
USING DERIVATIVES IN MAJOR CURRENCIES FOR CROSS-HEDGING CURRENCY RISKS IN ASIAN EMERGING MARKETS

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INTRODUCTION

Cross-border direct and portfolio investments to continue to increase at a faster pace than global economic output, and thus continue to grow in importance.¹ This trend for an ever higher proportion of investments to be made across borders seem to have accelerated in recent years, but an increasing proportion of foreign portfolio investments is going to emerging markets especially, as they offer investments with better risk/return combinations [e.g., Harvey (1994)], even though investing in emerging markets is often limited by their relative lack of liquidity and by restric-

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¹Cross-border trade in equities was estimated to be about \$35 trillion in 1995, having grown 5.5 times in five years (*Financial Times*, February 16, 1996, p. 4). The Bank for International Settlements' 1992 annual report notes that the ratio of cross-border securities trades to GDP for the industrial countries was under 10% in 1980, but by 1990 it rose to 60, 100, 130, and 700% for Germany, U.S., Japan, and the U.K., respectively.

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tions placed on foreign investors [e.g., Aggarwal (1994)].² As the highest growth region, Asia attracts the largest proportion of cross-border investments.

Currency hedged benchmarks are widely used to evaluate portfolio managers, and the currency hedging decision, while important, is generally made after the portfolio composition is established [e.g., Karnosky and Singer (1994)]. Currency hedging overlay policies are considered useful if they improve the risk–return performance of a portfolio (e.g., if they have a positive Sharpe performance index). Even though currency hedging is unlikely to be useful if purchasing power and interest rate parity conditions hold, there is now considerable evidence for the major currencies that hedging can be very beneficial. Hedged portfolios have been shown to offer better return–risk ratios than unhedged portfolios [e.g., Perold and Schulman (1988), Eaker, Grant, and Woodard (1993), Glen and Jorion (1993), Kritzman (1993), and Gastineau (1995)].

Although there is considerable literature on the benefits of hedging currency risks in cross-border investments in the developed countries, relatively little attention has been paid to the issue of such hedging for investments in emerging markets. Hedging investments in emerging markets against currency risks is often difficult or impossible because of the lack of well-developed derivatives markets and the widespread existence of exchange controls and other regulations restricting the activities of the foreign exchange markets [e.g., Aggarwal (1994), Euromoney (1995), Quirk and Schoofs (1988)]. Consequently, investments in emerging markets that have imperfect and incomplete financial markets may have to be hedged by offsetting investments in assets, liabilities, or derivatives denominated in related but more liquid currencies. Such cross hedging permits hedging of investments in currencies with no or illiquid forward, futures, and options markets, and it can also reduce hedging costs and the number of currencies traded in implementing hedging decisions for widely diversified investments.

This article documents that for the Asian emerging markets, hedging currency risks using futures and options in major currencies such as the Japanese yen can be beneficial and can result in improved Sharpe per-

²Some \$167 billion of private capital flowed into emerging economies in 1995 (up from \$70 billion in 1990; *Economist*, March 16, 1996, p. 78). Cross-border equity investments are increasingly being made in emerging markets, which are expected to account for 45% of world equity market capitalization by 2010, rising from 17% in 1995 and 3.5% in 1986 (*Wall Street Journal*, June 20, 1996, p. C16). By 1995 over \$220 billion of emerging market equities were held by developed country investors (up from \$2.4 billion in 1986), with \$95 billion flowing to emerging markets in 1995 alone (*Financial Times*, May 16, 1996, p. 5). Also see, for example, Aggarwal (1994), Chuhan (1994), Divecha et al. (1992), Greenwood (1993), and Peavy (1994)].

formance indexes (SPIs). Further, prior-period minimum variance cross-hedge ratios are generally significant and stable enough to be useful in improving the SPIs of Asian emerging market investments. These results should be of practical and policy interest.

CROSS-HEDGING CURRENCY RISKS

Cross hedging has been used most commonly to manage agricultural risks. Studies of such activity [e.g., Elam, Miller, and Holder (1986)] have shown that price risk or basis risk of commodities can be reduced by using futures contracts for different, yet related, commodities. The futures contract selected for the cross hedge may differ materially in location, type, grade, or timing. Cross hedging can be thought of as the use of a futures contract for hedging a cash position that is not directly deliverable under the terms of the futures contract.³

Cross hedging can be used to minimize exchange rate risk when direct hedging of a currency position is inefficient or impossible for many emerging market currencies where markets for forward and futures contracts and for options are either nonexistent or very inadequate. For example, with a cross hedge, the exchange-rate risk in a long Taiwan dollar investment can be reduced by hedging with a futures contract in a different but related currency, for example, the Japanese yen. Cross hedging is somewhat more complicated than direct hedging because the appropriate cross hedge instrument must be selected and the proportion of the investment to be hedged (between 0 and 1) must be determined.

