

# DOES THE MARKET EVALUATE FIRM'S FX RISK MANAGEMENT? -- EVIDENCE FROM THE KOREAN STOCK MARKET --

DOYEON KIM \* · TAEYOON SUNG \*\*

*We examine the influence of FX Risk on the Korean stock market. We find that, except the period when the Korean government maintained the fixed exchange rate regime, FX Risk had a significant influence on firm value in the Korean stock market. FX Risk exposure turns out to be significantly different among firms. Particularly, we show that large firms tend to be more sensitive to FX Risk and have more incentives to control the risk.*

JEL Classification: F31; G15

Keywords: Foreign Exchange, FX Risk, Risk Management, Firm Size, Stock Market

## I. INTRODUCTION

Since the economic crisis in 1997, the Korean government has adopted the free-floating exchange rate system.<sup>1</sup> This exchange-rate regime switch made firms more aware of FX (foreign exchange rate) fluctuations and the need of FX risk management.

Exchange rate movement affects firm's behavior directly or indirectly,

---

*Received for publication: April 23, 2007. Revision accepted: Sep. 15, 2007.*

\* KAIST Graduate School of Management, Cheongryangri-Dong 207-43, Seoul 130-722, Korea.

\*\* Corresponding Author: Yonsei University, School of Economics, 134 Shinchon-Dong, Seoul 120-749, Korea. Email: tsung@yonsei.ac.kr; Tel: +82-2-2123-5494.

<sup>1</sup> Even before the economic crisis, Korea was not under a fixed exchange rate system. However, daily exchange rate fluctuation was allowed within a certain range. Therefore, we consider the exchange rate system to be fixed for this study. On December 16, 1997, the Korean government abolished the band on the Korean currency's exchange rate against the US dollar (see Kim and Sung, 2005).

and thus, it can affect firm's value. If the variation in exchange rate negatively influences the firm's income stream, investors will be less willing to invest in the firms exposed to FX risk. However, although we have the same FX fluctuations, FX risk varies depending on firms' characteristics. In other words, the sensitivity of stock price reaction to exchange rate fluctuation can differ across firms.

Thus, whereas some firms put substantial efforts to hedge FX risk, others do not. However, since hedging is costly, firms have to compare costs and benefits of FX risk management by examining their FX risk exposure.<sup>2</sup> Although firms are exposed to FX risk, if FX risk is low enough to bear, expensive hedging is not necessarily required. Thus, it is meaningful to examine whether investors in the stock market value firms' FX risk management.

Since the arbitrage pricing theory of Ross (1976), many studies have suggested factors explaining the stock price.<sup>3</sup> Especially, Jorion (1991) used the exchange rate as a factor, and suggested two- and multi-factor models to analyze the FX risk premium in the U.S. stock market.<sup>4</sup> Both two-factor and multi-factor models show that exchange risk is statistically insignificant in the case of the U.S. stock market.

Thereafter, many studies have adopted or modified Jorion's model to examine the exchange risk. For example, Doukas, Hall, and Lang (1999) modify Jorion's model and analyze 1,079 Japanese firms. Their study suggests the model that includes six instruments and four factors that are orthogonal to all the instruments to examine the rate of return in the stock market.<sup>5</sup> In the empirical investigation, they show that the exchange risk premium plays a role as a significant factor in explaining the Japanese

---

<sup>2</sup> See Kim and Sung (2005), for the determinants of Korean firms' FX risk management.

<sup>3</sup> Solnik (1983) and Ikeda (1991) extended the APT to an international setting.

<sup>4</sup> The two-factor model includes the market rate of return and the exchange rate to explain the stock rate of return. The multi-factor model includes the exchange rate and six additional factors suggested by Chen, Roll, and Ross (1986). The six other factors are market return, industrial production growth, change in expected inflation, unexpected inflation, risk premium, and term structure.

<sup>5</sup> In their study, six instruments include industrial production growth, unexpected inflation, term structure, money supply, US-Japan interest rate spread, and trade balance. Four factors include one-month Eurodollar interest rate compounded by the Yen variation relative to the US dollar minus the on-month Japanese risk free rate of return, Fama-and-French-(1996)-type value minus growth return spreads, Fama-and-French-(1996)-type small minus large return spreads, and market rate of return.

stock market. Iorio and Faff (2001) adopt Jorion's two-factor model to analyze the foreign exchange risk in the Australian stock market. Their study divides 10-year time series data into 4 sub-periods in accordance with the fluctuation of exchange rate, and finds that the existence of the foreign exchange risk varies with sub-periods. Choi, Hiraki and Takezawa (1998) add the interest rate risk factor to Jorion's two-factor model and analyze the Japanese stock market using a three-factor model. They find that exchange risk is priced regardless of sub-periods. Kwon and Park (1999) analyze the exchange risk in the Korean stock market by adopting Jorion's model. They find that the exchange risk premium varies significantly with industries. However, although they provide an interesting result, the major limitation of their study is that they use industry data instead of individual firm data.

As mentioned, some studies show the presence of the FX risk in a specific stock market. Thus, some of them also refer to the necessity of FX risk management such as hedging strategy through derivatives. Nevertheless, when some studies investigate the characteristics of firms that manage FX risk, we also find that only the large firms tend to hedge the FX risk due to the high cost of FX risk management.<sup>6</sup> For instance, Kim and Sung (2005) find that firm size and export revenue are important factors determining firm's decision to manage exchange risk by analyzing Korean firm data. Phillips (1995) also reports that large firms tend to hedge the FX risk with derivatives by examining survey data. Thus, to figure out why some firms with specific features do FX risk management whereas others do not in spite of FX risk, it is important to examine the efficiency of hedging strategy or FX risk management.

