Is Hedging with Financial Derivatives Effective During Financial Crises?

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Abstract

We explore a research issue of whether firms protect their firm values by timely adjusting their hedging positions of derivatives to sudden changes in exchange rates during financial crises. To this end, we sample non-financial firms in Korea for 2001-2010 and compare firms experiencing significant changes in exchange rate exposures ('change firms') with firms experiencing no such changes ('no change firms') surrounding the global financial crisis. We find that 'change firms' outnumber 'no change firms' and use significantly more derivatives than 'no change firms' to hedge exchange risk from changes in Korean won/U.S. dollar. We also show that 'change firms' have significantly lower firm values than 'no change firms'. More importantly, the lower values of 'change firms' are strongly related to their usage of derivatives for hedging financing risk associated with foreign currency debt, but not to the derivatives use for hedging operating risk associated with export revenues. We report similar results for Korean won/Japanese yen exchange rates. Our results offer strong evidence that derivatives would aggravate exchange rate exposures and further erode firm values if they are not timely or properly rebalanced in the face of sudden changes in exchange rates during financial crises.

Key words: Financial derivatives; Exchange rate exposures; Financial crises; Korean firms
JEL Classification: G34, G31

I. Introduction

Exchange rate changes bring in impacts on business operations, and the degree of the impact varies by firm. Firms employ various hedging tools including derivatives products to manage their exchange rate exposures.[1] While firms would in general manage their exposures relatively well in the environments of stable and anticipated exchange rate changes, it is questionable whether firms perform as well using derivatives products in different environments of sudden exchange rate changes during financial crises. A financial crisis is a situation where some financial assets suddenly lose a large portion of their nominal value and often accompanies a currency crisis where a currency value depreciates at least 10%.[2] Among others, the key questions would include: Do firms' existing positions in derivatives continue to work and protect firm values in the environments of sudden changes in exchange rates during financial crises? If not, what derivatives positions contribute to the mismanagement of exchange rate exposures? This paper attempts to offer new insights into these questions by taking a sample of firms in Korea surrounding the global financial crisis.

As a financial crisis typically affects exchange rates, changes in exchange rates during a financial crisis would have a direct impact on the values of firms' assets and liabilities through the devaluation and/or appreciation of local currency relative to foreign currency. At the same time, the financial crisis would influence firms' external markets and macroeconomic factors such as interest rates and market demand as well, which would then indirectly affect firm values. As a potential negative effect that the financial crisis can bring in indirectly through exchange rate changes, Allayannis, Brown, & Klapper (2003) point out the effect on financial markets, especially derivatives markets. They show that East Asian firms' values declined more than the changes in exchange rates surrounding the 1997 Asian financial crisis, which was mainly due to the decreased liquidity in the financial derivatives markets caused by the crisis. Bae, Kim, & Kwon (2018) also show that the reduction in firm risk resulting from hedging with currency derivatives

[1] The literature shows that firms with greater exchange rate exposures are more likely to use derivatives products (see, e.g., Bae & Kwon, 2013; Bae, Kim, & Kwon, 2018; Geczy, Minton, & Schrand, 1997).
[2] *Wikipedia* (https://en.wikipedia.org/wiki/Financial_crisis).

by Korean firms surrounding the 2007 global financial crisis was not materialized into an increase in firm values, which they attribute at least in part to the excessive costs associated with hedging in the derivatives markets during the crisis.

In this regard, if one intends to assess the full effects of exchange rate changes on firm values during a financial crisis, measuring only the direct effect of exchange rate changes would offer incomplete evidence. For example, before the 2007 global financial crisis, GM Daewoo in Korea held dollar-forward sell contracts (or dollar short position) in order to manage the exchange rate exposures from its dollar revenues (or dollar long position). During the crisis, GM Daewoo suffered a sharp decline in sales caused by a declining market demand. In spite of a decrease in its foreign currency revenues position, the firm continued to maintain its forward contacts (or dollar short position) previously made in the derivatives markets, which resulted in a loss of approximately USD 2.3 billion.[3] This mega loss for GM Daewoo exemplifies a firm's failure to timely adjust its derivatives position. Although the size of the hedged assets was substantially reduced due to the exchange rate changes caused by the crisis, the size of the previously-set derivatives positions for hedging remained unchanged without rebalancing. This case suggests that in order to properly protect firm values from sudden exchange rate changes, firms must consider both the direct effect of the exchange rate changes and the indirect effect of such changes through their impacts on firms' external factors and environments.

