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The Introduction of Won/Yen Futures Contract and Its Hedging Effectiveness

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Abstract

Despite of regional closeness and active trading between Korea and Japan, there is little empirical analysis on the foreign exchange risk of Korean won and Japanese yen. Recently, the Korea Exchange (KRX) has introduced a Japanese yen currency futures contract. The main objective of this study is to examine the hedging performance of this foreign exchange hedging tool. This study sets up a theoretical framework for four hedging scenarios of investment and capital procurement schemes with direct and cross hedge types. According to the simulation results, the 1:1 naïve and the minimum variance hedge strategies outperform no-hedge strategy. The hedging effects of investment case are far greater than those of the capital procurement case. With respect to risk reduction, the minimum variance hedge is considered to be superior to the 1:1 naïve hedge. More importantly, the hedging performances of direct hedge strategies prove to be even better than those of cross hedge strategies. The differences in the hedging performances between direct and cross hedges would be regarded as the effects of introducing Japanese yen currency futures contract.

Keywords: Won/Yen Futures Contract, Hedging Effectiveness, Direct and Cross Hedges

JEL classification: C15, F31, G32

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1. Introduction

As an international portfolio strategy, investment banks and hedge funds invest their capital in foreign assets. In order to meet capital spending requirement, sovereign governments and multinational corporations have been generating liabilities in a different mix of currencies through commercial banks and the capital markets. As a result, they might possess unhedged investments and liabilities denominated in various foreign currencies. They also experience large gains and losses associated with exchange rate fluctuations as well as the values of invested assets and liabilities. In fact, the global fund managers, debt issuers and liability managers concern the risks inherent in their foreign investment and debt portfolios.

Recently, Korean investment banks and securities are increasingly seeking for investment on foreign assets and securities as a measure of investment diversification. On the other hand, due to the availability of longer maturities and lower interest rates it is expected for many Korean companies to continue to fund a large portion of its borrowings in foreign currencies from oversea capital markets. Theoretically, the risk exposures related to asset prices and exchange rates can be hedged in derivatives markets including forwards and futures. Except for US dollar futures and options, there has been no instrument to hedge the foreign exchange risks of Korean won against major foreign currencies due to the lack of domestic financial market development.[1]

However, the Korean won becomes a more convertible currency and the Korean financial market has been developed further. Consequently, domestic and foreign market participants have been continuously demanding for the futures contract of foreign currencies other than US dollar. On May 26 of 2006, KRX started the trading of

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[1] The US dollar futures and options contracts have been traded since April 1999 with the start of Korea Futures Exchange. This exchange was integrated with the Korea Stock Exchange into the Korea Exchange (KRX) in January 2005. The non exchange-traded domestic forward markets and non-deferrable forward (NDF) markets in Hong Kong and Singapore are concentrated on the exchange rate of Korean won against US dollar.

Japanese yen futures and euro futures contracts. Each contract covers 5 millions yen and 50 thousands euro, respectively.[2] We expect that these futures contracts would provide domestic and foreign market participants with a proper hedging tool for yen and euro currency risks as well as investment opportunities.

This study tries to examine the usefulness of the newly listed Japanese yen currency futures contract. For this purpose, a theoretical model is set up to deal with the scenarios of investment and capital procurement with and without covering foreign exchange risks. In addition, the hedging effectiveness of direct hedging type is compared with that of cross hedging type. The direct hedging scheme refers to protect foreign exchange risk using the corresponding futures contracts. The cross hedging strategy involves protection against the concerned foreign exchange risk using a highly correlated foreign currency.

This paper is organized as follows. In section 2 the main results and implications of the previous studies related to the estimation of hedge ratio are summarized. Section 3 describes the theoretical framework, and section 4 explains the sample data used and the procedure of empirical analysis. Section 5 reports the empirical results, and section 6 concludes.

2. Literature Review

In the theoretical point of view, two approaches to derive the optimal hedge ratios have been highlighted in the literature. One is to maximize the expected utility by applying modern portfolio theory to the hedging problem (Stein, 1961). The other is to minimize the variance of underlying wealth, formulating the minimum variance hedge ratio based on portfolio approach (Johnson, 1960; Ederington, 1979). Although the expected utility maximization approach is more realistic, it has practical problems. This approach includes the selection of the appropriate functional form of the firm's utility function and the determination of the degree of risk aversion.

[2] Detailed specifications for these contracts are found in the www.krx.co.kr.

Many researchers have favored the minimum variance approach due to its easy use and practical usefulness. This approach is consistent with the expected utility approach if futures markets are unbiased, regardless of the true utility function form (Benninga et al., 1983). Since futures markets are typically found to be unbiased (Newbery and Stiglitz, 1981), it is practically appealing. However, this approach is still restrictive in the sense that it only concerns risk ignoring the factor of expected return. In other words, this approach is basically based on the separation theorem that the hedger's decision on spot and futures position can be determined without reference to a utility function or risk preferences.

The mean-variance approach is analogous to the expected utility approach if the utility function is quadratic or negative exponential and/or the wealth is normal (Levy and Markowitz, 1979). In spite of its wide use, the assumption of the utility functional form is fairly restrictive (Hanoch and Levy, 1969; Pratt, 1964). Also, many studies find the evidence against the assumption of normal distribution associated with commodity prices (Yang and Brorsen, 1993).