Although theoretical models for cross hedging have been developed [e.g., Anderson and Danthine (1981)], empirical evidence on the effectiveness of cross hedging to reduce foreign exchange risks has been limited. Eaker et al. (1993) examined simple, multiple, portfolio, and commodity cross hedges, and showed that for the major currencies, cross hedging offered opportunities for risk reduction but was less effective than traditional similar-asset hedges. However, in assessing the U.S. dollar performance of a hedging strategy where German mark futures were used to cross hedge the Italian lira, Braga, Martin, and Meilke (1989) found, using stochastic dominance rules to assess out-of-sample trading results, that, on average, the German mark cross-hedge strategy was much cheaper than the traditional forward market hedge. Kroner and Sultan (1993) confirm that currency hedging can significantly improve portfolio returns and that more optimum hedge ratios can be estimated

³In its simplest form cross hedging entails the use of a futures contract in only one commodity or instrument; multiple cross hedging involves the use of futures contracts in more than one commodity.

if the time-varying nature and co-integrating relationships among asset returns is taken into account.

There seem to be few studies of the hedging of currency risks in emerging market investments. Benet (1990) examines the use of commodity futures during the 1973–1985 period for hedging exchange risks in selected developing country currencies with mixed results. Hauser, Marcus, and Yaari (1994) contend that for the 1986–1991 time period, it does not seem to be beneficial to hedge emerging market currency risks even if it is assumed that markets for hedging emerging market currencies exist and are liquid and efficient. However, emerging market currency and derivative markets often do not exist or are generally poorly developed, and the difficulties of hedging investments in emerging markets has been discussed widely [e.g., Quirk and Schoofs (1988)].⁴

As this brief review of the literature indicates, studies of the effectiveness of using futures and options denominated in liquid developed-country currencies to hedge the currency risks of investing in emerging markets would be very useful. The economies of the Asia–Pacific region are greatly increasing their intraregional economic and financial ties [e.g., Kwan (1994)]. There also seems to be some evidence of a nascent yen bloc in the Asia–Pacific region, as it has been documented that currencies of the Asian newly industrialized countries (NICs) are co-integrated with the Japanese yen [e.g., Aggarwal and Mougoue (1996)]. Thus, it may be useful to examine if investments in these Asian NICs can be hedged with the use of instruments denominated in the Japanese yen or other major currencies.

Specifically, this article fills a gap in the literature by examining the effectiveness of cross hedging the currency risks of investments in seven Asian emerging markets: Hong Kong, South Korea, Singapore, Taiwan (the four Tigers), Indonesia, Philippines, and Thailand (the remaining ASEAN countries). The cross-hedging effectiveness of futures and options denominated not only in the Japanese yen, but also in the other major currencies such as the pound sterling, Canadian dollar, German mark, and the Swiss franc is examined.

RESEARCH METHODOLOGY AND DATA

Framework for Assessing Hedging Strategies

An investor facing exchange risk inherent in a foreign currency payable generally faces three alternatives. First, such an investor can simply wait

⁴For examples of such discussions in the business press see, for example, Graham Cooper (1996): "Exotic Currencies: Special FX" *Risk*, 6(10):42–48; and Nilly Landau (May 1994): "Managing Exotic Risks," *International Business*, 62–66.

until the payment comes due and then buy the foreign currency at the spot rate. Second, the short cash position can be hedged with a long futures contract in the same currency, or it may be cross-hedged by going long in futures in a related foreign currency. Third, the investor can cross hedge by buying a currency call option in a related foreign currency (FC). Because the last two alternatives involve investment in an additional asset, a derivative, they may be viewed as risk reduction through diversification.

As in Braga et al. (1989), each alternative differs in its payoff. If the first strategy is chosen, the payoff for this unhedged strategy in U.S. dollars per FC is

$$E(U) = E(S_2 - S_1)$$

where $E(U)$ is the expected profit or loss in U.S. dollars of the unhedged position, and S_i are the spot prices of the FC against the U.S. dollar at the time the purchase order is placed ($i = 1$) and at the time the actual payment is made ($i = 2$). When the cross-hedging strategy with futures is selected, the net return of this strategy is

$$E(F) = E(S_2 - S_1) + bE(F_2 - F_1)$$

where $E(F)$ is the expected profit or loss in U.S. dollars of the futures hedge, b is the proportion of the cash position hedged with futures contracts, and F_i is the foreign currency futures price in U.S. dollars when the hedge is placed ($i = 1$) or lifted ($i = 2$). In the case of a currency options hedge, the investor will exercise the option only if it is profitable to do so. Thus, the expected return from this hedge alternative is

$$E(C) = E(S_2 - S_1) + b(S_2 - K - C_1), \quad \text{if } S_2 > K$$

$$\text{or } E(S_2 - S_1) - bC_1, \quad \text{if } S_2 \leq K$$

where $E(C)$ is the profit or loss of the call option cross hedge in U.S. dollars, b is the proportion of the cash position hedged with call option contracts, K is the strike price, and C_1 is the call option premium paid at the time the call option is bought. It should be noted here that a hedger is able to create a perfect hedge with a hedge ratio of 1 (or full hedge) as long as the hedging period of the investor matches the time to maturity of the hedging instrument. Because exchange-traded currency futures and options mature only four times a year, perfect hedges are limited to those periods unless a hedger has access to non-exchange-traded futures and options.

