Futures vs Forward;
Focused on the Hedge Performance against Won-dollar Exchange Risk

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Abstract

This paper investigates the hedge performance of Won-dollar futures and forward markets to cover the downside risk of Won-dollar cash market. For this purpose we compare optimum hedge ratio and hedge effects between the traditional minimum variance hedge model(OLS) and the vector error correction model as well as between Won-dollar futures and forward markets.

Using the daily Won-dollar spot, nearby futures and 1 month forward data from January 8, 2004 to November 17, 2005 we find the evidence that the hedge performance of Won-dollar forward market is relatively better than that of futures market.

We also find that the hedge performance of VECM is similar to that of conventional minimum variance hedge model. These results are consistent with those of Cecchetti et al. (1988), Kroner (1993), Myers (1991). From these results we infer that the exporter companies in Korea may use the forward market and VECM model to hedge the foreign currency risk.

INTRODUCTION

Hedging is to reduce the risk and offset the loss generating from the spot position like commodities, foreign exchange, and financial assets with the use of derivative securities. In particular, currency futures markets different from commodities and interest rates considering complicated variables such as transaction cost, storage cost, and duration tend to work well as a hedging instrument against the risk exposure of cash. This paper provides empirical evidence on the effectiveness of hedging to reduce the Won-dollar exchange risk among the major functions of the currency futures including the price discovery and speculation.

The volatilities of Won-dollar exchange rates have been increased due to the introduction of complete floating exchange rate system, the enhancement of capital market after the 1997 Korean currency crisis. The recent strength of European, Japanese, and Korean currencies due to the weakness of dollar has given imminent alertness of exchange volatility to corporate and bank exchange managers who are in charge of foreign exchange risk management. In addition, the abolition of foreign investors' investment restriction has also contributed the increase of the volatility of the Won-dollar exchange rates. Those circumstances have increased the degree of the market integration as well as risk exposure in Korean capital market. Now, financial managers have to contemplate reducing the volatility of the exchange rate by seeking and developing various financial techniques.

Many previous papers show the empirical evidence on the effectiveness of hedging with futures and forwards to cover the downside risk of spot position in the foreign exchange markets, stock and bond markets. However, they didn't show the consistent results which performance between the constant hedge ratio models(conventional minimum variance hedge model, ECM hedge model) and the time varying hedge ratio models(ARCH hedge model, GARCH hedge model, and EGARCH hedge model, etc.) is better. This paper tries to compare the hedge performances between Won-dollar futures and forward markets with two hedge models. In addition, this research shows whether the Won-dollar futures or the forward can be one of the good instrument against the risk from the Won-dollar spot exchange rates under the dynamic exchange circumstances.

Several previous papers, Keynes (1930), Hicks (1953), and Working (1953) suggested the theory of conventional hedging models and Johnson (1960), Stein (1961), Ederington (1979), Figlewski (1984), Baillie & Mayers (1991), Myers (1991), Kroner & Sultan (1993), Ghosh (1993), Park and Switzer (1995), Crain & Lee (2004) presented the improvement of hedging performance by time-varying bivariate GARCH hedging model and ECM (error correction model) developing the conventional hedging models.

Cecchetti, Cumby and Figlewski (1988) estimated the hedging ratios of U.S. treasury bill and reported the hedging ratios of T-bill changed as time goes by. They employed time-varying bivariate ARCH model suggested by Engle (1982). In particular, Kroner and Sultan (1993) estimated the hedge ratios in 5 foreign currency futures, the British pound, the Canadian dollar, the German mark, the Japanese yen, and the Swiss franc by a bivariate error correction model in exchange rates of spot and futures with a GARCH error structure. They also presented the dynamic hedge model provided greater risk reduction than the conventional models in both within and out-of-sample comparisons.

In this paper, we employ the futures and forward of the Won-dollar exchange rates to cover the downside risk of the Won-dollar spot market. Also, we compare the hedge ratios and performance of the conventional hedge model with those of the ECM hedge model. Both within and out-of-sample tests reveal which model achieves better performance.