Thus, there have been some studies analyzing the efficiency of hedging strategy or exchange risk management. For example, Nelson, Moffitt and Affleck-Graces (2005) examine whether hedging generates abnormal returns. They measure the performance of hedging activities by simply

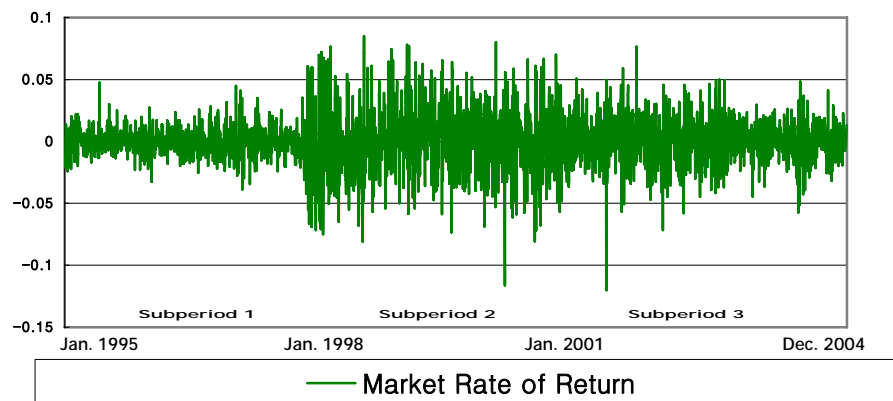
---

<sup>6</sup> Allayannis and Ofek (2001) found not only firm size but also foreign sales and foreign trade factors to be determinants of firm's derivatives usage by using samples from S&P non-financial firm data. Berkman and Bradbury (1996) examined corporate derivative use increases with leverage, size, the existence of tax losses, the proportion of shares held by directors, and the payout ratio and decreases with interest coverage and liquidity by analyzing 116 New Zealand corporations. Martin and Mauer (2004) and Mian (1996) examine the existence of scale economies in the risk exposure management.

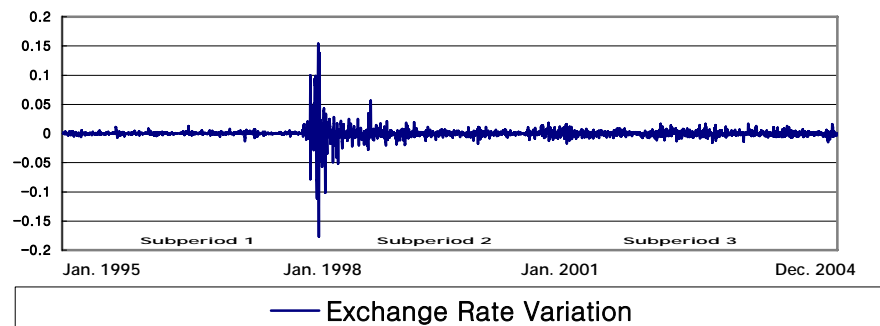
estimating abnormal returns of stocks. However, there could also be many other factors that affect abnormal returns. Additionally, the performance of currency hedging should be measured with exchange rate fluctuation and FX risk. The major function of currency hedging is mainly associated with the elimination of FX risk. However, they do not focus on the direct relationship between FX risk and currency hedging, although they examine the stock-market performance of firms that disclose the use of derivatives to hedge. Phillips (1995) examine that hedging with derivatives is somewhat profitable for firms, but his study mainly depends on survey data.

**[Figure 1]** Market Portfolio Return and Change in KRW/USD FX Rate: Daily Data

Panel A. Market Rate of Return: Daily Data



Panel B. Change in KRW/USD FX Rate: Daily Data



It is important to know how effective FX risk management is, but few studies have examined whether FX risk has been eliminated after firms started to manage it. If FX risk cannot be managed effectively, firms do not need to bear FX risk management costs. That is the main question that we analyze by using the case of the Korean stock market.

This paper is organized as follows. First, we estimate FX risk in the Korean stock market. We examine whether firms face significant FX risk in the stock market, and if so, try to figure out when they do across sub-periods. It also shows how many firms are exposed to the FX risk. In other words, what is the portion of firms exposed to FX risk in the Korean stock market. Second, we investigate what factors affect firms' FX risk. Finally, we analyze whether the FX risk disappears or decreases after firms begin risk management, which explains how effective the risk management is.

## II. DATA

We use 435 firms' daily return data of the KSRI (Korea Securities Research Institute) database. They are 10-year balanced panel data including all non-financial firms. Financial firms' annual reports do not have the information about FX risk management, and furthermore, in their behavior and accounting standards, they might have features different from non-financial firms. Thus, we focus on the balanced panel data of all non-financial firms listed in the stock market. Each firm's rate of return is calculated to reflect dividend gains. The time span is from January 1995 to December 2004, which is composed of 2,646 daily time-series data.<sup>7</sup>

We also use the KOSPI Index to obtain the market rate of return. It is 10-year daily rate of return time series data, which are consistent with firms' return data. We use KRW/USD exchange rate as a representative exchange rate. We have also used KRW/JPY as well, but it has little

---

<sup>7</sup> Note that there are 435 firms in the sample. This means that, if we use weekly or monthly data, the number of time-series observations doesn't exceed the number of firms. Thus, we use only daily data for the analysis of this paper, and do not test with different frequency, such as weekly or monthly.

impact.<sup>8</sup>

**[Table 1]** Definitions and Summary Statistics of Variables

**Panel A. Definitions**

Variables	Definitions
Risk Management Dummy	1 if manages FX risk, 0 otherwise
Derivatives Usage Dummy	1 if hedge FX risk with derivatives, 0 otherwise
Asset (logarithm scale)	Logarithm of total asset
Exportation Rate	Exportation divided by total sales
Foreign Currency Asset Ratio	Foreign currency asset divided by total asset
Foreign Currency Debt Ratio	Foreign currency debt divided by total debt
Foreign Exchange Net Gains	Foreign exchange net gain divided by foreign currency asset
Leverage	Total debt divided by total asset
Liquidity	Current asset divided by current debt

**Panel B. Summary Statistics (Total Observations)**

Variables	Obs.	Mean	SD	Min.	Max.
Risk Management Dummy	435	0.4069	0.4918	0	1
Derivatives Usage Dummy	435	0.1678	0.3741	0	1
Asset (logarithm scale)	435	8.3434	0.6210	6.9800	10.7306
Exportation Rate	435	0.0157	0.0793	0	0.9451
Foreign Currency Asset Ratio	435	0.0220	0.0400	0	0.4161
Foreign Currency Debt Ratio	435	0.0780	0.1072	0	0.6950
Foreign Exchange Net Gains	435	-0.0002	0.0031	-0.0323	0.0112
Leverage	435	0.5529	0.3496	0.1106	5.8818
Liquidity	435	1.5222	1.0948	0	7.2590

**Panel C. Summary Statistics (Large Firms with Assets over 500 billion KRW)**

Variables	Obs.	Mean	SD	Min.	Max.
Risk Management Dummy	103	0.6699	0.4725	0	1
Asset (logarithm scale)	103	9.2343	0.4323	8.7011	10.7306
Exportation Rate	103	0.0181	0.0879	0	0.7359
Foreign Currency Asset Ratio	103	0.0217	0.0387	0	0.2755
Foreign Currency Debt Ratio	103	0.0919	0.1129	0	0.6557
Foreign Exchange Net Gains	103	0.0000	0.0040	-0.0323	0.0112
Leverage	103	0.5613	0.1934	0.1486	1.2090
Liquidity	103	1.0335	0.6306	0.1914	4.6578

<sup>8</sup> In other words, we could not find any significant KRW/JPY exchange risk in any time period.

