Futures	Futures	Futures	Futures
Swiss franc	Call/0.40	-*	-*	-*	-[1]	Futures	Futures
	Put/0.40	-*	-*	-*	-[1]	Futures	Futures
	Call/0.42	-*	-*	Option	-[1]	Futures	Futures
	Put/0.42	-*	-*	-[1]	-[1]	Futures	Futures
West German mark	Call/0.47	-*	-*	Futures	Futures	Option	Futures
	Put/0.47	-*	-*	Option	Option	Option	Option
	Call/0.48	-*	Option	-[1]	Option	Option	Option
	Put/0.48	-*	Option	Option	Option	Option	Option
Japanese Yen	Call/0.0037	-*	-*	-*	Option	Futures	Option
	Put/0.0037	-*	-*	-*	Option	Option	Option
	Call/0.0037	-*	-*	Futures	Option	Option	Option
	Put/0.0037	-*	-*	Option	Option	Option	Option

* Unable to carry out the comparison due to lack of observations

[1] Neither portfolio dominated the other

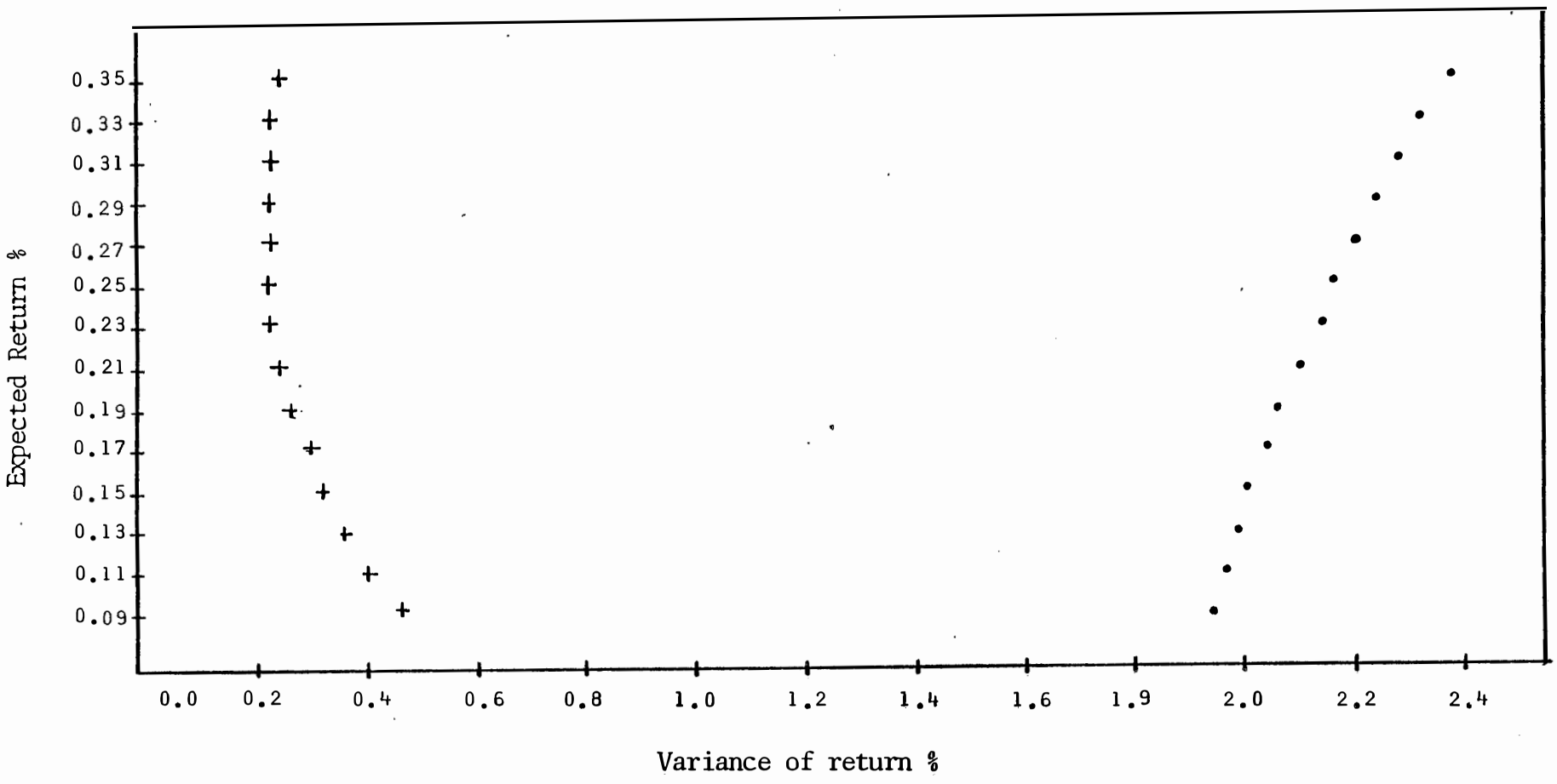

Figure 1 - Expected Return vs. Variance of Return of Hedged Portfolios

+ Portfolio of the spot currency-option contract

. Portfolio of the spot currency-futures contract

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