In this paper, we examine whether firms protect their firm values by timely and properly adjusting their hedging positions of derivatives to sudden changes in exchange rates during financial crises. We are particularly interested in uncovering empirical evidence on two research issues. The first research issue is whether there exist different characteristics and valuation effects of firms experiencing significant changes in their exchange rate exposures compared to firms experiencing no such changes. To this end, we first measure exchange rate exposures of sample firms and separate firms experiencing significant changes in their exchange rate exposures (labeled as 'change firms') from firms experiencing no such changes (labeled

[3] See Eiteman, Atonehill, & Moffett (2016), pg. 344.

as 'no change firms') for two separate periods surrounding the global financial crisis. The first period is 2001-2005 when the KRW/USD exchange rates followed a stable downward trend (that is, appreciation of KRW relative to USD); and the second period is 2006-2010, when the KRW/USD exchange rates increased (that is, devaluation of KRW relative to USD) with significant volatility, encompassing the global financial crisis. We then compare the determinants of the exchange rate exposures and the effects of such exposures on firm values between two groups of firms.

The second research issue is what causes the difference in the valuation effects of exchange rate exposures between the two groups of firms. We examine this issue by relating the usage of derivatives products for hedging operating and financing risk to firm values. The exchange risk management by firms relying on foreign trades and foreign capital typically involves derivatives products to hedge operating risk associated with foreign currency revenues from exporting activities and financing risk associated with foreign currency interest and principal payments of foreign currency debt. Hence, we intend to unveil which hedging position of derivatives between operating hedge and financing hedge contributes to the difference in firm values in the period of sudden exchange rate changes such as during the 2007 global financial crisis.[4]

For our study, we sample non-financial firms in Korea, one of the premier developing countries, for empirical evidence. Over the last decades, Korean firms have long engaged in international trades and resorted to foreign capital, which makes their firm values highly sensitive to exchange rate changes.[5] Consequently, they have been in great need of various hedging tools including financial derivatives to manage their exchange rate risk (Jung & Kwon, 2007). In this regard, Korean firms offer an ideal laboratory for the study of the effects of exchange rate exposures and the usage of derivatives products on firm values

[4] The current literature documents mixed empirical evidence on the effects of derivatives products on firm value. While several studies offer positive effects (e.g., Allayannis & Weston, 2001; Carter, Rogers, & Simkins, 2006; Clark & Mefteh, 2010), other studies reveal negative or no effects (e.g., Bartram, Brown, & Fehle, 2009; Guay & Kothari, 2003; Jin & Jorion, 2006).

[5] In addition, the current accounting system has also contributed to the exchange rate exposures of Korean firms as it requires firms to report the translation gains and losses in asset values associated with exchange rate changes in the concurrent year's balance sheets.

surrounding the 2007 global financial crisis.

Our results show that firms experiencing significant changes in their exchange rate exposures ('change firms') resulting from sudden changes in KRW/USD during the post-crisis period significantly outnumber and exhibit distinctively different characteristics than those experiencing no such changes in their exposures ('no change firms'). The results also reveal that change firms use financial derivatives significantly more than no change firms do throughout our study period of 2001-2010. While the derivatives use by both change firms and no change firms increases over the period of 2006-2008 compared to prior years, their usage by change firms increases sharply over the same period, recording the highest trading volume and more than twice that of no change firms in 2008.

We also show that change firms have significantly lower firm values than no change firms and that firms continuing to manage their exchange risk with previously-set derivatives positions are affected more negatively by sudden exchange rate changes. More importantly, we uncover evidence that the lower values of 'change firms' are related to their usage of derivatives for hedging financing risk associated with foreign currency debt, but not to the derivatives use for hedging operating risk associated with export revenues. Our main results remain robust to different model specifications. Viewing from the importance of the long-standing Korea-Japan business relationships both as major trader partners and as direct competitors, we further extend our analyses to the changes in KRW/Japanese yen exchange rates and report similar results. Overall, our results offer strong evidence that firms' derivatives positions could aggravate their exchange rate exposures and further erode firm values if they are not timely or properly rebalanced in the face of sudden changes in exchange rates during financial crises.

In the following Section 2, we present testing hypotheses. Section 3 discusses empirical models and data, and Section 4 reports empirical results, with the conclusion in Section 5.