Full Hedge and Minimum Variance Hedging

What proportion of an exposed position, b , should be hedged for optimal benefit? This optimal hedge ratio can be 1, as in the naive or full hedge model, or it can be a ratio that minimizes portfolio risk. Ederington's (1979) portfolio model provides the procedures that minimize the variance of expected dollar returns on a FC spot position by taking a position, usually opposite, in another currency's corresponding futures contracts. By using variance as a measure of risk, the decision process reduces to an application of the Markowitz portfolio selection model for the two-asset case with the spot position fixed at 1 and risk and return defined in terms of changes in value [e.g., Lypny (1988)]. In such a case

$$b^* = \frac{\text{COV}(S,F)}{\text{VAR}(F)}$$

Thus, the optimal or least-risk hedge ratio, b^* , can be estimated as the negative of the slope coefficient of a regression, a_1 , of spot price changes, S_t , on futures or option price changes, H_t , with the coefficient of determination, R^2 , of the regression as a measure of the ex post hedging effectiveness for the minimum-risk hedge:

$$S_t = a_0 + a_1 H_t + e_t$$

Estimating and using the minimum-variance hedge ratio based on this regression may have some limitations in practice. For example, it assumes that spot price changes need not always equal price changes in futures or options, that there are no significant autocorrelations, and that the optimal hedge ratios remain stable over time. In addition, if the estimated minimum-risk hedge ratios are significantly different from 1, then there is no guarantee that they will outperform the naive full hedge ratio when adopted as ex ante cross hedges. Indeed, Lypny (1988) examines the optimal hedge ratios in a two-currency spot portfolio of Canadian dollars and German marks and finds that using the naive full hedge model, where the hedge ratio is 1, is more effective in reducing currency risk than the minimum-variance hedge. Thus, in this study, naive full hedge and minimum-variance hedging strategies using both futures and options are examined.

Measuring Hedging Effectiveness

As both risks and returns of a portfolio change with hedging, both dimensions should be used in evaluating hedging strategies. Therefore, the

effectiveness of hedging strategies is measured in this study by estimating the Sharpe performance index (SPI) in which the excess return on the portfolio hedge is compared with the portfolio standard deviation:

$$\text{SPI} = \frac{R_p - R_F}{\sigma(R_p)},$$

where R_p is the expected return of the portfolio hedge; R_F is the risk-free rate of return. Within the expected utility maximizing framework, the higher the SPI value, the more effective and more desirable the hedged portfolio [e.g., Nelson and Collins (1985)].

The overall period in this study is divided into four subperiods. Stability of hedge ratios is tested by using sets of binary variables for these time periods in the following regression, where D_2 , D_3 , D_4 , are 0,1 dummy variables that take on the value of 1 in Periods 2, 3, and 4, respectively; other variables are as defined earlier; and c_2 , c_3 , c_4 , are 0 if the hedge ratios are stable across time periods:

$$S_t = a_0 + b_1H_t + c_2D_2H_t + c_3D_3H_t + c_4D_4H_t + e_t$$

In addition, to estimate the effects of any instability in cross-hedge ratios on hedging performance, the first-period estimated hedge ratios are used in the second subperiod to evaluate the out-of-sample cross-hedging effectiveness of currency futures and options. The out-of-sample hedging effectiveness in the test period is expected to be significantly lower than the in-sample hedging performance in the estimation period or the entire study period [e.g., Lypny (1988); Braga et al. (1989)].

Data Set

The data used in this study cover the 10-year period, January, 1983–December, 1992, and is from the United States Department of Agriculture (USDA), *IMM Yearbooks*, International Monetary Fund Statistics, Futures Industry Institute Data, Philadelphia Stock Exchange, and the *Federal Reserve Bulletin*. Prices are all closing or settlement prices in U.S. dollar per foreign currency collected monthly for the last day of the month.⁵ Currency futures and options contracts are available with four maturity dates: March, June, September, and December. For each contract, as suggested by Eaker et al. (1993), the hedge periods run for the

⁵The last available market day data for the call option is used, regardless of whether the option is in-, at-, or out-of-the-money. It is assumed that the call option has no resale value on the payment date, so strike prices do not remain constant during the test period.

3 months prior to maturity with 12 monthly hedge periods during each of the 10 years (120 observations each for currency futures and options). The overall period is divided into four subperiods, reflecting changes in international exchange rate regimes. The first period ends just before the Plaza Agreement of September, 1985, the second just before the Louvre Accord of January, 1987, the third period ends in December, 1989 reflecting the peak of Japanese asset prices.