**[Table 2]** Correlation between Variables**Panel A. Total Observations**

Risk Management Dummy	1								
Derivatives Usage Dummy	0.5422	1							
Asset (logarithm scale)	0.3895	0.4749	1						
Exportation Rate	0.0508	0.1067	0.0273	1					
Foreign Currency Asset Ratio	0.1278	0.1323	-0.0002	0.3645	1				
Foreign Currency Debt Ratio	0.2838	0.1902	0.0849	0.1426	0.2261	1			
Foreign Exchange Net Gains	0.0602	0.0799	0.0536	-0.0885	-0.3479	0.0385	1		
Leverage	-0.0212	-0.0045	-0.0678	0.0178	0.0578	-0.0826	-0.0214	1	
Liquidity	-0.0782	-0.1250	-0.2130	-0.0217	-0.0047	-0.0399	0.0524	-0.3295	1

**Panel B. Large Firms with Assets over 500 billion KRW**

Risk Management Dummy	1							
Asset (logarithm scale)	0.3491	1						
Exportation Rate	0.0603	0.0219	1					
Foreign Currency Asset Ratio	0.1364	0.0407	0.4803	1				
Foreign Currency Debt Ratio	0.3063	-0.0507	0.1177	0.3307	1			
Foreign Exchange Net Gains	0.0411	0.0716	0.0126	-0.3088	-0.0198	1		
Leverage	0.1345	0.1160	0.1767	0.2154	0.0556	-0.1256	1	
Liquidity	-0.0558	-0.2408	-0.0753	-0.0291	-0.0593	-0.0083	-0.5376	1

Individual firm's data come from KIS-VALUE.<sup>9</sup> They are based on firms' financial statements. Finally, we collect all firms' annual reports that are submitted to the Korean Financial Supervisory Service. We also construct the data, which show not only whether each firm managed FX risk or not, but also which hedging instruments it used. For example,

<sup>9</sup> For example, they include total asset, foreign currency asset, total debt, foreign currency debt, exportation, total sales, foreign exchange net gain, leverage, and liquidity.

some firms use derivatives to hedge exchange risk, but other firms use internal methods that include matching, netting, leading and lagging. The information about a firm's FX risk management has been available in its annual report since 2001. Thus, we collected 4 annual reports of each firm and recorded whether it managed the risk with any methods and whether it used external methods which represent using derivatives. For the period of 4 years, in our data, 177 firms turn out to have managed FX risk with internal or external methods, and 73 firms have used derivatives to hedge the risk, out of 435 firms.

We introduce definitions and summary statistics of these variables in Table 1, and the correlation between them in Table 2.<sup>10,11</sup> As shown in Table 2, there are little correlations between variables so that we are not concerned about multi-collinearity problems in independent variables. We also check VIF values in other regressions. From Table 4 to Table 8, VIF values are very close to 1, indicating little possibility of multi-collinearity.

### III. FX RISK ESTIMATION

#### III.1. Model

We basically follow Jorion's model which adapts two-factor version of Ross's APT. Under the assumption that both market portfolio return and exchange rate shift are the only factors explaining individual stock return, stock  $i$ 's rate of return is explained as follows:

$$R_{it} = E(R_{it}) + \beta_i^m [R_{mt} - E(R_{mt})] + \beta_i^x F_{xt} + \varepsilon_{it} \quad (1)$$

All returns are basically nominal returns in excess of the risk-free rate.<sup>12</sup>  $R_{it}$  is stock  $i$ 's rate of return, at time  $t$ , and  $E(R_{it})$  is stock  $i$ 's expected rate of return at time,  $t$ .  $R_{mt}$  is the market portfolio's rate of

<sup>10</sup> In Table 1 (Panel C) and Table 2 (Panel B), we present the information on the sample large firms as well as the total sample, since we focus on firms' size effects on FX risk throughout this study. We also provide a statistical analysis especially using large firm data.

<sup>11</sup> Since we consider leverage as total debt divided by total asset, it is usually between 0 and 1. However, occasionally, that of firms in deficit net worth exceeds 1.

<sup>12</sup> We assumed risk-free rate to be zero in data analysis, since we use daily stock-market return data.



return at time,  $t$ , and  $E(R_{mt})$  is the expected market portfolio's rate of return at time,  $t$ .  $F_{xt}$  is the exchange rate movement which is orthogonal to market portfolio's rate of return at time,  $t$ .  $\beta_i^m$  is stock  $i$ 's sensitivity to market portfolio's rate of return, and  $\beta_i^x$  is stock  $i$ 's sensitivity to exchange rate movement.

$F_{xt}$  is obtained by following regression:

$$R_{xt} = \gamma_0 + \gamma_1 R_{mt} + F_{xt} \quad (2)$$

$R_{xt}$  is exchange rate movement, which is not orthogonal to market portfolio's rate of return at time,  $t$ .  $F_{xt}$  is the residual of regression (2), so that the expectation of  $F_{xt}$  equals 0.

Given Ross's APT, stock  $i$ 's expected rate of return can be described by a linear function of the sensitivity of two factors, market portfolio's return and exchange rate movement, as follows:

$$E(R_i) = \delta_0 + \delta_m \beta_i^m + \delta_x \beta_i^x, \quad (3)$$

where  $R_i$  is stock  $i$ 's rate of return, and  $E(R_i)$  is its expected value.  $\delta_0$  is the zero-beta portfolio return,  $\delta_m$  is the premium on the market risk, and  $\delta_x$  is the premium on the FX risk.