2. Development of Testing Hypotheses

Firms are expected to manage their exchange rate exposures effectively using various hedging tools including derivatives during the period of relatively stable and anticipated changes in exchange rates. It is,

however, questionable—and thus subject to empirical scrutiny—whether firms are able to manage their exchange risk in a financial crisis as effectively as in a stable exchange rate environment. A financial crisis typically brings in sudden changes in exchange rates, but it also influences other external market and macroeconomic factors such as interest rates and global economic conditions that would in turn affect firms' operating and financing elements (i.e., export revenues and foreign currency debt). Hence, it is reasonably expected that firms will be exposed to magnified effects of exchange rate changes on their firm values during a financial crisis, relative to the period before the financial crisis. While exchange rate changes affect business operations and thus firm values, the degree of their effects on firm value will vary by firm. Accordingly, it is highly plausible that firm values will be more negatively affected by sudden changes in exchange rates if firms are more vulnerable to such changes and thus experiencing more significant changes in their exchange rate exposures than firms experiencing no such changes in their exposures. This discussion leads to our first testable hypothesis as follows:

> *Hypothesis 1: Values of firms experiencing significant changes in their exchange rate exposures due to sudden changes in exchange rates surrounding a financial crisis are affected more negatively than those of firms experiencing no such changes in their exposures.*

As we have observed in the instance of GM Daewoo in Korea that incurred a mega loss in spite of its usage of derivatives surrounding the global financial crisis, firms often fail to timely and properly adjust and rebalance their derivatives positions according to sudden changes in exchange rates and other external market factors such as interest rates. This observation raises questions on whether the mismanagement of exchange rate exposures by firms surrounding financial crises is related to firms' misuses of derivatives and, if so, what derivatives positions contribute to the mismanagement of exchange risk. Relying on international trades and foreign capital, Korean firms frequently resort to derivatives products mainly to hedge their operating risk stemming from export revenues in foreign currencies and financing risk

associated with payments of interests and principals of foreign currency debt.[6] Hence, it is plausible that these two types of hedging with derivatives products are closely related to the mismanagement of exchange risk and thus to potential value losses for firms experiencing significant changes in their exposures during a financial crisis. Following this discussion, we develop our second hypothesis as follows:

> *Hypothesis 2: The derivatives products that firms maintain to hedge operating and financing risk associated with foreign currency export revenues and foreign currency debt, respectively, contribute to potential value losses for firms experiencing significant changes in their exchange rate exposures surrounding a financial crisis.*

3. Empirical Models and Data

3.1. Measurement of exchange rate exposures

We examine the effects of sudden changes in exchange rates on firms' exchange rate exposures and the causes of such effects on firm values. As a first step, we measure the degree of a firm's exchange rate exposure by the exchange rate exposure coefficient in the following regression equation (1) (Jorion, 1990):

$$r_t = \beta_o + \beta_1 exr_t + \epsilon_t \quad (1)$$

where r = a firm's stock returns, exr = real exchange rate of KRW/USD, t = time, and the subscript for firm is omitted for convenience sake.

We also assess whether the characteristics of a firm's exchange rate exposures change by period or not through the examination of the direction and significance of the regression coefficient, β_1, in equation (1) between two subperiods surrounding the global financial crisis. Period 1 is 2001-2005 when KRW/USD exchange rates followed stable downward trends; and Period 2 is 2006-2010 when KRW/USD exchange rates increased with significant volatility, encompassing the global financial crisis. More specifically, if β_1

[6] Several studies show that firms often borrow foreign currency debt to hedge exchange rate risk resulting from exporting activities (see, e.g., Allayannis & Ofek, 2001; Bae & Kwon, 2013; Kedia & Mozumdar, 2003; Mora, Neaime, & Aintablian, 2013).

is insignificant regardless of its sign (either positive or negative) in Period 1but turns significant in Period 2, we judge that there is a significant change in the exchange rate exposure. If β_1 is significant in Period 1 but becomes insignificant in Period 2, we also judge that there is a significant change in the exposure. Although not frequent cases, if β_1 carries a significant coefficient in Period 1 and still carries a significant coefficient but with an opposite sign in Period 2, we also judge this case as a significant change in the exposure.

3.2. Analysis of determinants of exchange rate exposures

We first examine the determinants of firms' exchange rate exposures using the following regression equation (2):

$$EREXP_i = \gamma_0 + \gamma_1 Derivative_i + \gamma_2 Export_i + \gamma_3 Import_i + \gamma_4 Nfcdebt_i + \gamma_5 Forsub_i$$
$$+\gamma_6 Divindex_i + \gamma_7 Fsize_i + \gamma_8 Debt_i + \gamma_9 Age_i + \gamma_{10} Rnd_i + \gamma_{11} Conowner_i + \gamma_{12} Forowner_i$$
$$+ \gamma_{13} Pass_i + t.dInd_i + \epsilon_i \quad (2)$$

The dependent variable of *EREXP* in regression equation (2) is the degree of a firm's exchange rate exposure coefficient estimated as the regression coefficient of β_1 in the regression equation (1). Below we offer a brief explanation and measurement of other variables in the regression equation (2).