In addition, Cecchetti et al. (1988) and Castellino (1990) point out that the minimum variance hedge ratio is in general inconsistent with the mean-variance framework. This is because a consistent hedge ratio can be guaranteed by implicitly assuming that either expected returns on the futures contract need to be zero or that investors are infinitely risk averse. This assumption implies that they will renounce an infinite amount of expected return in exchange for an indefinitely small risk reduction. However, such an assumption is undoubtedly unrealistic.

The mean-Gini approach has been proposed to avoid the practical difficulty inherent in the expected utility approach, that is, the arbitrary choice of utility function form (Bey et al., 1984; Okunev, 1991; Shalit and Yitzhaki, 1984, 1989). However, this approach is still subject to arbitrarily chosen risk aversion coefficients. Thus, it is less practical to expect futures traders and practitioners to know exactly how much they penalty risk.

In the context of empirical estimation, several techniques to estimate the hedge ratios have been proposed in the literature. While these techniques hold theoretical appeal, there is no univocal evidence as to their effectiveness. As a widely used technique to estimate the hedge ratio is to use the simple method of the ordinary least-square (OLS) regression. If the spot and futures prices are not cointegrated and the conditional variance-covariance matrix is time invariant, a constant hedge ratio can be obtained from the slope coefficient in the regression of the spot prices on the futures prices.

In spite of its popularity, this method has suffered various criticisms. The first issue is the appropriate choice of data form. The conventional approach to estimating the optimal hedge ratios is to use the OLS regression of spot price levels on futures price levels or spot price changes on futures price changes. Some researchers use the regression of spot market returns on futures market returns, where returns are defined as the proportional price change from period to period. That is, the question of whether price levels, changes, or returns should be used in the simple regression approach has become controversial (Hill and Schneeweis, 1981; Brown 1985, 1986; Kahl 1983, 1986; Bond et al., 1987; Witt et al., 1987; Myers and Thompson, 1989).

After considering statistical, theoretical and practical questions about the appropriateness of using one model over another, Witt et al. (1987) point out that the gauge is the degree of linearity between the spot price and futures price differences when comparing the price change models with the return models. In other words, if the spot prices respond linearly with the futures prices the price change model would be preferred because a goal is to keep the model as simple as possible. However, if a definite nonlinear relationship exists between the parties, the return model may be preferred.

Myers and Thompson (1989) show that none of these simple regression approaches are appropriate for hedge ratio estimation except under special circumstances. This is because the slope parameter from an OLS regression provides only a ratio of unconditional covariance between spot and futures prices to the unconditional variance of futures prices. In the mean-variance approach, the covariance and variance in the optimal hedging rule are definitely conditional second moments that depend on information available at the time the hedging decision is made. As an alternative to the simple regression approach, the authors suggest a generalized approach that takes account of relevant conditioning information. In addition, they note that simple regression using price levels or returns leads to errors in optimal hedge ratio estimation in an application to storage hedging but that simple regression using price changes provides reasonably accurate estimates.

The second issue is related to the notion that the OLS method might ignore the important role of possible cointegration relationship between spot and futures prices in determining the hedge ratio (Ghosh, 1993a, 1993b; Wahab and Lashgari, 1993; Lien 1996, 2004). In fact, the presence of the efficient market hypothesis and the absence of arbitrage opportunity imply that spot and futures prices are cointegrated and an error correction representation must exist. Following this argument, various error correction models (ECM) are adopted to estimate the hedge ratio.

Another issue addressed by a large number of researchers is that the spot and futures returns typically exhibit time-varying conditional heteroscedasticity (Bollerslev, 1990; Baillie and Myers, 1991; Lien and Luo, 1994; Park and Switzer 1995a, 1995b; Lien and Tse, 1998; Yang and Allen, 2005). Thus, the data do not support the assumption that the variance-covariance matrix of return is constant over time. In order to incorporate these data characteristics, it is necessary to consider the possible time-varying nature of the second moments. In this context, the generalized autoregressive conditional heteroscedasticity (GARCH) class of models is proposed, and these models allow the conditional variances and covariances used as inputs to the hedge ratio to be time-varying.

Recently, other researchers have proposed more complex techniques and some special case of the above techniques for the estimation of the hedge ratio. Among them, there are the random coefficient autoregressive (Bera et al., 1997), the fractional cointegrated error correction model (Lien and Tse, 1999), the exponentially weighted moving average estimator (Harris and Shen, 2002), and the asymmetric GARCH (Brooks et al., 2002).

As an alternative to the statistical time-series approach, the finance literature stresses the derivative pricing model approach. The derivative pricing model approach is based on the assumption that the seller of a derivative could form a risk-free portfolio by holding just the right quantity of the underlying security (Black and Scholes, 1973; Merton, 1973). This approach directly incorporates the arbitrage relationships between the derivative and underlying assets. Bryant and Haigh (2005) find that the derivative pricing models cannot outperform a vector ECM with a GARCH error structure. The authors point out that the derivative pricing models' unpalatable assumption of deterministically evolving futures volatility seems to impede their hedging effectiveness.