We orthogonalize the exchange rate movement to market portfolio return, so that  $\beta_m^x$  equals to 0. Since  $\beta_m^m = 1$ , we obtain  $E(R_m) = \delta_0 + \delta_m$  by substituting  $m$  for  $i$  in (3). We substitute this equation in (3),  $\delta_m$  can be removed as follows.

$$E(R_i) = \delta_0 + [E(R_m) - \delta_0] \beta_i^m + \delta_x \beta_i^x \quad (4)$$

$E(R_m)$  represents market portfolio's expected rate of return. If  $\delta_x$  equals to 0, the equation (4) is the same as CAPM, which is the model explaining that individual stock return is affected only by market factor. Therefore, we can conclude that exchange rate movements affect individual stock return when  $\delta_x$  has non-zero value. It means that exchange risk exists on the stock market if the null hypothesis,  $\delta_x = 0$ , is rejected. Since equation (4) always holds at time  $t$ , we can rewrite it as:

$$E(R_{it}) = \delta_0 + [E(R_{mt}) - \delta_0]\beta_i^m + \delta_x\beta_i^x. \quad (4)'$$

By substituting equation (4)' in equation (1), we can eliminate  $E(R_{it})$  and  $E(R_{mt})$  as follows:

$$R_{it} = [\delta_0(1 - \beta_i^m) + \delta_x\beta_i^x] + \beta_i^m R_{mt} + \beta_i^x F_{xt} + \varepsilon_{it} \quad (5)$$

Finally, we obtain equation (5) to be estimated. In equation (5),  $R_{it}$  is dependent variable, and  $R_{mt}$  and  $F_{xt}$  are independent variables.  $\delta_0, \delta_x, \beta_i^m$ , and  $\beta_i^x$  are coefficients to be estimated. The estimation procedure follows Gibbons (1982), as shown in Section III.2.

Equation (5) is basically the expansion of Ross's two-factor APT model. Thus, we need to test the hypothesis on a restriction in equation (5) to examine the adequateness of the model. Equation (5) is the restricted regression. First, we can consider the following unrestricted regression of  $R_{it}$  on  $R_{mt}$  and  $F_{xt}$ .

$$R_{it} = \beta_i^0 + \beta_i^m R_{mt} + \beta_i^x F_{xt} + \varepsilon_{it} \quad (6)$$

For equation (6), the coefficient and residual can simply be obtained with OLS. Given the estimated results, we can test the following hypothesis:

$$H_0 : \beta_i^0 = \delta_0(1 - \beta_i^m) + \delta_x\beta_i^x \quad (7)$$

If the APT model is consistent with the data, this null hypothesis will not be rejected. We test this hypothesis by using Likelihood Ratio (LR) test.

### III.2. Estimation Procedure

To estimate coefficients in equation (5). In principle, we follow the procedure of Gibbons (1982). Gibbons suggests basically the estimation method of one-factor CAPM model which does not include exchange risk factor. Given the estimation procedure, first, we obtain OLS estimates of  $\alpha_i, \beta_i^m$ , and  $\beta_i^x$  in equation (8) for each individual stock:

$$R_{it} = \alpha_i + \beta_i^m R_{mt} + \beta_i^x F_{xt} + \varepsilon_{it} \quad (8)$$

In the second step, we estimate the variance-covariance matrix  $\Sigma$  of using residuals from the regression of equation (8).

At the third step, by using the coefficient, we obtain from the regression of equation (8), we estimate the coefficients in equation (5). We basically use a modified procedure of Black, Jensen, and Scholes (1972) to estimate  $\delta_0$  and  $\delta_x$ . We estimate the coefficients in equation (9) by using GLS. Each coefficient can be obtained from equation (10). In equation (9),  $\alpha, \iota_N, \beta^m, \beta^x$ , and  $\varepsilon$  are  $N \times 1$  matrices, and  $\delta_0$  and  $\delta_x$  are scalars.

$$\alpha = \delta_0(\iota_N - \beta^m) + \delta_x \beta^x + \varepsilon \quad (9)$$

$$\begin{pmatrix} \delta_0 \\ \delta_x \end{pmatrix} = \left[ \begin{pmatrix} (\iota_N - \beta^m)' \\ \beta^x' \end{pmatrix} \Sigma^{-1} \begin{pmatrix} (\iota_N - \beta^m) \\ \beta^x \end{pmatrix} \right]^{-1} \left[ \begin{pmatrix} (\iota_N - \beta^m)' \\ \beta^x' \end{pmatrix} \Sigma^{-1} \alpha \right] \quad (10)$$

where

$$\begin{aligned} i &= 1, \dots, N, \quad t = 1, \dots, T, \quad \alpha = \bar{R} - \beta^m \bar{R}_m - \beta^x \bar{F}_x, \\ \beta^m &= (\beta_1^m, \dots, \beta_N^m)', \quad \beta^x = (\beta_1^x, \dots, \beta_N^x)', \quad \iota_N = (1, \dots, 1) \\ \bar{R}_m &= \frac{\sum_{t=1}^T R_{mt}}{T}, \quad \bar{F}_x = \frac{\sum_{t=1}^T F_{xt}}{T}, \quad \bar{R} = \left( \frac{\sum_{t=1}^T R_{1t}}{T}, \dots, \frac{\sum_{t=1}^T R_{Nt}}{T} \right)'. \end{aligned}$$

Originally, Black, Jensen, and Scholes (1972) used OLS instead of GLS, and estimated  $\delta_0$  and  $\delta_x$  as shown in equation (11).

$$\begin{pmatrix} \delta_0 \\ \delta_x \end{pmatrix} = \left[ \begin{pmatrix} (\iota_N - \beta^m)' \\ \beta^x' \end{pmatrix} \begin{pmatrix} (\iota_N - \beta^m) \\ \beta^x \end{pmatrix} \right]^{-1} \left[ \begin{pmatrix} (\iota_N - \beta^m)' \\ \beta^x' \end{pmatrix} \alpha \right] \quad (11)$$

In the fourth step, we newly estimate  $\beta_i^m$  and  $\beta_i^x$  by substituting  $\delta_0$  and  $\delta_x$  obtained from (10) in (12), and estimate the variance-covariance matrix  $\Sigma$  of residuals.

$$(R_{it} - \delta_0) = \beta_i^m(R_{mt} - \delta_0) + \beta_i^x(F_{xt} + \delta_x) + \varepsilon_{it} \quad (12)$$

Finally, we repeat the third and fourth steps until the values of the coefficients converge, and estimate  $\delta_0, \delta_x, \beta_i^m$ , and  $\beta_i^x$ .

Given the estimated results, as mentioned, we test the null hypothesis (7). When it is not rejected, the estimated APT model is said to be consistent with the data. To test the hypothesis, we use Likelihood Ratio test as follows.

$$-2 \ln \lambda = T[\ln|\Sigma_r| - \ln|\Sigma_u|] \sim \chi_{N-1}^2, \quad (13)$$

where  $|\Sigma_r|$  is the determinant of the covariance matrix of residuals in the restricted model, and  $|\Sigma_u|$  is that in the unrestricted model.