Derivative is measured as the total amount of outstanding derivatives contracts (including currency forwards, currency futures, risk insurance, options, and swaps), relative to total assets, at the end of each fiscal period. Firms tend to manage their remaining exchange rate exposures using derivatives products after employing operational and financial hedging activities such as domestic-currency invoicing, matching and offsetting, and exchange rate pass-through, among others. Hence, if properly hedged with derivatives, the derivatives use would not be related to firms' exchange rate exposures. If firms use derivatives for a (speculative) trading purpose rather than for a hedging purpose, however, firms' exchange rate exposures would increase, which would then make the derivatives use be significantly related to firm's exchange rate exposures. Hence, *Derivative* is included in the regression to test these relationships.

The first set of variables is related to firms' overseas business activities. *Export* represents export ratio measured by total export amount relative to total sales. *Import* represents a firm's import ratio. Because data on firms' import ratios are regarded as trade secrets and thus not publicly available, we use the imported input share of sales in the sector where a firm's produced goods belong as the proxy for a firm's import ratio.[7] *Nfcdebt* represents the net amount of foreign currency debt, measured by the difference between a firm's total foreign currency debt and total foreign currency assets. While *Export* is expected to increase a firm's positive exchange rate exposure (where a rise in the exchange rate increases firm value), *Nfcdebt* is expected to increase a firm's negative exchange rate exposure (where a rise in the exchange rate decreases firm value). *Forsub* represents the degree of a firm's internal transactions with its foreign subsidiaries, measured by the total amount of internal transactions with foreign subsidiaries divided by total sales. As *Forsub* reflects the outcome of a firm's foreign direct investment, *Forsub* is likely to affect the firm's exchange rate exposure (Miller & Reuer, 1998).

The second set of variables is related to firms' domestic business activities. *Divindex* represents the degree to which a firm's operations are diversified and is measured by the widely-used Caves weighted index of diversification based on the firm's sales (Caves et al., 1980). A firm's diversification activity will lower the exchange rate exposure owing to the portfolio effect. *Fsize* represents firm size and is measured by the natural log of the sum of market value of common stock and book values of preferred stock and debt. Firm size is known to affect types of hedging activities that firms engage in for managing their exchange rate exposures (Allayannis & Ofek, 2001; Choi & Prasad, 1995; He & Ng, 1998; Nance, Smith, & Smithson, 1993) and is related to the level of the exchange rate exposure that a firm can handle (Bodnar & Wong, 2003; Dominguez & Tesar, 2006). *Debt* is total debt to total assets ratio and may indirectly magnify the exchange rate exposure as it affects firms' stock returns due to the leverage effect (Wei & Starks, 2013). *Age* is the number of operational years of a firm and may be related to the firm's exchange rate exposure from the perspectives of the accumulated experience of managing exchange rate exposures and the

[7] The imported input shares of sector sales are collected from the input-output tables reported by the Bank of Korea. See Bae & Kwon (2013) for the detailed discussion on the measurement of import ratios.

competitiveness. *Pass* is exchange rate pass-through ratio, representing a firm's competitiveness to pass through exchange rate exposures, which would affect the firm's ability to manage its exchange rate exposure. *Pass* is estimated by relating input-output worksheets and item-by-item transfer pricing to each firm's compositions of sales items. *Rnd* is R&D expenses to total assets ratio. Two corporate governance variables are also included: *Conowner* and *Forowner* are controlling and foreign shareholders' ownership, respectively, and are measured by common shares held by the largest shareowner or foreign investors divided by total common shares.

For the control variable, we include an industry dummy variable of *Dind* that spans twenty-two industries from food and beverage (KSIC 10) to publishing (KSIC 58) based on two-digit KSIC codes. A firm's exchange rate exposure is expected to vary depending on the business sector where the firm belongs (Jin & Jorion, 2006). Since firms may change their industry classifications as time goes by, the sales item with the highest actual sales is used to identify each firm's primary industry.

3.3. Analysis of the effect of changes in exchange rate exposures on firm value

Firms' exchange rate exposures may induce significant effects on firm value. If the estimated regression coefficient of a firm's exchange rate exposure changes in terms of the direction and significance level from one period to the subsequent period, then this change in exposure may be regarded as significant and thus affect firm value. We estimate regression equation (3) to examine the relationship between the changes in the regression coefficients of exchange rate exposure and firm value.