Despite of merits of different methods in the statistical point of view, the distinctive superiority of one model over another is still a question under debate. In fact, the model selection for the hedge ratio estimation will be completely related to the empirical comparison in terms of hedging effectiveness among estimation methods. This study adopts the simple OLS regression approach. Although there exist presumable defects in theoretical and statistical sense, the estimation of minimum variance hedge ratio using the simple regression is useful in that it could provide a benchmark for comparison of the hedging performances.

In addition, Moosa (2003) and Bowman (2004) support the appropriateness of simple OLS regression for hedge ratio estimation. In fact, since the hedge ratio from OLS regression minimizes the within-sample unconditional variance, it will likely perform better than the hedge ratio from ECM regression in terms of out-of-sample hedged portfolio variance. This argument is valid regardless of the sizes of the two samples. However, when there exist substantial structural changes between the two subsamples, the ECM hedge ratio may outperform the OLS hedge ratio. More recently, Lien (2005) demonstrates that the OLS model provides a hedge ratio that usually outperforms that derived from the correct ECM even when the OLS model is misspecified in the presence of cointegration relationship between spot and futures prices.

In sum, model specification has little effect on the hedging effectiveness. What matters most is the correlation between the prices of the unhedged position and the hedging instrument (Moosa, 2003). In addition, the preliminary test results such as unit root and cointegration tests are not important in the context of simulation analysis of hedging performance. As a result, no matter whether they are stationary or not, or no matter whether a theory or a statistical implication suggests a specific model, what is more important is which hedge rule performs best. Thus, the simulation results will directly tell us.

3. Theoretical Framework

As mentioned above, this study analyzes the hedging effectiveness of Japanese yen currency futures contract by different hedging schemes and types. The hedging schemes considered in this study include investment hedging scheme and capital procurement hedging scheme. For each hedging scheme, direct and cross hedging types are implemented and simulated to empirically analyze the hedging effectiveness. Consequently, four scenarios regarding the management of exchange rate risk are established: hedging for investment with direct hedge (Scenario I), hedging for investment with cross hedge (Scenario II); hedging for capital procurement with direct hedge (Scenario III); and hedging for capital procurement with cross hedge (Scenario IV).

The investment hedging scheme refers to the situation when a Korean company invests some amount of capital denominated in foreign currency (Japanese yen). Ignoring the fluctuation in the value of invested capital, the risk exposure faced by the company would be the foreign exchange risk stemming from the fluctuation of Japanese yen currency values against local currency (Korean won).[3] This is because the spot exchange rate is not expected to be constant, and moves all the time, i.e., stochastic. Thus, it is assumed that the distribution of the spot exchange rate is known, but its realization is not. The spot exchange rate is the crucial source of risk to be considered in

[3] In reality, the value of invested capital in foreign currency, here Japanese yen, may change during the investment period. This implies that there exists a risk exposure related to the fluctuations of asset or commodity prices. Focusing on the exchange rate risk, this study assumes the constant value of investment in foreign currency, and this assumption would not be far from reality.

this study.

In order to protect against the foreign exchange risk, one could place short position in Japanese yen currency futures or buy a foreign currency that is highly correlated with Japanese yen. When Korean won appreciates (depreciates) relative to Japanese yen during the investment period, the amount of invested capital in Korean won would decrease (increase) assuming the value of investment in Japanese yen to be unchanged. The end-of-period return from investment in Korean won with direct and cross hedging types are given as follows:

$$R_t(DX) = (P_{xt} - P_{xt-i})\cdot INV_{t-i}(FX) + (F_{xt-i} - F_{xt})\cdot X_{t-i} \qquad (1)$$

$$R_t(DX) = (P_{xt} - P_{xt-i})\cdot INV_{t-i}(FX) + U_{xt}\cdot(C_{xt-i} - C_{xt})\cdot X_{t-i} \qquad (2)$$

where

$R_t(DX)$	=	return from investment in Korean won at the time of t;
$INV_{t-i}(FX)$	=	investment amount in Japanese yen at the time of t-i;
P_{xt}, P_{xt-i}	=	spot exchange rate of won/yen at the time of t and t-i;
F_{xt}, F_{xt-i}	=	futures exchange rate of won/yen at the time of t and t-i;
U_{xt}	=	spot exchange rate of won/dollar at the time of t and t-i;
C_{xt}, C_{xt-i}	=	spot exchange rate between dollar against foreign currencies at the time of t and t-i; and
X_{t-i}	=	currency hedging amount bought (if > 0), or sold (if < 0).

The time subscript t-i stands for the time when one starts an investment program and a currency hedge is placed and t for the time when he or she closes the investment and the hedge is lifted. Here, i = 1, 3, 6, 9, and 12 months. The first terms of right-hand sides of equations (1) and (2) are the returns from investment denominated in local currency, that is Korean won. The second terms are the exchange rate gains (losses) if positive (negative) resulting from the movements of currency futures prices or cross exchange rates.

For the capital procurement hedging scheme, assume that a Korean company borrows long-term debt from foreign capital market. This company pays interests by certain period of time until the maturity and the principal at the end of maturity. The interest payments could be in the form of fixed rate or floating rate payment. For expositional purpose, we consider only the fixed-rate payments.[4] This implies that the liability amount in foreign currency, here Japanese yen, is exogenously determined to be constant.