### III.3. Empirical Analysis: Exposure to FX Risk

The estimation result shows that FX risk did not significantly affect the Korean stock market, when we consider the sample of the whole period. Table 3 shows the result of FX risk estimation. In the regression of the whole sample period,  $\delta_x$  turns out to be insignificant, although LR test is not rejected. This means that, although the estimated model is consistent with the data, we do not observe FX risk in the stock market. Since FX risk does not exist on the stock market, the value of each firm's  $\beta_i^x$  is meaningless.

Given the result of the whole period that we do not observe RX risk significantly, we try to figure out why we could not find it. Figure 1 shows the daily return of market portfolio and daily rate of change in KRW/USD exchange rate. We can find similarity in both fluctuations in the graph. Until the end of 1997, when the economic crisis hits Korea, both the stock-market index and exchange rate have fluctuated with a small magnitude. Since the Korean government maintained the fixed exchange rate system, exchange rate moved little. However, right after the Korean government changed its exchange rate system into the floating one at the end of 1997, the exchange rate became much more volatile. Especially, KRW/USD exchange rate has moved by more than 15% in a

day at the period. But, since 2001, both the exchange rate and market portfolio return have become stable.

**[Table 3]** FX Risk Estimation Results

	LR statistic	$\delta_0$	$\delta_x$	Number of firms exposed to FX risk: Significance of $\beta_i^x$		
				P<0.01	P<0.05	P<0.1
Total Sample	255.52	$7.7 \times 10^{-4}$	$7.5 \times 10^{-5}$			
Period	(1.00)	(0.00)***	(0.38)	--	--	--
Period 1	330.13	$2.2 \times 10^{-4}$	$-9.2 \times 10^{-5}$			
	(0.99)	(0.09)*	(0.33)	--	--	--
Period 2	340.63	$2.0 \times 10^{-3}$	$7.7 \times 10^{-4}$			
	(0.99)	(0.00)***	(0.00)***	22	69	132
Period 3	396.74	$2.6 \times 10^{-4}$	$2.9 \times 10^{-4}$			
	(0.89)	(0.04)**	(0.01)***	24	63	118

Note: Standard errors are indicated in parentheses. \*, \*\*, and \*\*\* indicate significance levels at 10%, 5%, and 1%. Since FX risk is not found in the total sample period and period 1 case, the number of firms exposed FX risk is not available (indicated by “—”) for the cases.

Since different patterns of fluctuation in certain periods were found, we divide the whole period into some sub-periods, in order to find whether firms faced significant FX risk in sub-sample periods. In period 1 (January 1995 to December 1997), the exchange rate was under the fixed rate system. Period 2 (January 1998 to December 2000) is when the economic crisis hit the Korean economy. In period 3 (January 2001 to December 2004), the Korean Exchange Rate becomes more or less stable after the crisis.<sup>13</sup> During Periods 2 and 3, the exchange rate was under the floating rate system.

Given the sub-period results, we find significant FX risk in Periods 2 and 3. In Table 3, LR test is not rejected in any sub-periods, suggesting that the estimated APT model is valid.  $\delta_x$  is also significant in periods 2 and 3 with the 1% significance level. On the other hand, the FX risk

<sup>13</sup> The dividing point between period 2 and period 3 can be somewhat arbitrary. We do not make period 2 shorter because each period had to be at least 3 years long to avoid any singularity problem in regressions due to a short time-series period of the data. Additionally, we consider that firms have reported their FX risk management system in public since 2001. This point clearly differentiates period 3 from period 2. Therefore, in period 3, not only exchange rate shows a stable movement, but investors could make access to the information about firms' FX risk management.

estimation in Period 1 is insignificant, but unstable. As shown in Table 3, in Period 1,  $\delta_x$  is estimated to be insignificant. However, it also becomes significant depending on the time-series length of the sample. Significant FX risk could be found only when exchange rate fluctuates with a substantial magnitude. On the other hand, a small fluctuation causes the estimation to become unstable.

We also estimate the sensitivity of stock return to the market return,  $\beta_i^m$  and the sensitivity of stock return to exchange rate fluctuation,  $\beta_i^x$  of each firm. According to the estimation results, all the values of  $\beta_i^m$  are statistically significant at the 1% significance level, regardless of sub-periods or stocks. On the other hand, the statistical significance of  $\beta_i^x$  depends on stocks. Furthermore, the statistical significance of  $\beta_i^x$  varies across sub-periods even for the same stock. When  $\beta_i^x$  has a statistically significant value, the stock of firm,  $i$ , is interpreted to have FX risk. Firms expect FX risk to disappear by making use of derivatives to hedge. Otherwise, their efforts of hedging become invalid. Table 3 reports how many firms are exposed to FX risk by checking whether each firm's  $\beta_i^x$  is statistically significant. The result shows that, out of 435 firms, 132 firms were significantly exposed to FX risk in Period 2, and 118 firms in Period 3 at 10% significance level.<sup>14</sup> At 5% significance level, 70 firms were exposed to FX risk in Period 2, and 63 firms were in period 3.<sup>15</sup>

#### IV. EMPIRICAL ANALYSIS: RELATIONSHIP BETWEEN FX RISK MANAGEMENT AND FX RISK<sup>16</sup>

##### IV.1. Explanatory variables

Before presenting the empirical analysis, we need to add some explanations on the choices of explanatory variables in this study. In spite of many studies examining explanatory factors of FX risk management,

<sup>14</sup>  $\beta_i^x$  can be either positive or negative. In period 3, 93 have positive signs, and 25 have negative ones out of 118 firms. A positive sign means that stock price moves along KRW/USD rate. Thus, if a firm has significantly positive  $\beta_i^x$ , depreciation of KRW would be favorable for it.

<sup>15</sup> As shown in Table 3, in the total sample period and period 1, FX risk turns out to be insignificant. Thus, the number of firms exposed to FX risk is not valid.

<sup>16</sup> To examine the relationship between FX risk management and FX risk, we focus on the sub-sample result of period 3 when the information on FX risk management is available to public.

there are few studies which explain the determinants of FX risk itself. But, we can take variables commonly used in other researches related with FX risk management. From Table 4 to Table 8, we consistently consider variables, including total asset, exportation rate, foreign currency asset ratio, foreign currency debt ratio, foreign exchange net gains, leverage and liquidity.