RESULTS

Results for the Overall Period

Table I presents, for the overall 10-year period, the estimated minimum-risk cross-hedging ratios, b ; the Sharpe performance index, SPI, for both the naive full hedge ratio of 1 and for the minimum-risk hedge ratios for investments in each of the seven Asian emerging markets; and R^2 s that are measures of hedging effectiveness. These results are presented for cross-hedging currency risks in the seven Asian currencies with the use of futures and call options denominated in the developed-country currencies (the British pound, Canadian dollar, German mark, Japanese yen, and Swiss franc).

The results presented in Table I show that the best SPIs are generally obtained by using futures and options denominated in the Japanese yen, and for the minimum-risk hedge ratios (except for Indonesian rupiah investments). Further, the SPIs for investments in Hong Kong, Singapore, and Taiwan dollars increase by large amounts with cross hedges using derivatives in any of the developed country currencies.⁶ The generally low R^2 s indicate that, on average, fairly small proportions of emerging market currency risk are eliminated even though all of the minimum-risk hedge ratios are significant. However, overall these results show that a currency risk-management strategy that cross-hedges Asian emerging market investments by using options and futures denominated in the more liquid developed-country currencies can improve the risk–return combination of such portfolios.

Results for Subperiods

The practical usefulness of a hedging strategy can best be assessed if optimal hedge ratios determined in a prior period can be used in a sub-

⁶All numbers in the tables are in percentages, that is, actual numbers times 100. Negative SPIs indicate the need to go long in futures (or options) to hedge a long underlying position. As noted by an anonymous reviewer, the line between hedging and portfolio diversification is not clear, and going long in futures or options to hedge an underlying long position may not be considered as hedging.

TABLE I

Cross-Hedging Sharpe Performance Indexes: Minimum Risk and Full Hedges
(In-sample Results for January, 1983–December, 1992)

Investment Currency	Futures (N = 119)				Options (N = 118)			
	Full Hedge SPI	Minimum Risk Hedge			Full Hedge SPI	Minimum Risk Hedge		
		b*	R ²	SPI		b*	R ²	SPI
Cross-Hedging Using British Pound								
SKor-Won	0.23	1.37*	0.41	1.00	6.72	1.14*	0.38	5.05
Indo-Rup	0.78	2.09*	0.05	0.63	8.07	5.76*	0.53	8.17
Phil-Peso	0.58	3.38*	0.15	3.95	7.85	8.77*	1.34	10.29
Thai-Bht	0.37	7.94*	3.74	3.83	6.58	5.80*	2.67	2.23
Taiwan-\$	1.01	1.21*	0.17	39.48	4.35	0.70*	0.07	66.20
Singap-\$	6.65	17.00*	21.98	41.92	5.28	17.82*	32.26	49.85
HKong-\$	1.76	0.05*	0.00	40.65	4.90	-0.06*	0.00	41.56
Cross-Hedging Using Canadian Dollar								
SKor-Won	3.42	18.27*	7.60	3.72	7.56	-0.36*	0.19	9.84
Indo-Rup	0.89	13.48*	0.43	0.76	7.95	-0.65*	0.03	7.52
Phil-Peso	0.44	34.75*	1.65	1.75	7.87	-0.97*	0.08	3.73
Thai-Bht	4.35	1.70*	0.02	29.82	7.33	-1.24*	0.59	22.79
Taiwan-\$	7.51	4.51*	0.24	59.40	6.79	-2.43*	4.35	24.34
Singap-\$	34.40	2.09*	0.03	55.27	2.53	-1.18*	0.68	56.04
HKong-\$	7.95	-0.65*	0.01	40.47	6.86	-0.27*	0.07	42.25
Cross-Hedging Using German Mark								
SKor-Won	10.32	1.90*	0.67	8.50	18.31	1.54*	1.13	15.62
Indo-Rup	7.79	7.05*	0.51	7.93	18.79	7.44*	1.44	18.94
Phil-Peso	8.98	-3.46*	0.13	3.68	20.08	0.01*	0.00	7.68
Thai-Bht	9.05	10.17*	5.24	0.33	18.22	5.23*	3.55	1.48
Taiwan-\$	8.53	0.65*	0.04	79.11	16.31	1.06*	0.28	66.97
Singap-\$	12.61	16.86*	18.46	57.03	5.13	8.51*	12.03	53.50
HKong-\$	6.30	1.13*	0.16	38.76	15.70	0.19*	0.01	41.08
Cross-Hedging Using Japanese Yen								
SKor-Won	15.53	4.80*	3.65	35.81	0.44	0.28*	0.12	62.06
Indo-Rup	14.02	10.06*	0.88	16.75	5.05	-0.01*	0.00	9.67
Phil-Peso	9.91	-9.53*	0.87	7.74	8.02	-2.08*	0.41	7.65
Thai-Bht	25.83	15.72*	10.71	29.77	29.27	1.02*	0.45	29.96
Taiwan-\$	66.51	1.91*	0.30	85.13	79.26	0.65*	0.36	84.59
Singap-\$	55.41	18.61*	19.20	55.25	55.32	3.08*	5.26	54.93
HKong-\$	37.63	1.01*	0.11	40.62	40.88	-0.02*	0.00	41.50
Cross-Hedging Using Swiss Franc								
SKor-Won	7.87	1.44*	0.42	5.91	9.60	0.14*	0.03	2.71
Indo-Rup	5.20	5.25*	0.30	5.35	9.52	0.07*	0.00	12.31
Phil-Peso	6.26	-5.54*	0.37	2.11	9.71	0.00*	0.00	7.66
Thai-Bht	6.69	11.55*	7.32	0.51	9.35	1.26*	0.71	8.71
Taiwan-\$	6.35	1.16*	0.14	67.33	8.89	0.34*	0.10	67.17
Singap-\$	10.92	16.47*	19.08	57.37	3.55	2.65*	4.04	52.38
HKong-\$	24.25	0.68*	0.06	39.63	8.72	-0.43*	0.21	42.35