When the interest payments are due, the liability manager would buy Japanese yen with local currency, here Korean won. For each interval of interest payment, he or she would be concerned about the foreign exchange losses given the fixed-rate interest payments. That is, when Korean won is devaluated (revaluated) against to Japanese yen between each interval of interest payment, the payments in Korean won would increase (decrease) with the fixed amount of payments in Japanese yen. Contrary to the investment hedging scheme, one could place long position in Japanese yen currency futures to protect against the depreciation of Korean won. Alternatively, he or she can make short selling of a foreign currency that is highly correlated with Japanese yen. At each payment of interest, the interest payments in Korean won based on direct and cross hedging types are as follows:

$$I_t(DX) = P_{xt} \cdot AMT_t(FX) \cdot r - (F_{xt} - F_{xt-i}) \cdot X_{t-i} \tag{3}$$

$$I_t(DX) = P_{xt} \cdot AMT_t(FX) \cdot r - U_{xt} \cdot (C_{xt} - C_{xt-i}) \cdot X_{t-i} \tag{4}$$

where

$I_t(DX)$	=	interest payment in Korean won at the time of t;
$AMT_t(FX)$	=	liability amount in Japanese yen at the time of t; and
r	=	fixed interest rate.

The definitions of remaining variables are the same with those of investment hedging

[4] This case would be plausible if the company is aimed at the cost minimization at least in the short run. This problem setting does not make any difference from the profit maximization framework in terms of the final solution.

scheme. The time subscript t-i stands for the time when direct or cross currency hedge is placed and t for the time when the interests are paid and the hedge is lifted. The first terms of right-hand sides of equations (3) and (4) are the interest payments in Korean won. The second terms are the exchange rate gains (losses) if positive (negative) resulting from direct or cross hedge with a highly correlated foreign currency.

The next step to analyze the hedging effectiveness is to derive the hedge ratios corresponding to different hedging scenarios. Based on a basic mean-variance framework, the decision maker is assumed to maximize his or her expected utility. Using a quadratic utility function, or negative utility function and assuming a normal distribution of returns, this maximization of expected utility is equivalent to maximizing one's expected returns appropriately adjusted for risks. Assuming the unbiasedness of futures price and/or infinite risk aversion, the optimal hedge ratio is actually equal to the minimum variance hedge ratio.

In terms of local currency, the variances of the investment returns in equations (1) and (2) and the interest payments in equations (3) and (4) are given by:

$$\mathrm{var}[R_t(DX)] = [INV_{t-i}(FX)]^2 \cdot \mathrm{var}(P_{xt}) + X_{t-i}^2 \cdot \mathrm{var}(F_{xt}) - 2[INV_{t-i}(FX)] \cdot X_{t-i} \cdot \mathrm{cov}(P_{xt}, F_{xt}); \quad (5)$$

$$\mathrm{var}[R_t(DX)] = [INV_{t-i}(FX)]^2 \cdot \mathrm{var}(P_{xt}) + X_{t-i}^2 \cdot \mathrm{var}(U_{xt} \cdot C_{xt}) - 2[INV_{t-i}(FX)] \cdot X_{t-i} \cdot \mathrm{cov}(P_{xt}, U_{xt} \cdot C_{xt}); \quad (6)$$

$$\mathrm{var}[I_t(DX)] = [AMT_t(FX) \cdot r]^2 \cdot \mathrm{var}(P_{xt}) + X_{t-i}^2 \cdot \mathrm{var}(F_{xt}) - 2[AMT_t(FX) \cdot r] \cdot X_{t-i} \cdot \mathrm{cov}(P_{xt}, F_{xt}); \text{ and} \quad (7)$$

$$\mathrm{var}[I_t(DX)] = [AMT_t(FX) \cdot r]^2 \cdot \mathrm{var}(P_{xt}) + X_{t-i}^2 \cdot \mathrm{var}(U_{xt} \cdot C_{xt}) - 2[AMT_t(FX) \cdot r] \cdot X_{t-i} \cdot \mathrm{cov}(P_{xt}, U_{xt} \cdot C_{xt}). \quad (8)$$

Note that the term of $U_{xt} \cdot C_{xt}$ is equal to an arbitrated rate of exchange that corresponds to the exchange rate of Korean won against US dollar divided by or multiplied by the cross rate between US dollar and foreign currencies. The terms of var(X) and cov(X,Y) correspond to the variance of X variable and the covariance of X and Y variables. Adopting the minimum variance approach and assuming futures prices are typically found to be unbiased, the decision maker's problem is to minimize the variability of investment returns or interest payments in local currency with respect to X_{t-i}, respectively. The first order condition with respect to X_{t-i} are represented as follows:

$$\partial var[R_t(DX)]/\partial X_{t-i} = X_{t-i}\cdot var(F_{xt}) - [INV_{t-i}(FX)]\cdot cov(P_{xt}, F_{xt}) = 0; \quad (9)$$

$$\partial var[R_t(DX)]/\partial X_{t-i} = X_{t-i}\cdot var(U_{xt}\cdot C_{xt}) - [INV_{t-i}(FX)]\cdot cov(P_{xt}, U_{xt}\cdot C_{xt}) = 0; \quad (10)$$

$$\partial var[I_t(DX)]/\partial X_{t-i} = X_{t-i}\cdot var(F_{xt}) - [AMT_t(FX)\cdot r]\cdot cov(P_{xt}, F_{xt}) = 0; \text{ and} \quad (11)$$

$$\partial var[I_t(DX)]/\partial X_{t-i} = X_{t-i}\cdot var(U_{xt}\cdot C_{xt}) - [AMT_t(FX)\cdot r]\cdot cov(P_{xt}, U_{xt}\cdot C_{xt}) = 0. \quad (12)$$