Total asset, a proxy of firm size, is the most important variable explaining FX risk, since it turns out to be the only explanatory variable to describe the risk management in previous studies consistently (e.g., Kim and Sung, 2005). Additionally, we also consider an aspect that large firms are likely to hedge the risk, because they may have high risk, not only because of cost-side incentives.

Exportation can directly affect FX risk. For example, the depreciation of domestic currency would be favorable for exporting firms, while appreciation might hamper the performance. Thus, exportation variable can be positively correlated with FX risk,  $\beta_i^x$ .

Foreign currency asset and debt can directly affect FX risk too. Clearly, firms with high foreign currency asset or debt level would probably be exposed to significant FX risk. For example, firms having high portion of foreign currency asset would enjoy depreciation of domestic currency, while those with high foreign currency debt level would not. Thus, foreign currency asset (debt) is expected to be positively (negatively) correlated with  $\beta_i^x$ . Yi (2003) reports that foreign currency debt ratio is a significant determinant of hedging derivatives usage, although foreign currency asset ratio is not.

Foreign currency net gains would also be interpreted similarly, but the sign is not simple to be expected. Some firms gain from appreciation of domestic currency, but others gain from depreciation as well.

Leverage and liquidity are related with financial distress. Firms with high debt ratio or low current ratio would be likely to fall in financial distress. Foreign investors concerned about bankruptcy cost, and thus invest in firms with sound capital structure. Firms in default risk are more likely to hedge the FX risk to raise more capital from foreign investors. Howton and Perfect (1996) find that low liquidity causes firms to hedge FX risk with currency derivatives.

## IV.2. Which Firms are exposed to FX Risk?

In order to check which firms are exposed to FX risk, we run Probit Regression by using each individual firm's FX risk exposure dummy as the dependent variable. Table 4 reports the result. In probit regressions, we could not find any significant factors which explain firm's FX risk exposure. We also try to add industry data, as well as firm-level data, as additional explanatory variables, but any factor still does not explain FX risk exposure significantly.

Although we could not find any significant factors explaining whether firms are exposed to FX risk, we could report an interesting factor influencing FX risk, in terms of risk size.

We focus on the magnitude of  $\beta_i^x$ , which stands for the size of FX risk.<sup>17</sup> Since it is reasonable to consider the FX risk size only when  $\beta_i^x$  is statistically significant, we collect the data of firms that have significant value of  $\beta_i^x$  in Period 3 with the 10% significance level. We consider the magnitude of  $\beta_i^x$  as the dependent variable. Table 5 reports the OLS regression results.<sup>18</sup> In the regression, we find a factor which explains the magnitude of  $\beta_i^x$  (i.e., firm size<sup>19</sup>).

In addition to the case in which the magnitude of  $\beta_i^x$  is considered as the dependent variable, we also try alternative analysis focusing on the absolute significance of  $\beta_i^x$ , irrespective of (+) or (-) signs. We set statistically insignificant  $\beta_i^x$  to 0 and use significant 1 as it is. Table 6 shows the similar result as Table 5, except lower  $R^2$ .

<sup>17</sup> The size of FX risk here is  $\beta_i^x$  itself, not the absolute value of that. The sign as well as the absolute magnitude provides meaningful information. For example,  $\beta_i^x$  has a positive sign when stock price rises (drops) with KRW's depreciation (appreciation). On the other hand, when stock price rises (drops) with KRW's appreciation (depreciation),  $\beta_i^x$  has a negative sign.

<sup>18</sup> Leverage is statistically significant and it has negative coefficient. If they have abundant debt, including foreign currency debt, they are likely to gain from appreciation of domestic currency. Their stock prices move reversely with USD/KRW exchange rate.

<sup>19</sup> It is somewhat unexpected that exportation variable is not statistically significant in Table 5 because exporting firms are likely to have high,  $\beta_i^x$  intuitively. However, exporting firms do also import so that they can possibly have negative net export. Exportation variable in this regression does not mean net export. It indicates a firm's total exportation divided by its total asset.



**[Table 4]** FX Risk Exposure Determinants: Probit Regression

Variables	Risk Existence in Period 3			
	Coefficients	P-values	Coefficients	P-values
Risk Management Dummy	0.0076	(0.96)		
Derivatives Usage Dummy			-0.2139	(0.30)
Asset (logarithm scale)	0.0502	(0.66)	0.1106	(0.36)
Exportation Rate	-0.0681	(0.94)	-0.0045	(1.00)
Foreign Currency Asset Ratio	0.6247	(0.75)	-0.3925	(0.84)
Foreign Currency Debt Ratio	0.6366	(0.32)	0.7324	(0.23)
Foreign Exchange Net Gains	-8.5562	(0.70)	-6.1030	(0.78)
Leverage	0.3173	(0.14)	0.3227	(0.14)
Liquidity	0.0035	(0.96)	0.0016	(0.98)
Constant	-1.2512	(0.21)	-1.7306	(0.10)
Observations	435		435	
Chi-square	3.85 (0.87)		4.92 (0.77)	
Pseudo R <sup>2</sup>	0.0076		0.0097	

Note: \*, \*\*, and \*\*\* indicate significance levels at 10%, 5%, and 1%.

**[Table 5]** Determinants of FX Risk Size: OLS Regression  
(Firms Exposed to Significant FX Risk)

Variables	Risk Size in Period 3	
	Coefficients	P-values
Risk Management Dummy	0.0321	(0.73)
Asset (logarithm scale)	0.1234	(0.06)*
Exportation Rate	1.1924	(0.10)
Foreign Currency Asset Ratio	-1.2976	(0.32)
Foreign Currency Debt Ratio	0.1199	(0.72)
Foreign Exchange Net Gains	19.4250	(0.07)*
Leverage	-0.1602	(0.04)**
Liquidity	0.0649	(0.14)
Constant	-0.8258	(0.15)
Observations	118	
F	3.18 (0.00)***	
R <sup>2</sup>	0.1894	

Note: \*, \*\*, and \*\*\* indicate significance levels at 10%, 5%, and 1%.

Firm size turns out to be a significant factor which determines how sensitive firms' stock returns are to exchange rate changes. In other words, among firms exposed to FX risk, larger firms have greater value of the risk. It means that large firms can be more sensitive to exchange risk than small ones.