According to the test results, during both within and out-of sample period, first, in terms of hedging models the hedging performance of the vector error correction model is better than that of the conventional hedge model in both the Won-dollar futures and forward markets. Second, in terms of derivative instruments the hedge effectiveness of Won-dollar forward markets is relatively better than that of futures markets based on conventional minimum variance model as well as the error correction model.

The rest of this paper is organized as follows. Section Ⅰ explains the data and preliminary statistics, while section Ⅱ presents the methodology. We put the main result in section Ⅲ and section Ⅳ concludes the paper.

Ⅰ. Data and Preliminary Statistics

This study uses daily price changes of Won-dollar spot, Won-dollar futures data on the nearby contracts and 1month forward contracts from January 8, 2004 to November 17, 2005. The data are from data-stream and Bloomberg. The closing data of the Won-dollar spot futures data are from 4:00 p.m. on the basis of Seoul Standard time. The price changes of all time series are calculated as follows:

$$RST_t = \ln(ST_t) - \ln(ST_{t-1}) \quad (1)$$

$$RFTt_t = \ln(FT_t) - \ln(FT_{t-1}) \quad (2)$$

The terms, RST_t means the returns of Won-dollar cash price. RFT_t represents the daily returns of Won-dollar futures and forward market. Where ST_t and ST_{t-1} are the Won-dollar spot price at time t and at time t-1 respectively. FT_t and FT_{t-1} are the closing price of the Won-dollar futures and forward at time t and at time t-1 respectively.

Table 1 reports the summary statistics for the daily Won-dollar spot and futures, and 1 month forward data. According to the result of Table 1 the price changes of all data are positive. In terms of both price and return variables of four time series, the futures has the highest standard deviation. All price and return variables are skewed to the left except the price of the futures. Measures for excess kurtosis are leptokurtic with the normal distribution. The Bera-Jacque statistics for the level and return variables of the Won-dollar cash and futures, forward are statistically significant, indicating the presence of serial correlation (linear dependencies).

Furthermore, all the Won-dollar exchange spot, futures and forward series are tested to ensure whether they are stationary. As we expected the level variables are all non-stationary which means that each has a unit root in its autoregressive representation. This indicates that each series is non-stationary, necessitating the calculation of first differences and the difference series are then checked for the presence of a unit root. We see that the ADF and the PP tests clearly reject the null hypothesis of the presence of a unit root for each series, implying that the difference series are indeed stationary, that is, I (0).

Since it is established that each series is I (1), the next step is to test the co-integration relationship between Won-dollar spot and futures as well as between Won-dollar spot and forward. We employ the Johansen co-integration test. According to the test results, there is a co-integration relationship between the level variables of Won-dollar cash and futures (forward) data.

Therefore, when we estimated the optimal hedge ratios and hedge performances of Won-dollar futures (forward) markets, we incorporate the error-correction term in our hedging model suggested by Engle and Granger (1987). The error correction term imposes the long-run restrictions into this short-run model.

Table 1

Data summary statistics for daily Won-dollar spot exchange rate, futures and forward exchange rate from January 8, 2004 to November 17, 2005. Returns of spot exchange rate, futures and forward exchange rate are defined as the value: $RST_t = \ln(ST_t) - \ln(ST_{t-1})$, $RFT_t = \ln(FT_t) - \ln(FT_{t-1})$, where ST_t and FT_t is the spot and futures (forward) exchange value at time t.

B-J is the Bera-Jarque test for normality. The statistic is B-J = $T\left[\frac{skewness^2}{6} + \frac{(kurtosis-3)^2}{24}\right]$ B-J is distributed X_2^2 under the null of normality. *** indicates the significance at the 0.1 percent level.