Through algebraic manipulation, the minimum variance hedge ratios for each hedging scenario are expressed as follows:

$$b_{MV} = X_{t-i}^{*}/[INV_{t-i}(FX)] = cov(P_{xt}, F_{xt})/var(F_{xt}); \quad (13)$$

$$b_{MV} = X_{t-i}^{*}/[INV_{t-i}(FX)] = cov(P_{xt}, U_{xt}\cdot C_{xt})/var(U_{xt}\cdot C_{xt}); \quad (14)$$

$$b_{MV} = X_{t-i}^{*}/[AMT_t(FX)\cdot r] = cov(P_{xt}, F_{xt})/var(F_{xt}); \text{ and} \quad (15)$$

$$b_{MV} = X_{t-i}^{*}/[AMT_t(FX)\cdot r] = cov(P_{xt}, U_{xt}\cdot C_{xt})/var(U_{xt}\cdot C_{xt}). \quad (16)$$

The minimum variance hedge ratio of scenario I in equation (13) turns out to be identical with that of scenario III in equation (15). Likewise, the minimum variance hedge ratios of scenario II in equation (14) and IV in equation (16) are the same. However, the empirical estimation of hedge ratios by hedging scenario can be quite different, explained in the next section.

4. Data and Procedure of Empirical Analysis

4.1. Data

This study uses the monthly averages of daily spot exchange rates of ten foreign currencies in terms of Korean won.[5] The sample covers the period of January 2000 to April 2006. The foreign currencies include Japanese yen (JPY), US dollar (USD), European Monetary System euro (EUR), United Kingdom pound sterling (GBP), Canadian dollar (CAD), Swiss franc (CHF), Australian dollar (AUD), Hong Kong dollar (HKD), Singapore dollar (SGD), and China Yuan Renminbi (CNY). The exchange rate of Korean won against Japanese yen is used for direct hedging type, and the arbitrated rates of exchange of Korean won against the remaining foreign currencies are tested for cross hedging type.

Table 1 shows the correlation coefficients (ρ), the slope coefficients (b), and the coefficients of determination (R^2) between Japanese yen and other foreign currencies in Korean won. All the data series are differenced by one month. The correlation coefficients range from 0.254 for HKD to 0.551 for CHF. As a measure of hedge ratio for 1-month investment hedging scheme, the slope coefficients of the simple OLS regressions of Japanese yen on other foreign exchange rates in Korean won vary from 0.192 for GBP to 1.623 for CNY. As a measure of hedging effectiveness, the values of R^2 of the OLS regression range from 0.064 for HKD to 0.303 for CHF.

Table 1. Relationship between Japanese yen and foreign currencies in Korean won

Statistics	USD	EUR	GBP	CAD	CHF	AUD	HKD	SGD	CHY
ρ	0.259	0.511	0.462	0.411	0.551	0.464	0.254	0.473	0.256
b	0.199	0.265	0.192	0.377	0.444	0.380	1.413	0.732	1.623
R^2	0.067	0.261	0.214	0.169	0.303	0.215	0.064	0.224	0.066

Note: All data series are differenced by one month.

[5] Instead of monthly averages, the end-of-month series are used to implement the simulation. The results are almost the same, and are available from author on request.

The data set is available from the Economic Statistics System of Bank of Korea. This monthly data set has 76 observations, and is reduced to 64 observations by deleting the first 12 observations for differencing up to 12 months of hedging period. For *ex ante* analysis, the whole sample period is divided into the first in-sample period of January 2001 to December 2002 (24 observations) for estimating hedge ratios and the second out-of-sample period of January 2003 to April 2006 (40 observations).

Due to the short trading period of Japanese yen currency futures in KRX, this study generates theoretical settlement price series of Japanese yen currency futures for the sample period. For this purpose, Korean and Japanese market interest rates are collected as inputs for the following formulae of theoretical futures prices designated by KRX:

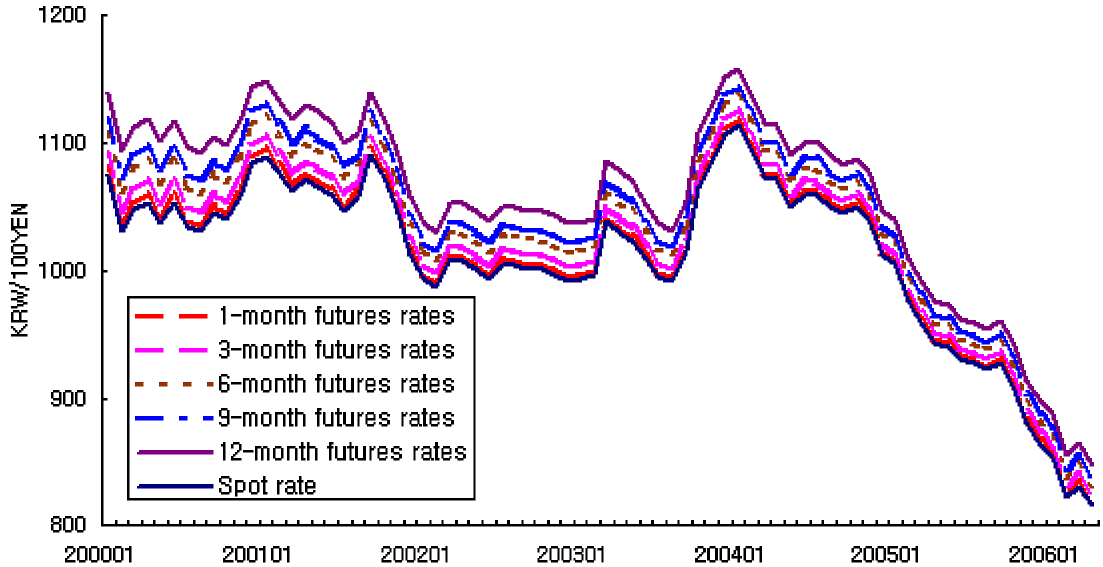
$$F = S \cdot [1 + r \cdot (t/365)] / [1 + r_f \cdot (t/365)]. \quad (17)$$

Here, F and S stand for the theoretical futures and spot prices of Japanese yen currency denominated in Korean won, respectively. t is the remaining days until the last trading day. The interest rates of r and r_f correspond to the Korean and Japanese market rates, respectively. The Korean market rates are obtained by averaging the 1-day uncollateralized call rates from direct interbank transactions and 91-day yields on commercial paper (CP). For the Japanese market rates, the averages of 3-month LIBOR (London) and 6-month LIBOR (Paris) are used.[6] This data set is also available from the Economic Statistics System of Bank of Korea.

Figure 1 shows the price series of spot and futures with delivery of 1, 3, 6, 9 and 12 months for the whole sample period. As noticed in Figure 1, the spot prices are located below the futures prices of every maturity representing contangos. In reality, there should be repeats of contango and backwardations in the market, but due to the characteristics of artificially generated futures prices the contango situation dominates.

[6] In fact, KRX uses the averages of 1-month, 3-month, 9-month and 12-month TIBOR from the Japanese Bankers Association as Japanese market interest rates in the formulae. Due to inaccessibility of the corresponding data, this study uses LIBOR rates.

Figure 1. Spot and futures prices of Japanese yen currency by maturity



4.2. Procedure of Empirical Analysis

As discussed in section 2, the use of OLS regression for hedge ratio estimation would be appropriate even when there exists a cointegration relationship between spot and futures prices. More importantly, it should be noted that the choice of estimation method wholly depends on the hedging performances in terms of hedging effectiveness. Therefore, the OLS estimation of hedge ratios would be enough to evaluate the comparative performances of different hedging scenarios and periods. Specifically, this research estimates the minimum variance hedge ratios for each hedging scenario and period using the following simple OLS regressions:

$$(P_{xt} - P_{xt-i}) = a + b_{t-i} \cdot (F_{xt} - F_{xt-i}); \quad (18)$$

$$(P_{xt} - P_{xt-i}) = a + b_{t-i} \cdot (U_{xt} \cdot C_{xt} - U_{xt-i} \cdot C_{xt-i}); \quad (19)$$

$$P_{xt} = a + b_{t-i} \cdot (F_{xt} - F_{xt-i}); \text{ and} \quad (20)$$

$$P_{xt} = a + b_{t-i} \cdot (U_{xt} \cdot C_{xt} - U_{xt-i} \cdot C_{xt-i}). \quad (21)$$

As shown above, in the case of investment hedging schemes in equations (18) and (19) the dependent and explanatory variables are differenced, that is, in the form of price changes. Contrarily, the capital procurement hedging schemes in equations (20) and (21) the dependent variables are in the form of price levels, while the explanatory variables are in the form of price changes. Also, note that the changes of spot and the futures rates are calculated by using the rates of time t-i and t of distant futures contracts corresponding to each maturity, not by rolling over the most nearby (one-month) futures contracts.

The difference in the estimation model specification stems from the difference in hedging scheme. That is, for investment hedging scheme there exists an exact linear relationship between the spot price and futures price differences. However, for capital procurement hedging scheme, the spot rates in time t-i do not matter in the hedging decision. This, in turn, implies that one cannot postulate a linear relationship between the spot price and futures price differences.

Related to the estimation of hedge ratios, this study adopts a simple dynamic rule by rolling over the in-sample and renewing hedge ratios each month. That is, the hedge ratio in January 2003 is estimated by using the data covering January 2001 through December 2002. As new spot and futures rates become available in the markets, the hedge ratio in February 2003 is estimated by using the data spanning February 2001 through January 2003. This updating process to obtain hedge ratios continues until the last month of out-of-sample period. Although this study does not explicitly consider a possible time-varying mean and/or variance of data by using a GARCH-type model, it is likely to incorporate new information into the hedging decision.