Since large firms tend to have the great magnitude of FX risk if they

are exposed to the risk, we can find another reason why firm size is a major determinant of firm's FX risk management. Once they are exposed to FX risk, large firms are more sensitive to the risk than small ones. Thus, large firms have more incentives to manage the risk than small ones do.<sup>20,21</sup>

**[Table 6]** Determinants of FX Risk Size: OLS Regression (Total Observations)

Variables	Risk Size in Period 3	
	Coefficients	P-values
Risk Management Dummy	0.0109	(0.69)
Asset (logarithm scale)	0.0434	(0.05)**
Exportation Rate	0.2106	(0.20)
Foreign Currency Asset Ratio	-0.0552	(0.88)
Foreign Currency Debt Ratio	0.0143	(0.91)
Foreign Exchange Net Gains	10.1803	(0.02)**
Leverage	-0.1150	(0.00)***
Liquidity	0.0046	(0.70)
Constant	-0.2528	(0.18)
Observations	435	
F	3.63 (0.00)***	
R <sup>2</sup>	0.0638	

Note: \*, \*\*, and \*\*\* indicate significance levels at 10%, 5%, and 1%.

**[Table 7]** Large Firms' FX Risk Exposure Determinants: Probit Regression

Variables	Risk Dummy in Period 3	
	Coefficients	P-values
Risk Management Dummy	-0.6512	(0.04)**
Asset (logarithm scale)	0.4041	(0.24)
Exportation Rate	0.1283	(0.95)
Foreign Currency Asset Ratio	-0.0760	(0.99)
Foreign Currency Debt Ratio	0.9305	(0.47)
Foreign Exchange Net Gains	-43.8838	(0.25)
Leverage	0.2255	(0.79)
Liquidity	0.1787	(0.48)
Constant	-4.1544	(0.20)
Observations	103	
Chi-square	6.32 (0.61)	
Pseudo R <sup>2</sup>	0.0484	

<sup>20</sup> As for the details of the cost-side incentives of FX risk management, see Kim and Sung (2005).

<sup>21</sup> Foreign investors might have some influence on this result. If foreign investors are interested especially in large firms, the rate of return for large firms can be more sensitive to exchange rate movement.

### IV.3. Is FX Risk Management Meaningful in the Stock Market?

Finally, we investigate whether FX risk management is meaningful in the stock market. Table 4 has already shown that firm's risk management dummy is not statistically significant in explaining FX risk exposure. Although we consider the derivatives usage dummy instead of FX risk management dummy, the derivative usage dummy does not explain the risk exposure either. In other words, neither derivatives nor internal methods help to eliminate FX risk. They do not affect the FX risk magnitude either.

However, we find that the result could be different if we focus on the sample of only the large firms. As already mentioned in Section IV.1, large firms tend to have the great magnitude of FX risk, if they are exposed to the risk. Given this result, we focus on the sub-sample of large firms.

We focus on the sample of 103 large firms with assets over 500 billion KRW.<sup>22</sup> We run Probit Regression of considering firm's risk exposure dummy as a dependent variable. Table 7 shows Probit estimation result. In the result, firm's risk management dummy has a negative coefficient with 5% significance level, which is consistent with the intuition that the risk management helps to eliminate the exchange risk.

Again, we set statistically insignificant  $\beta_i^x$  to 0 and use significant one as it is as attempted in Table 6. Table 8 shows the result.<sup>23</sup> Firm's risk management dummy is negatively correlated with FX risk size. Therefore, we suggest that the risk management is effective especially for large firms.

We also check how many large firms and small firms are respectively exposed to FX risk, because we cannot say that the risk management of large firms is effective if small firms are rarely exposed to the risk so that they do not have to control it. 34 out of 103 large firms, indicating 33.0%, are exposed to the risk. In the case of small firms, similarly, 84 out of 332,

<sup>22</sup> To figure out top 100 big companies ranked by asset size, we use the threshold of 500 billion KRW.

<sup>23</sup> Foreign currency net gains variable is statistically significant and its coefficient is positive. It indicates that large firms mostly gain from KRW depreciation. Interpretatively, they may possess more foreign currency asset than debt.

25.3%, are exposed to the risk. It means that small firms do not spend enough resources in FX risk management not because they are not sufficiently exposed to the risk.

**[Table 8]** Large Firms' FX Risk Size Determinants: OLS Regression

Variables	Risk Size in Period 3	
	Coefficients	P-values
Risk Management Dummy	-0.1085	(0.06)*
Asset (logarithm scale)	0.0072	(0.91)
Exportation Rate	0.1765	(0.57)
Foreign Currency Asset Ratio	0.4118	(0.60)
Foreign Currency Debt Ratio	0.9885	(0.68)
Foreign Exchange Net Gains	17.4447	(0.01)***
Leverage	0.0179	(0.91)
Liquidity	0.0355	(0.44)
Constant	0.0187	(0.97)
Observations	103	
F	1.65 (0.12)	
R <sup>2</sup>	0.1231	

According to the regression of the large-firm sub-sample, firms that use the risk management tend to have little FX risk. This implies that FX risk management can be usually effective for large firms but not for small firms. We can also explain this finding, in line with the relative importance of costs and benefits. In other words, building a good FX risk management system may be more costly for small firms, relative to more benefits to large firms. Large firms try to manage FX risks because their management is effective, but small firms would not manage because the market does not evaluate sufficiently their efforts of FX risk management, although they bear the costs of FX risk management.

## V. CONCLUSION

This paper focuses on the relationship between firm's FX risk management and FX risk exposure, while previous studies have mostly focused on what makes firms control the FX risk or whether the stock market has significant exchange risk. By examining whether the stock market evaluates the FX risk management that firms operate, we show

how both studies can be applied in the Korean stock market and in firms.

Many previous studies find that firm size is the major factor that determines the firm's behavior related with FX risk management. This empirical result has been consistent in most studies. These studies consider the firm size as a proxy for hedging cost, because the cost must be relatively cheaper for large firms than for small ones, especially when there are economies of scale in FX risk management. We confirm this fact, but also find that the cost is not the only reason why large firms tend to control FX risk. We find alternative explanations for this fact by investigating firm's sensitivity to the risk and effectiveness of the risk management.

We estimate FX risk in the Korean stock market, and cannot find the existence of risk significantly in the total sample period, so we divide the sample period into 3 sub-groups. We find different estimation results in each sub-period analysis. The results show that the stock market faces FX risks significantly when exchange rate fluctuates with the substantial magnitude. Since the Korean government has adopted the free-floating exchange rate system from the end of 1997, we find the significant FX risk exposure in sub-periods after 1998. In the period when exchange rate followed fixed system, (before the end of 1997) the FX risk estimation is insignificant or relatively unstable.