Note: The numbers in the table are 100 times their actual values. The SPI measures the excess return per unit of risk. Boldface SPIs reflect a short position and the other SPIs reflect a long position in the hedging instrument.

*Significantly different from 1 at the 5% level.

sequent period. As discussed above, the overall period is subdivided into four periods, and the hedge ratios are tested for stability from one period to the next (three period-to-period changes). Because 10 hedging instruments are examined (five currency futures and five currency options) for investments in seven currencies with three stability tests for each combination, a total of 210 ($10 \times 7 \times 3$) stability coefficients must be examined for significance. Only 13 of the 210 coefficients are found to be significant in indicating instability (mostly for the Singapore dollar when futures are used for hedging).⁷ Thus, cross-hedge ratios are found to be generally stable even though the study time period covers a range of exchange-rate regimes and major changes in currency values.

Table II presents hedging results when the overall period is broken down into four subperiods.⁸ For each of the last three periods, hedge ratios used in each period are minimum-risk hedge ratios estimated in the prior period. Although the naive full hedge ratios sometimes provide a better SPI than the use of the minimum-risk hedge ratio, in general, the SPIs for the minimum-risk ratios are higher. Once again, these results also show that using Japanese yen futures or options result in the best SPIs for most of the emerging market currencies examined (except for the second period when the Swiss franc derivatives generally seem to be slightly better). When the Japanese yen SPIs are not the best, they are close. These results show that for Asian emerging-market investments, ex-ante cross-hedge ratios estimated in a prior period by using options and futures in the more liquid developed country currencies can improve the risk-return combination of such portfolios in a subsequent period.

Finally, because there is some evidence of identifiable trends in exchange rates [e.g., Weigel (1993)], Table III presents the improvements in SPI possible if cross-hedging of emerging market investments could take advantage of expected directional movement of exchange rates. In particular, these results indicate that forecasting exchange-rate trends before formulating cross-hedging strategies for Asian emerging-market currency investments can improve the risk-return performance of such portfolios. Naturally, the results presented in this table should be viewed with caution, as it may not be possible to forecast even the direction of currency changes.⁹

⁷For brevity, these results are not presented here, but are available from the authors.

⁸Similar results are obtained when the overall period is broken down into more (or less) than four periods. In the interests of simplicity, only the results obtained when the overall period is broken down into four periods are presented.

⁹In common with other studies of cross hedging, transactions costs have not been considered explicitly because, as prior research has shown, such costs are relatively small in this context [e.g., Braga et al. (1989)]. Also, this study focuses on the analysis of simple cross hedges. Multiple cross hedges may prove to be more effective in some cases.

TABLE II

Sharpe Performance Index for Currency Cross Hedging (Minimum-Risk Hedge Ratios Based on Prior Period)