Table 2 shows the means and standard deviations of the hedge ratios estimated using the equations (18) to (21) for the out-of-sample period. The hedge ratios vary by hedge type and period. On average, the cross hedges tend to yield hedge ratios far less than those of the direct hedges. In addition, the hedge ratios of the investment hedges exceed those of the procurement hedges.

Table 2. Averages of hedge ratios by hedge type

Hedge type	1-month	3-month	6-month	9-month	12-month
Investment hedge					
Direct hedge	0.996	0.988	0.976	0.970	0.957
Cross hedge	0.199	0.356	0.284	0.478	0.602
Procurement hedge					
Direct hedge	0.768	0.648	0.580	0.567	0.549
Cross hedge	0.142	0.235	0.249	0.362	0.399

To compare the *ex ante* out-of-sample hedging performances, this study simulates the investment returns in equations (1) and (2) and the interest payments in equations (3) and (4) each month by different hedging scenario and period. The investment and liability amounts in Japanese yen are fixed to be unit. This setting assumes the situation that there is no risk exposure related to the changes in the values of investment and liability. This study also compares the means and standard deviations of investment returns and interest payments. In addition, it calculates the hedging effectiveness of one-to-one (1:1) naïve hedge and the minimum-variance (MV) hedge against no hedge case. The conventional measure of hedging effectiveness is defined as [1 – (variance of hedged cash flow)/(variance of unhedged cash flow)] (Ederington, 1979). This is equivalent to the percentage reduction in the hedged cash flow compared to the unhedged cash flow.

Finally, one could examine the effect of introducing Japanese yen currency futures into Korean financial market. That is, the difference of hedging effectiveness between the direct and cross hedging types would be the effect of introducing the new Japanese yen currency futures contract.

5. Empirical Results

Table 3 shows the simulation results for investment hedging scenario.[7] In the case of no hedge, the mean and standard deviation of investment returns over one month for the out-of-sample period turn out to be –4.43 won and 17.87 won, respectively. As the investment period expands, the means of the returns decrease while the standard deviations increase.

In terms of the mean and variance, the 1:1 naïve hedge strategy outperforms no-hedge strategy regardless of hedging periods. That is, the 1:1 naïve hedge produces the investment returns about twice as much as those of no-hedge case. Noticeably, it completely eliminates the fluctuations of returns. Thus, this simple hedging strategy could result in an ideal situation with respect to the mean-variance framework. Presumably, this finding is associated with the down trending characteristics of out-of-sample period reflecting Korean won appreciation relative to Japanese yen.

The minimum variance hedge strategy produces quite a similar result with that of 1:1 naïve hedge. The improvements in the means are slightly decreased. However, the reduction effects in the variances turn out to be marginally improved except for 9-month hedging period.

Turning to the case of cross hedge using the US dollar, the hedging performances deteriorate compared to those of direct hedge. The only improvement is found for the means of investment returns from the 1:1 hedge. This result is consistent with the finding that the correlation coefficient between the won/yen and won/dollar exchange rates becomes to be low. In addition, the coefficient of determination from the OLS regression of the won/yen on won/dollar exchange rate turns out to be quite low.[8]

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[7] An *ex post* within-sample analysis is also performed for the whole sample period, and the results are basically similar with those of the *ex ante* out-of-sample analysis reported here. The results are available from author upon request.

[8] To conserve the space, only the cross hedge using US dollar is reported here. The cross hedging results using other foreign currencies are available from author on request.

Table 3. Simulation results for investment hedge (Unit: Korean won)

Hedge type	1-month	3-month	6-month	9-month	12-month
No-hedge					
Mean	-4.43	-13.04	-23.33	-29.40	-34.23
Std. Dev.	17.87	39.99	58.53	70.89	88.87
	Direct hedge (Scenario I)				
1:1 hedge					
Mean	0.03	0.23	0.90	1.81	3.54
Std. Dev.	0.11	0.70	1.67	2.41	4.28
Change in mean	100.6%	101.7%	103.9%	106.2%	110.4%
Change in variance	-100.0%	-100.0%	-99.9%	-99.9%	-99.8%
MV hedge					
Mean	0.00	0.04	0.49	1.28	2.68
Std. Dev.	0.09	0.58	1.56	2.56	4.08
Change in mean	100.0%	100.3%	102.1%	104.3%	107.8%
Change in variance	-100.0%	-100.0%	-99.9%	-99.9%	-99.8%
	Cross hedge (Scenario II)				
1:1 hedge					
Mean	1.9	6.0	9.2	20.9	38.8
Std. Dev.	20.8	37.7	56.0	66.6	75.5
Change in mean	143.8%	146.1%	139.3%	171.0%	213.3%
Change in variance	35.8%	-11.2%	-8.6%	-11.6%	-27.9%
MV hedge					
Mean	-2.88	-4.11	-9.06	0.59	20.98
Std. Dev.	17.61	38.46	51.50	58.68	61.30
Change in mean	34.9%	68.5%	61.2%	102.0%	161.3%
Change in variance	-2.9%	-7.5%	-22.6%	-31.5%	-52.4%

Table 4 reports the simulation results for capital procurement hedging scenario. For the no-hedge case, the means and standard deviations of interest payments are the same regardless of the payment intervals.