Panel a: Won-dollar spot and futures exchange rates

	Spot		Futures	
	Level variable	Returns	Level variable	Returns
Mean	1086.798	-0.000284	1087.415	-0.000287
Median	1055.700	-0.000350	1055.900	-0.000297
Maximum	1188.500	+0.016185	1190.800	+0.016658
Minimum	997.10	-0.016951	997.0000	-0.016749
Standard deviation	66.87298	+0.003985	67.44944	+0.003977
Skewness	0.127084	+0.065529	0.129448	+0.086155
Kurtosis	1.252907	+5.029149	1.250974	+5.035978
J-B	60.00099***	79.59143***	60.17776***	80.36679***

Panel b: Forward exchange rates

	forward	
	Rate	Return
Mean	1088.230	-0.000291
Median	1058.575	-0.000410
Maximum	1191.700	+0.016219
Minimum	997.6000	-0.016889
Standard deviation	68.10245	+0.003979
Skewness	0.133420	+0.058469
Kurtosis	1.250129	+4.987591
J-B	60.31509***	76.31071***

Ⅱ. Methodology

A. Ederington's (1979) Risk Minimization Hedge

Ederington (1979) suggests that the minimum variance hedge model in which the spot position is considered fixed and the optimal hedge ratio (number of futures contract per spot contract) is determined from the Ordinary Least Squares (OLS) regression of spot price changes on futures and forward price changes. The optimal hedge ratio represents the minimum risk level for the spot/futures portfolio and consists of the covariance between the spot and futures divided by the variance of the futures. The objective of the hedger is to minimize the variance of the price changes for the Won-dollar exchange spot rate/futures rate portfolio. The expected price change and variance of the hedged position are established as follows;

$$RST_t = \alpha + \beta RFT_t + \varepsilon_t \qquad (3)$$

where RST_t represents the returns of the Won-dollar spot exchange rate from t-1 to t, RFT_t represents the returns of the Won-dollar futures and month forward exchange rate from t-1 to t. β is the optimal hedge ratio estimated by the Ordinary Least Squares (OLS) regression. The slope coefficient of equation (3) is used as the measure of optimal hedge ratio under the conventional hedge model system. We also define the optimal hedge ratio as the covariance between Won-dollar cash and futures and between Won-dollar cash and forward markets.

The regression results are reported in Table 2. The hedge ratios of 0.98350 for Won-dollar futures and 0.99453 for forward market imply that 0.98350 daily contract of the Won-dollar futures and 0.99453 forward markets need to be shorted for a long position of 1 spot exchange to minimize the variance of the hedged position value change. This hedge ratio is considerably less than one, which implies that the Won-dollar futures and forwards exchange are more volatile than the Won-dollar spot exchange rates.

Hedging effectiveness (HE) of Won-dollar futures and forward markets can be measured as the percent reduction in the variance of the unhedged Won-dollar spot position by the risk minimization hedge as follows;

$$\text{HE} = \frac{Var(\Delta C_{t,t+1}) - Var(\Delta Portfolio_{t,t+1})}{Var(\Delta C_{t,t+1})} \qquad (4)$$

For example, the minimum variance of the Won-dollar spot exchange and futures portfolio value change is as follows:

$$Var(\Delta Portfolio_{t,t+1}) = Var(\Delta C_{t,t+1}) - \frac{[Cov(\Delta C_{t,t+1}, \Delta F_{t,t+1})]^2}{Var(\Delta F_{t,t+1})} \quad (5)$$

The same equation is applied for the minimum variance between Won-dollar spot and forward portfolio value changes. Consequently, from the above equations 4 and 5, we employ the following equation (6) to figure out the hedge performance between Won-dollar futures and forward market.

$$\text{HE} = \frac{[Cov(\Delta C_{t,t+1}, \Delta_{t,t+1})]^2}{Var(\Delta C_{t,t+1}) Var(\Delta F_{t,t+1}} = \rho^2 \quad (6)$$

where ρ^2 is the population coefficient of determination between Won-dollar spot and futures exchange changes as well as Won-dollar spot and forward rate change, and it can be estimated as R^2, the sample coefficient of determination of regression 3. Table 2 reports R^2, of 0.96350, 0.98642 so that a 96.35% and 98.642% reduction of the daily variance of the Won-dollar spot position has been achieved by the risk minimum hedging strategy. In details, if we have a long position of one (1) Won-dollar portfolio at foreign exchange spot market theoretically we have to take a short position of 0.96350 contracts at the Won-dollar futures market to hedge the downside risk of Won-dollar spot position during the period from January 8, 2004 to November 17, 2005. As a result, the variance reduction for the hedged portfolio is 96.35% compared with the unhedged spot position. In case of Won-dollar forward markets, the risk averse hedger have to sell 0.98642 forward contract to cover the downside risk in Won-dollar spot position.