Investment Currency	Period 2 (9/85-1/87)				Period 3 (2/87-12/89)				Period 4 (1/90-12/92)			
	Currency Futures		Currency Options		Currency Futures		Currency Options		Currency Futures		Currency Options	
	Full	MR	Full	MR	Full	MR	Full	MR	Full	MR	Full	MR
Cross-Hedging Using British Pound												
SKor-Won	31.99	28.56	0.99	-6.96	8.94	10.74	13.26	3.01	6.60	6.61	13.23	13.21
Indo-Rup	31.37	31.10	1.59	2.40	6.37	6.37	11.06	11.06	6.73	6.73	12.87	12.86
Phil-Peso	31.63	26.33	0.28	2.86	6.47	0.64	10.99	4.04	6.65	3.30	11.61	2.00
Thai-Bht	31.65	22.62	2.08	19.25	6.80	5.44	11.18	42.15	6.10	7.28	13.28	9.79
Taiwan-\$	31.70	52.76	2.51	29.11	7.72	19.93	11.63	54.71	5.85	54.52	13.01	22.25
Singap-\$	25.08	24.38	9.43	44.91	0.00	90.57	1.75	78.60	11.41	50.21	1.95	52.96
HKong-\$	30.04	178	3.24	85.60	5.68	45.44	9.60	438.59	6.73	262.31	11.85	223.24
Cross-Hedging Using Canadian Dollar												
SKor-Won	15.90	15.08	0.28	2.56	27.64	25.26	16.29	16.20	14.99	14.99	17.21	15.29
Indo-Rup	23.46	24.46	9.58	12.34	25.81	25.80	16.19	16.20	14.89	11.24	17.03	13.75
Phil-Peso	19.18	9.97	1.79	0.88	24.55	21.22	16.10	15.09	14.66	2.63	17.18	4.91
Thai-Bht	12.97	1.25	3.39	11.52	24.28	18.45	16.05	28.71	15.40	26.34	18.77	39.09
Taiwan-\$	10.12	208.09	6.31	46.08	21.48	27.12	15.87	10.93	14.99	5.27	18.48	44.88
Singap-\$	10.55	46.60	24.4	41.26	19.24	93.78	12.66	4.28	45.56	59.46	58.66	58.44
HKong-\$	8.22	50.57	7.66	31.28	19.34	332.13	15.71	61.17	18.98	146.89	26.51	269.41
Cross-Hedging Using German Mark												
SKor-Won	106.56	104.97	36.54	24.78	7.41	1.87	35.32	24.67	1.92	2.25	21.18	21.20
Indo-Rup	89.84	90.48	36.57	37.16	7.29	7.29	37.11	37.07	1.68	1.67	21.40	21.31
Phil-Peso	103.13	103.76	35.62	14.21	6.63	11.59	35.64	49.08	0.83	4.35	22.17	11.92
Thai-Bht	104.43	40.31	33.91	8.890	6.38	0.49	34.91	86.17	1.53	2.46	21.36	15.79
Taiwan-\$	105.22	153.33	33.63	107.86	4.06	41.35	30.03	67.75	1.16	13.62	21.88	30.03
Singap-\$	86.84	26.33	20.52	33.40	21.06	111.10	11.06	87.29	21.36	80.28	5.27	47.78
HKong-\$	100.86	331.40	30.92	124.21	3.33	118.43	30.20	422.05	0.40	206.68	19.66	264.17
Cross-Hedging Using Japanese Yen												
SKor-Won	72.61	24.93	7.71	180.00	1.05	110.61	9.58	134.73	14.62	12.27	4.68	0.87
Indo-Rup	80.13	60.74	18.85	28.62	3.06	2.70	0.62	2.57	14.49	13.29	4.49	1.02
Phil-Peso	18.79	3.19	6.23	5.04	35.40	60.45	61.03	62.02	2.33	5.20	4.55	5.19
Thai-Bht	70.04	95.22	86.64	94.13	197.26	105.54	90.57	88.41	38.37	41.91	41.93	41.87
Taiwan-\$	84.67	217.42	148.18	213.33	83.25	95.03	94.82	94.40	39.8	53.04	45.54	52.78
Singap-\$	40.61	42.23	41.79	41.76	94.09	92.06	91.29	90.96	59.54	58.73	59.23	58.66
HKong-\$	212.65	326.58	244.26	321.61	228.68	501.02	495.04	493.78	180.22	274.98	210.26	274.96
Cross-Hedging Using Swiss Franc												
SKor-Won	93.88	92.06	21.29	7.29	2.83	16.87	5.28	133.37	1.06	2.77	17.71	17.69
Indo-Rup	81.31	83.87	20.25	17.07	1.91	1.91	6.15	6.18	0.69	0.67	17.64	17.63
Phil-Peso	91.61	93.40	20.88	16.64	1.47	4.98	7.30	9.82	0.68	3.66	17.39	16.06
Thai-Bht	92.73	79.72	19.27	7.53	1.39	2.53	8.05	68.81	1.05	2.67	17.50	16.30
Taiwan-\$	92.75	126.17	19.21	89.20	0.11	49.94	9.93	94.88	0.50	51.51	17.38	2.56
Singap-\$	82.31	21.50	7.130	34.88	20.19	116.55	61.72	106.41	17.15	79.13	14.08	7.18
HKong-\$	89.57	217.56	16.90	78.54	1.14	111.23	12.86	592.37	0.73	204.07	17.17	112.48

Note: The numbers in the table are 100 times their actual values. Boldface SPIs reflect a short position in the hedging instrument, and the other SPIs reflect a long position in the hedging instrument. Period 1 extends from 1/83-8/85 and is the estimation period to forecast the SPIs in Period 2. MR = minimum-risk hedge; full = fully hedged.