Similar with the case of investment hedging scenario, the 1:1 naïve hedge strategy reduces the variances of interest payments by 12% to 72% compared to the no-hedge strategy. Note that the hedging effectiveness improves as the hedging period expands. However, the average costs of payments turn out to be slightly increased. As a result, the overall hedging performance would depend on the decision maker's risk preference. Nevertheless, unless he or she is assumed to be infinitely risk averse, the reductions in the variances sufficiently surpass the increases in the average costs. This would result in an improvement of wealth in the mean-variance framework.

As with the investment hedging scenario, the minimum variance hedge strategy produces quite a similar result with that of 1:1 naïve hedge. Interestingly, the reduction magnitudes in the variances become to be increased regardless of hedging periods. In addition, the improvements in the means are slightly increased for the hedging periods of more than 6 months.

However, the hedging performances of the cross hedge with US dollar severely deteriorate compared to those of direct hedge. That is, the average costs of interest payments increase and the variances of payments increase as well except for the case of 12-month minimum variance hedge.

In sum, the hedging performances of Japanese yen currency futures turn out to be quite a noticeable regardless of hedging scenarios. The 1:1 naïve and the minimum variance hedge strategies outperform no-hedge strategy in terms of the means and/or variances of simulated cash flows. The hedging effects of investment case are far greater than those of the capital procurement case. With respect to risk reduction, the minimum variance hedge is considered to be superior to the 1:1 naïve hedge. More importantly, the hedging performances of direct hedge prove to be even better than those of cross hedge. The differences in the hedging performances between direct and cross hedges would be regarded as the effects of introducing the Japanese yen currency futures contract.

Table 4. Simulation results for capital procurement hedge (Unit: Korean won)

Hedge type	1-month	3-month	6-month	9-month	12-month
No-hedge					
Mean	989	989	989	989	989
Std. Dev.	82	82	82	82	82
	Direct hedge (Scenario III)				
1:1 hedge					
Mean	994	1,003	1,014	1,020	1,027
Std. Dev.	77	66	54	48	43
Change in mean	0.4%	1.3%	2.4%	3.2%	3.8%
Change in variance	-12.0%	-34.1%	-56.1%	-65.5%	-72.1%
MV hedge					
Mean	995	1,004	1,011	1,014	1,016
Std. Dev.	76	62	51	47	39
Change in mean	0.6%	1.4%	2.2%	2.5%	2.7%
Change in variance	-13.6%	-42.2%	-60.8%	-66.3%	-77.2%
	Cross hedge (Scenario IV)				
1:1 hedge					
Mean	996	1,008	1,022	1,040	1,062
Std. Dev.	82	83	88	90	84
Change in mean	0.6%	1.9%	3.3%	5.1%	7.4%
Change in variance	0.8%	2.9%	16.5%	21.8%	5.9%
MV hedge					
Mean	989	993	996	1,009	1,022
Std. Dev.	86	87	84	82	73
Change in mean	0.0%	0.4%	0.7%	2.0%	3.3%
Change in variance	10.0%	14.7%	6.5%	1.2%	-19.7%

6. Conclusions

Despite of regional closeness and active trading between Korea and Japan, there is little empirical analysis on the exchange risk of Korean won and Japanese yen. Recently, the Korea Exchange has introduced a Japanese yen currency futures contract coping with the demand of foreign exchange market. The main objective of this study is to examine the hedging performance of the newly listed Japanese yen futures contract.

For this purpose, a theoretical model is developed to cover four scenarios of investment and capital procurement hedging schemes with direct and cross hedge types. The sample data includes ten spot exchange rates and interest rates for the period of January 2000 to April 2006. Using these data, this study generates the futures rates of Japanese yen currency and simulates the returns and costs of various hedging strategies. In addition, it compares the means and standard deviations of the simulated cash flows of four hedging scenarios by 1:1 naïve and minimum variance hedging strategy.

The main findings of empirical analysis are as follows. For the investment hedging scheme, the 1:1 naïve hedge strategy outperforms no-hedge strategy in terms of the mean and variance regardless of hedging periods. That is, the means of return turn out to be doubled and the variances are completely eliminated. The minimum variance hedge strategy produces a similar result with that of 1:1 naïve hedge. On average, the direct hedge type with Japanese yen currency futures outperforms the cross hedge type with spot US dollar currency.

With the capital procurement hedging scheme, the 1:1 naïve hedge strategy reduces the variances of interest payments by 12% to 72% compared to the no-hedge strategy while the means of payments turn out to be slightly increased. The minimum variance hedge strategy produces better results than those of 1:1 naïve hedge. That is, both of the means and variances of payments decrease further. However, the hedging performances of the cross hedge severely deteriorate compared to those of direct hedge.

More importantly, the hedging performances of direct hedge strategies prove to be even better than those of cross hedge strategies. This finding implies that the effects of introducing the Japanese yen currency futures contract would be measured by the differences in the hedging performances between direct and cross hedges.

A further study would be necessary when one can collect enough data of Japanese yen currency futures trading. In addition, it would be instructive to investigate the effects of Japanese yen currency futures on the relationship between two countries' trading volume and foreign exchange risk exposure.

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