Table 2

The estimation results of optimal hedge ratio using conventional minimum variance hedge model with constant hedge ratio to Won-dollar futures and forward market.

To determine the optimal hedge ratio of Won-dollar futures and forward market against the downside risk of Won-dollar spot position, the following regression is estimated using time-matched daily data for the period from January 8, 2004 to November 17, 2005.

$$RST_t = \alpha + \beta RFT_t + \varepsilon_t$$

where $\varepsilon_t = \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i} + \eta_t$, the dependent variable is the returns of Won-dollar spot exchange rate and the independent variable is the returns of Won-dollar futures and forward from day t and t+1, β coefficient represents the minimum risk hedge ratio (number of futures and forward contracts per one(1) Won-dollar spot position), and the coefficient of determination, R^2, measures the hedging effectiveness in terms of the percent reduction of the variance of the unhedged spot position. *** indicates the significance at the 1% percent level. Asymptotic t-statistics are given in parentheses.

	Won-dollar Futures Market	Won-dollar Forward Market
α	-0.00001	+0.00005
	(-0.0003)	(0.2512)
Hedging Ratio (β)	0.98350***	+0.99453***
	(+110.25)	(182.79)
Hedging Effectiveness (R^2)	0.96350	0.98642
F	12156.13***	33412.43***

B. Error Correction Term Hedge

Although the minimum variance hedge model is widely used to estimate the optimal hedge ratio by Ederington (1979), Figlewski (1984), Stulz, Wasserfallen, and Stucki (1992), Ghosh (1993), and others. It is misspecified because it excludes an error correction term and it doesn't consider the impact of last period's equilibrium error. To incorporate those problems, this study employs error correction term model.

$$s_t = a_{0s} + a_{1s}(S_{t-1} - \delta F_{t-1} - C) + \sum_{i=1}^{m} \gamma_{is} s_{t-i} + \sum_{j=1}^{n} \theta_{js} f_{t-j} + \varepsilon_{st} \qquad (7)$$

$$f_t = a_{0f} + a_{1f}(S_{t-1} - \delta F_{t-1} - C) + \sum_{i=1}^{m} \gamma_{if} s_{t-i} + \sum_{j=1}^{n} \theta_{jf} f_{t-j} + \varepsilon_{ft} \qquad (8)$$

$$e_t = \begin{bmatrix} \varepsilon_{st} \\ \varepsilon_{ft} \end{bmatrix} \mid \psi_{t-1} \sim N(0, H_t) \qquad H_t = \begin{bmatrix} c_{ss} & c_{sf} \\ c_{fs} & c_{ff} \end{bmatrix}$$

where s_t and f_t are the returns of the won-dollar spot exchange, the won-dollar exchange futures and forward prices, respectively, e_t is a (2x1) vector of residuals, ψ_{t-1} is the information set at time t-1, H_t is a (2x2) conditional variance-covariance matrix of residuals, $S_{t-1} - \delta F_{t-1} - C$ is the error correction term, and the ε and c matrices are assumed to be diagonal. The error correction term model employed by previous several researches, Kroner and Sultan (1993), etc, reflects the change in the spot variable to the change in the futures and forward, to the past equilibrium errors, and to past changes in the both markets.

These coefficients are estimated using the Berndt, Hall, Hall, and Hausman (1974) algorithm. According to Baillie and Myers (1991), the expected return to holding futures is zero, the minimum variance hedging rule leads to a hedge ratio which depends solely on the elements of the conditional variance-covariance matrix, H_t. In particular, the minimum variance hedge ratio, HR^*_{ft}, is expressed as follows;

$$HR^*_{ft} = \frac{h_{sf,t}}{h_{ff,t}} \qquad (9)$$

where $h_{sf,t}$ is the conditional covariance between the Won-dollar spot and futures markets, between Won-dollar spot and forward markets. $h_{ff,t}$ means the conditional variance between the Won-dollar futures markets and Won-dollar forward markets, respectively.