TABLE III
Difference between Hedged and Unhedged Sharpe Performance Index (Minimum-Risk Hedge Ratios Based on Full and Prior Period)

Investment Currency	Change in Sharpe Performance Index Full period: 1/83-12/92				Change in Sharpe Performance Index Second Subperiod: 9/85-1/87				Change in Sharpe Performance Index Third Subperiod: 2/87-12/89				Change in Sharpe Performance Index Fourth Subperiod: 1/90-12/92			
	Currency Futures		Currency Options		Currency Futures		Currency Options		Currency Futures		Currency Options		Currency Futures		Currency Options	
	Full	MR	Full	MR	Full	MR	Full	MR	Full	MR	Full	MR	Full	MR	Full	MR
Cross Hedging Using British Pound																
SKor-Won	62.16	61.39	69.06	67.39	116.56	115.45	83.27	81.30	2.45	20.25	1.44	2.13	2.92	2.93	16.91	16.89
Indo-Rup	10.44	10.29	1.60	1.50	3.56	58.91	25.45	24.64	97.34	97.34	100.91	100.91	11.43	11.43	31.03	31.02
Phil-Peso	8.52	3.99	0.19	2.63	26.59	31.37	4.62	2.04	68.78	61.67	74.75	67.80	1.45	1.90	16.81	3.20
Thai-Bht	29.81	26.35	36.54	27.73	60.59	55.80	26.84	21.27	95.30	93.94	98.83	45.50	30.51	29.46	54.91	46.44
Taiwan-\$	11.97	6.60	17.82	4.85	23.85	84.32	57.76	47.05	14.09	8.06	9.18	2.63	31.27	0.65	50.23	23.43
Singap-\$	22.03	13.08	25.76	12.47	68.11	21.34	32.49	13.76	20.92	12.03	24.05	13.05	1.70	1.44	15.18	8.22
HKong-\$	38.88	0.01	46.40	0.06	343.17	148.52	304.56	225.98	506.25	455.13	503.29	131.58	236.89	5.37	255.59	29.90
Cross Hedging Using Canadian Dollar																
SKor-Won	58.97	58.67	69.90	52.50	100.52	100.23	84.03	83.51	16.38	16.42	4.43	4.44	11.31	11.31	13.53	11.61
Indo-Rup	10.55	10.42	1.72	17.19	4.35	3.35	17.46	14.7	116.78	116.77	106.04	73.65	3.27	29.40	1.13	31.91
Phil-Peso	8.38	6.19	0.21	3.93	14.14	15.01	3.11	5.78	86.86	83.53	79.86	78.85	9.46	7.83	11.98	0.29
Thai-Bht	25.83	0.36	37.29	7.17	43.81	38.98	27.36	82.58	112.78	99.14	95.81	52.25	26.23	15.29	18.40	1.91
Taiwan-\$	7.77	1.49	19.85	2.91	41.04	1.51	57.30	42.65	5.47	14.95	6.31	5.16	22.61	44.79	19.85	8.20
Singap-\$	8.70	0.03	29.79	0.50	31.12	2.34	18.25	1.75	31.56	2.95	30.54	27.97	8.75	0.73	6.94	0.14
HKong-\$	32.69	0.17	48.36	0.75	321.67	263.55	300.28	289.64	519.91	168.44	509.40	485.06	225.22	97.68	218.52	0.42
Cross Hedging Using German Mark																
SKor-Won	72.71	70.89	80.65	77.96	191.15	190.49	120.83	116.61	3.92	3.43	23.65	25.16	5.60	1.43	24.86	17.52
Indo-Rup	1.67	1.73	9.12	9.27	62.03	62.67	9.530	10.12	98.26	98.26	126.96	126.92	19.84	19.83	39.56	39.47
Phil-Peso	1.04	4.26	12.42	0.02	98.09	108.8	30.72	9.31	68.94	50.72	99.40	14.68	6.03	0.85	27.37	6.72
Thai-Bht	39.23	30.51	48.18	28.48	200.13	87.38	63.91	55.50	94.88	81.54	122.56	4.70	38.20	34.79	62.99	57.42
Taiwan-\$	22.51	3.86	30.78	8.51	51.85	150.62	19.54	70.22	15.31	4.48	14.94	16.08	38.43	26.41	59.20	10.00
Singap-\$	25.14	8.57	31.47	5.20	112.87	19.03	62.27	20.43	17.64	5.95	36.68	14.36	4.26	1.95	22.73	8.89
HKong-\$	46.94	1.88	57.20	0.42	427.43	29.25	338.71	196.71	503.90	401.79	523.89	109.13	243.41	68.33	263.47	11.09

TABLE III (Continued)
 Difference between Hedged and Unhedged Sharpe Performance Index (Minimum-Risk Hedge Ratios Based on Full and Prior Period)