We also examine which firms are significantly exposed to FX risk. We report that larger firms tend to be exposed to FX risk more than smaller firms. Since we have shown that large firms are more sensitive to FX risk than small ones, we provide an alternative explanation as to why large firms tend to control the risk (i.e., their high sensitivity to the FX risk).

Finally, we try to show whether FX risk management is effective, in the sense that the stock market evaluates firms' FX risk management. We do not find that hedging is effective in analyzing the total sample. However, since firm size is strongly related with FX risk and the risk management, we focus on the sub-sample of large firms. We find that FX risk management is more effective for large firms. The FX risk management of large firms helps to eliminate the FX risk, but in small firms it does not.

The previous studies have shown that small firms prefer to take FX risk

rather than hedge the risk. These studies suggest that the FX risk management cost drives this result. In other words, it can be more profitable to take the FX risk than to put resources in the FX risk management for small firms. It is true that firm size can be a proxy for the hedging cost. This is emphasized in the previous literature.

Additionally, this paper suggests a notable reason, especially in terms of benefits of FX risk management. Large firms would like to manage FX risk rather than bear the risk, not only because the cost of management is relatively low, but because there are differences in the effectiveness of controlling FX risk. Large firms are more sensitive to FX risk than small firms in the stock market, and thus their risk management is more effective than that of small firms.

## References

- Allayannis, G. and E. Ofek (2001), "Exchange Rate Exposure, Hedging, and the Use of Foreign Currency Derivatives," *Journal of International Money and Finance*, Vol. 20, No. 2, 273-296.
- Berkman, H. and M. E. Bradbury (1996), "Empirical Evidence on the Corporate Use of Derivatives," *Financial Management*, Vol. 25, No. 2, 5-13.
- Black, F., M. C. Jensen and M. Scholes (1972), "The Capital Asset Pricing Model: Some Empirical Findings," in M. C. Jensen, eds., *Studies in the Theory of Capital Markets*, New York: Praeger, 79-121.
- Chen, N. F., R. Roll and S. A. Ross (1986), "Economic Forces and The Stock Market," *Journal of Business*, Vol. 59, No. 3, 383-403.
- Choi, J. J., T. Hiraki and N. Takezawa (1998), "Is Foreign Exchange Risk Priced in The Japanese Stock Market?" *Journal of Financial and Quantitative Analysis*, Vol. 33, No. 3, 361-382.
- Di Iorio, A. and R. Faff (2002), "The Pricing of Foreign Exchange Risk in the Australian Equities Market," *Pacific-Basin Finance Journal*, Vol. 10, No. 1, 77-95.
- Doukas, J., P. H. Hall and L. H. P. Lang (1999), "The Pricing of Currency Risk in Japan," *Journal of Banking and Finance*, Vol. 23, No. 1, 1-20.
- Fama, E. F. and K. R. French (1996), "Multifactor Explanations of Asset Pricing Anomalies," *Journal of Finance*, Vol. 51, No. 1, 55-84.
- Geczy, C., B. A. Minton and C. Schrand (1997), "Why Firms Use Currency Derivatives," *Journal of Finance*, Vol. 52, No. 4, 1323-1354.
- Gibbons, M. R. (1982), "Multivariate Tests of Financial Models," *Journal of Financial Economics*, Vol. 10, No. 1, 3-27.
- Guay, W. and S. P. Kothari (2003), "How Much Do Firms Hedge with Derivatives?," *Journal of Financial Economics*, Vol. 70, No. 3, 423-461.
- Hagelin, N. (2003), "Why Firms Hedge with Currency Derivatives: an Examination of Transaction and Translation Exposure," *Applied Financial Economics*, Vol. 13, No. 1, 55-69.
- Howton, S. D. and S. B. Perfect (1998), "Currency and Interest-Rate Derivatives Use in US Firms," *Financial Management*, Vol. 27, No. 4, 111-121.
- Ikeda, S. (1991), "Arbitrage Asset Pricing Under Exchange Risk," *Journal of Finance*, Vol. 46, No. 1, 447-455.
- Jorion, P. (1991), "The Pricing of Exchange Rate Risk in the Stock Market," *Journal of Financial and Quantitative Analysis*, Vol. 26, No. 3, 363-376.
- Kim, W. and T. Sung (2005), "What Makes Firms Manage FX Risk?" *Emerging*

- Markets Review*, Vol. 6, No. 3, 263-288.
- Kwon, T. and J. Park (1996), "The Exchange Risk Premium in Korean Stock Market and Firms' Characteristics," *Korean Journal of Financial Management*, Vol. 16, No. 1, 245-260. [in Korean]
- Martin, A. D. and L. J. Mauer (2004), "Scale Economies in Hedging Foreign Exchange Cash Flow Exposures," *Global Finance Journal*, Vol. 15, No. 1, 17-27.
- Mian, S. L. (1996), "Evidence on Corporate Hedging Policy," *Journal of Financial and Quantitative Analysis*, Vol. 31, No. 3, 419-439.
- Nance, D. R., C. W. Smith, and C. W. Smithson (1993), "On the Determinants of Corporate Hedging," *Journal of Finance*, Vol. 48, No. 1, 267-284.
- Nelson, J. M., J. S. Moffitt and J. Affleck-Graves (2005), "The Impact of Hedging on the Market Value of Equity," *Journal of Corporate Finance*, Vol. 11, No. 5, 851-881.
- Phillips, A. L. (1995), "1995 Derivatives Practices and Instruments Survey," *Financial Management*, Vol. 24, No. 2, 115-125.
- Ross, S. (1976), "The Arbitrage Theory of Capital Asset Pricing," *Journal of Economic Theory*, Vol. 13, No. 3, 341-360.
- Smith, C. W. and R. M. Stulz (1985), "The Determinants of Firms' Hedging Policies," *Journal of Financial and Quantitative Analysis*, Vol. 20, No. 4, 391-405.
- Solnik, B. (1983), "International Arbitrage Pricing Theory," *Journal of Finance*, Vol. 38, No. 2, 449-457.
- Yi, C. (2003), "Foreign Exchange Exposure and Hedging Determinant of Derivatives of International Transaction Firms," *International Business Journal*, Vol. 14, No. 3, 25-48. [in Korean]