Table 3 reports the optimal hedge ratios for the Won-dollar futures and forward markets to cover the downside risk of Won-dollar spot position from the period of January 8, 2004 to November 17, 2005, employing the error correction term model. The coefficients are similar to those computed from the conventional minimum variance hedging model: 0.989498 for Won-dollar futures market and 0.9992425 for Won-dollar forward market respectively. This means that 0.989498 daily futures contracts and 0.9992425 forward contracts need to be shorted for a long position of one spot exchange to minimize the variance of the hedged position value change.

Also, similar to the risk minimization hedge, the hedge effectiveness of the ECT hedging model can be measured as the percent reduction in the variance of the unhedged Won-dollar spot position. Therefore the hedge performances of the ECT hedging are estimated as follows;

Hedge Performance: R^2 = 1-Var(HP)/Var(UP) (10)

where Var(HP) is the variance of hedged portfolio, Var(UP) means the variance of unhedged portfolio.

Table 3

The estimation results of optimal hedge ratio in Won-dollar futures markets using ECT model

Estimates of the following ECT model are established as follows;

$$s_t = a_{0s} + a_{1s}(S_{t-1} - \delta F_{t-1} - C) + \sum_{i=1}^{m} \gamma_{is} s_{t-i} + \sum_{j=1}^{n} \theta_{js} f_{t-j} + \varepsilon_{st}$$

$$f_t = a_{0f} + a_{1f}(S_{t-1} - \delta F_{t-1} - C) + \sum_{i=1}^{m} \gamma_{if} s_{t-i} + \sum_{j=1}^{n} \theta_{jf} f_{t-j} + \varepsilon_{ft}$$

$$e_t = \begin{bmatrix} \varepsilon_{st} \\ \varepsilon_{ft} \end{bmatrix} \mid \psi_{t-1} \sim N(0, H_t) \qquad H_t = \begin{bmatrix} c_{ss} & c_{sf} \\ c_{fs} & c_{ff} \end{bmatrix}$$

where s_t and f_t are the returns of the won-dollar spot exchange, the won-dollar exchange futures and forward contracts, respectively, e_t is a (2x1) vector of residuals, ψ_{t-1} is the information set at time t-1, H_t is a (2x2) conditional variance-covariance matrix of residuals, $S_{t-1} - \delta F_{t-1} - C$ is the error correction term, and the ε and c matrices are assumed to be diagonal. The model is estimated using time-matched daily from January 8, 2004 to November 17, 2005. Asymptotic t-value is given in parentheses. The $b^* = c_{sf} / c_{ff}$ is the hedge ratio of ECT model.

	Won-dollar Futures market	Won-dollar Forward market
c_{ss}	0.00001892	0.00001603
c_{sf}	0.00001865	0.000015908
c_{ff}	0.00001885	0.00001592
b^*	0.989498	0.9992425

Ⅲ. Comparisons of Hedging Performance among Won-dollar futures and forward markets

The objective of this paper is to compare the conventional hedge model with the vector error correction term model. Also, we intended to address the issue of choosing between Won-dollar futures and forward to hedge the downside risk of Won-dollar spot position. For these purposes, we divide the full sample period into two sub-periods. One is within sample period from January 8, 2004 to August 17, 2005 and the other is out-of-sample period from August 18, 2005 to November 17, 2005.

For within-sample hedging period, the computation of the optimal hedging ratio and the hedging effectiveness is calculated simultaneously. In other words, when we develop the hedge model we assume a perfect forecasting on the returns of Won-dollar spot, Won-dollar futures and forward in the future time. These kinds of assumption are obviously far from real world. Therefore we need to figure out the hedge performance during out-of-sample period in which an optimal hedge ratio from the historical data is estimated and apply it to study the hedge effectiveness.

According to the estimation results on optimal hedging ratio for Won-dollar futures and forward markets, optimal hedge ratio for Won-dollar forward markets are relatively higher than those of Won-dollar futures market both in the conventional hedge model and error correction term hedge model during the within-sample period.

As mentioned above, the hedging performance is measured by the percent reduction in the variance of the unhedged Won-dollar spot position. Table 4 provides the result on hedge performance of each hedging model during the within sample period. According to the test results during the within sample period, First, in terms of the comparison of hedge models, the hedging performances (0.9997822 for futures market, 0.9998526 for forward market) of the conventional minimum variance hedge model is a little bit less than those (0.9998447 for futures market, 0.9997198 for forward) of the error correction term hedging model.