Investment Currency	Change in Sharpe Performance Index Full period: 1/83-12/92				Change in Sharpe Performance Index Second Subperiod: 9/85-1/87				Change in Sharpe Performance Index Third Subperiod: 2/87-12/89				Change in Sharpe Performance Index Fourth Subperiod: 1/90-12/92			
	Currency Futures		Currency Options		Currency Futures		Currency Options		Currency Futures		Currency Options		Currency Futures		Currency Options	
	Full	MR	Full	MR	Full	MR	Full	MR	Full	MR	Full	MR	Full	MR	Full	MR
Cross Hedging Using Japanese Yen																
SKor-Won	77.92	26.58	62.78	0.28	160.84	146.62	95.93	27.31	3.93	2.41	7.04	0.53	18.30	15.95	8.36	4.55
Indo-Rup	4.36	7.09	4.62	0.00	52.32	32.93	8.19	1.58	94.03	93.67	89.23	87.28	32.65	31.45	22.65	17.14
Phil-Peso	1.97	0.20	0.36	0.01	13.75	8.23	1.33	0.14	26.91	1.86	2.73	1.74	2.87	0.00	0.65	0.01
Thai-Bht	4.35	0.41	0.69	0.00	40.77	4.82	9.75	0.10	43.40	12.76	14.23	0.84	14.55	2.60	7.60	0.50
Taiwan-\$	11.26	0.22	2.92	0.02	39.38	5.18	3.41	0.41	0.01	0.01	0.45	0.00	14.41	0.08	7.54	0.23
Singap-\$	0.84	0.16	0.32	0.01	2.74	0.91	0.72	0.21	0.68	0.02	0.14	0.02	0.45	0.06	0.15	0.01
HKong-\$	3.01	0.02	0.62	0.00	150.40	0.26	76.66	0.30	290.16	0.45	169.25	0.09	85.09	0.04	54.34	0.01
Cross Hedging Using Swiss Franc																
SKor-Won	70.26	68.30	71.94	65.05	178.47	177.82	105.57	100.97	8.52	6.79	16.98	0.50	4.74	0.91	21.39	21.37
Indo-Rup	4.46	4.30	0.15	2.64	53.50	56.06	6.79	44.11	92.88	92.88	83.70	83.67	18.85	18.83	35.80	35.79
Phil-Peso	1.68	5.83	2.05	0.00	86.57	98.44	15.98	11.74	63.78	57.33	56.46	53.94	4.52	1.54	22.59	10.86
Thai-Bht	36.87	30.69	39.31	21.25	188.43	175.42	48.86	45.33	81.96	78.59	72.09	18.84	37.71	38.96	54.11	53.10
Taiwan-\$	20.06	6.93	21.99	6.67	38.67	143.26	34.71	59.28	20.04	9.07	26.41	0.29	37.74	2.21	54.46	50.52
Singap-\$	24.50	8.98	31.14	3.46	125.16	24.62	48.88	21.17	14.10	5.63	5.09	1.01	4.16	1.97	20.37	17.80
HKong-\$	64.89	1.01	50.22	0.85	416.14	109.01	324.77	230.96	499.43	408.79	506.55	106.22	243.04	70.94	260.77	143.85

Note: The numbers in the table are 100 times their actual values. Boldface represents a short derivatives position. Italics means the unhedged strategy is better.
 MR = minimum risk hedge; Full = fully hedged.

CONCLUSIONS

Although there have been sharp increases in foreign portfolio investments in the Asian emerging countries, most studies of hedging currency risks have focused on investments in the developed countries. Investments in the developing and emerging markets are often difficult to hedge, as derivative markets in such currencies are nonexistent or relatively underdeveloped, so they are often not very liquid. Thus, there is a critical need to examine the effectiveness of cross-hedging portfolio investments in emerging markets by using derivatives denominated in the more liquid developed-market currencies. This study examines the effectiveness and efficiency of cross-hedging investments denominated in Asian emerging market currencies (South Korean Won, Indonesian rupiah, Philippine peso, Thailand bhat, Taiwan dollar, Singapore dollar, and Hong Kong dollar) with futures and options denominated in the major currencies (British pound, Canadian dollar, German mark, Japanese yen, and the Swiss franc). The results of this study should be of interest not only to investors and portfolio managers, but also to policy makers and others interested in exchange rate movements.

This study documents that investments in Asian emerging markets can be effectively hedged by using futures and options in developed country currencies. Such hedging is shown to improve portfolio performance as measured by the Sharpe performance index. Further, when the overall period is broken down into subperiods, such cross hedges are shown to be stable, and ex-ante cross hedges are beneficial even when based on prior-period hedge ratios. Finally, cross-hedging performance can be further improved even if just the direction of these emerging-market exchange-rate changes can be forecast. These results imply that hedging investments denominated in emerging-market currencies can be beneficial, and are thus consistent with similar results for hedging currency risks in the major currencies. Interestingly, these results are also consistent with evidence [e.g., in Aggarwal and Mougoue (1996)] of an emerging yen bloc in Asia, as futures and options denominated in the Japanese yen are often the most effective currency denomination for hedging investments in Asian emerging markets.

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