Second, in terms of the hedge performance comparison between Won-dollar futures markets and Won-dollar forward markets, the hedge effectiveness of Won-dollar forward markets(0.9998526 for OLS, 0.9997198 for VAR) is almost the same to that of futures market (0.9997822 for OLS and 0.9998447) in the conventional minimum variance model.

Table 4

Comparisons of Hedging Effectiveness between Won-dollar futures and forward markets during the within sample period

The reduction of variances in the hedged spot/futures portfolio value is reported. The within-sample results are computed for the period from January 8, 2004 to August 17, 2005. The percent reduction in variance is computed as follows;

1- (variance of the hedged position / variance of the unhedged position)

Method	Won-dollar futures market	Won-dollar forward market
Minimum Variance Hedge Model	0.9997822	0.9998526
ECT Hedge Model	0.9998447	0.9997198

Now, we turn to the out-of-sample hedging. The results are reported on table 5. First, based on the hedge performance of hedge models, the hedge effectiveness of OLS (0.9990182 for futures market, 0.9993353 for forward market) of the conventional minimum variance hedge model) are relatively less than those of the error correction term hedging model(0.9991192 for futures market, 0.9995441 for forward market).

Second, in terms of the hedge performance between Won-dollar futures markets and forward markets, the hedge performances (0.99993353, 0.9995441) of the Won-dollar forward markets are relatively better than those (0.9990182, 0.9991192) of futures markets in the conventional minimum variance model.

Table 5

Comparisons of Hedging Effectiveness between Won-dollar futures and forward markets during out-of-sample period

The reduction of variances in the hedged spot/futures portfolio value is reported. The out-of-sample results are computed based on hedge ratio for the period from January 3, 2004 to December 31, 2004. The percent reduction in variance is computed as follow;

1- (variance of the hedged position / variance of the unhedged position)

Method	Won-dollar Futures markets	Won-dollar forward markets
Minimum Variance Hedge Model	0.9990182	0.9993353
ECT Hedge Model	0.9991192	0.9995441

Ⅳ. Conclusion

The main purpose of this research to show whether the Won-dollar futures or forward market can be one of the good instruments against the risk from the Won-dollar spot exchange rates under the dynamic exchange circumstances after the 1997 Korean currency crisis.

This study presents alternative hedging model for calculating risk-minimizing hedge ratios in Won-dollar currency futures and forwards contracts and compares the hedging performances of the error correction term hedging model with that of the conventional hedging method. The data we employ is the daily Won-dollar spot, Won-dollar futures and one month forward contracts from January 8, 2004 to November 17, 2005.

In the case of the estimation results of hedge performance during out-of sample period, the evidence presented in this paper indicates that first, the hedging performances of the conventional minimum variance hedge model are similar to that of the error correction term hedging model. Second, the hedge effectiveness of Won-dollar forward markets is relatively better than that of futures markets in the conventional minimum variance model but not much difference. We think these kinds of test results might be helpful for the investors and export company to set up any hedge strategy against downside risk of Won-dollar spot position. From these results we infer that the exporter companies in Korea may use the forward market and VECM model to hedge the foreign currency risk.

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Figure 4: Trend of Won-dollar futures' trading volume

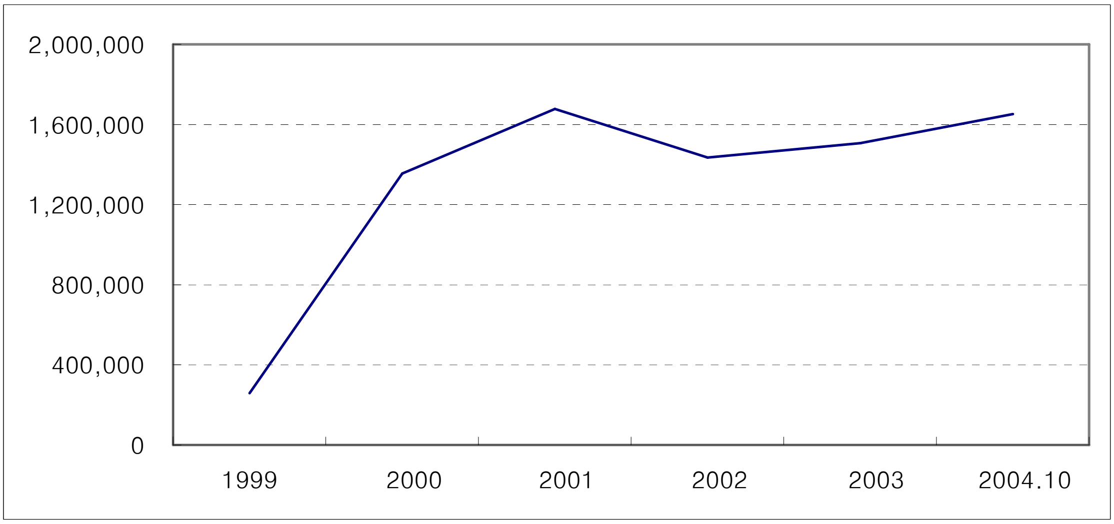

Figure 5: Trend of Won-dollar spot exchange rate

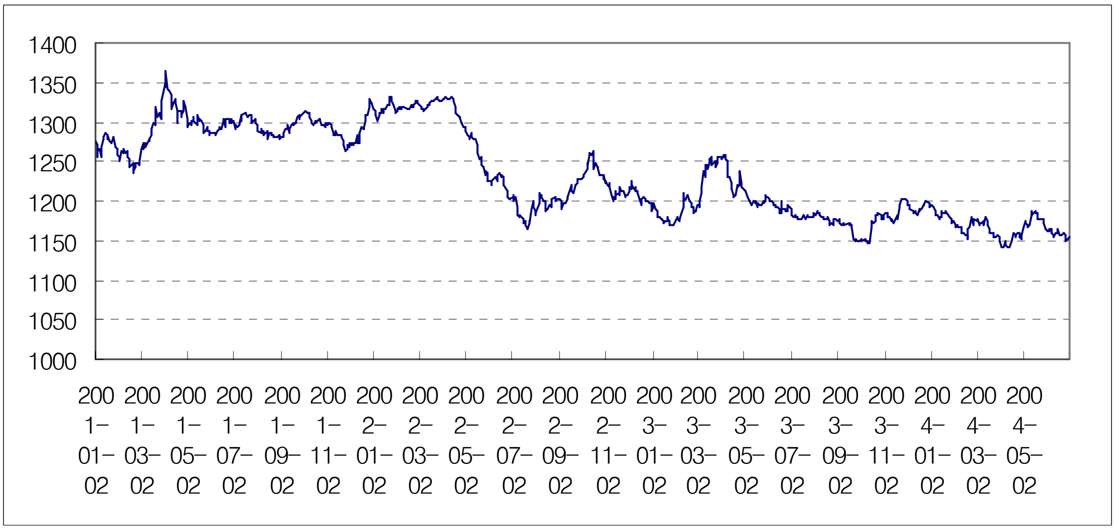

Table 7: The characteristics of US dollar futures

Underlying Asset	US Dollars
Trading Unit	US $50,000
Contract Months	The first three consecutive contract months (two serial expirations and one quarterly expiration) plus the next three months in the quarterly cycle (March, June, September, December)
Trading Hours	- 09:00 ~ 16:00 (Mon. - Fri.) - 09:00 ~ 11:30 (Last trading day)
Price Quotation	Korean Won (KRW) per US Dollar (USD)
Minimum Price Fluctuation	0.1, representing a value of KRW 5,000
Last Trading Day	Second trading day preceding the final settlement day
Final Settlement Day	Third Wednesday of the contract month
Settlement Method	Delivery settlement
Daily Price Limit	- None - However the limit on order price is imposed to prevent errors in entering orders.
Single Price Auction	Orders gathered during the pre-open session (08:30am-09:00am) will be matched at a single price auction.

Source: Korea Futures Exchange (http://www.kofex.com), December 31, 2004