$$\begin{aligned} Tobinq_i = {} & \delta_0 + \delta_1 dEREXP_i + \delta_2 Derivative_i + \delta_3 Export_i + \delta_4 Import_i + \delta_5 Nfcdebt_i + \delta_6 Forsub_i \\ & + \delta_7 Divindex_i + \delta_8 Fsize_i + \delta_9 Opcf_i + \delta_{10} Sg_i + \delta_{11} Debt_i + \delta_{12} Age_i + \delta_{13} Rnd_i \\ & + \delta_{14} Conowner_i + \delta_{15} Pass_i + w_i Dind_i + \varepsilon_i \end{aligned} \quad (3)$$

In regression equation (3), the dependent variable of *Tobinq* is used as proxy for firm value and measured by the sum of market value of common stock and book values of preferred stock and debt divided by total assets. The key test variable is *dEREXP*, which has the value of 1 for firms whose exchange rate exposure coefficient changes from one period to another period ('change firms'), and 0 otherwise ('no

change firms'). A negative value of the estimated regression coefficient of δ_1 in regression equation (3) would indicate that the values of change firms are on average lower than those of no change firms.

We use several control variables in regression equation (3), which are expected to affect firm values and have been widely used in the literature. These variables include: the amount of derivatives products relative to total assets (*Derivative*); export ratio (*Export*); import ratio (*Import*); net foreign debt ratio (*Nfcdebt*); internal transaction amount with foreign subsidiaries (*Forsub*); diversification index (*Divindex*); firm size (*Fsize*); operating cash flow ratio (*Opcf*); sales growth (*Sg*); debt ratio (*Debt*); firm age (*Age*); R&D expense ratio (*Rnd*); controlling shareholder ownership (*Conowner*); and exchange rate pass-through ratio (*Pass*). *Export*, *Import*, and *Nfcdebt* would affect firm value through their relationships with changes in exchange rates. *Forsub* may be related to firm value as they are used to transfer FDI firms' resources. *Divindex* is included to reflect the well-documented effects of diversification on firm value, and *Opcf* and *Sg* are expected to be directly related to firm value (Brush, Bromiley, & Hendrickx, 2000). *Debt* is included to control for the potential effect of capital structure on firm value, and *Age* and *Pass* control for the effects of a firm's competitive position on firm value. *Rnd* and *Conowner* control for the effects of growth potential and corporate governance, respectively, on firm value. The definitions and measurement of variables in regression models are summarized in Table 1.

[Insert Table 1 around here]

Similarly to our earlier analyses, we estimate the regression equation (3) for Periods 1 and 2 in order to compare the potentially different effects of changes in firms' exchange rate exposures on firm values between the two periods.

3.4. Data

Our sample includes all public non-financial firms continuously listed on the Korea Exchange during 2001-2010. Because our study examines the changes in exchange rate exposures between two periods of Period 1 (2001-2005) and Period 2 (2006-2010), we include firms listed continuously over the

entire years of each of Period 1 and Period 2.[8] Our study period is limited to 2010 due to the unavailability of detailed information about firms' usages of derivatives products starting 2011.[9] For estimating exchange rate exposures in regression equation (1), we employ KRW/USD real exchange rates by adjusting monthly KRW/USD nominal exchange rates with the difference in the monthly inflation rates between Korea and the U.S. We collect exchange rates and inflation rates from the Korean Statistical Information Services (KOSIS) database, stock returns of listed firms from the KIS Value database, and transaction amounts of firms' derivatives contracts from the section of "transactions (purchases and sales) of financial derivatives" in firms' annual operating reports during the sample period. We obtain the basic data for variables used in the regression models from the TS2000 database of Korean Listed Companies Council.

4. Empirical Results

4.1. Summary statistics of variables

Table 2 presents the summary statistics of variables used in our study. Both mean and median values of *Tobinq*, as proxy for firm value, are less than 1.0, indicating that the market values of sample firms are below their book values. A typical Korean firm in the sample engages in 27% and 19% of total sales for exporting revenues and importing expenses, respectively. The average derivatives transaction amount for Korean firms is approximately 3% of their total assets. Korean firms hold on average more foreign currency debt than foreign currency assets, whose difference represents approximately 3% of their total assets.

[Insert Table 2 around here]

4.2. Measurement and characteristics of exchange rate exposures

[8] This screening criterion yields a slightly different number of sample firm-year observations for the two periods as shown in later tables.

[9] Listed firms in Korea reported detailed information on their outstanding derivatives contracts at the end of fiscal year from 2000. Since the International Financial Reporting Standards (IFRS) were adopted in 2011, however, the listed firms have reported on the voluntary basis information on derivatives contracts in various forms (e.g., no report, contract amount only, etc.), which makes it impossible to collect complete and consistent data on derivatives contracts.

Table 3 reports the distributions of exchange rate exposures measured by the estimated regression coefficients of *exr* in regression equation (1) by two periods—Period 1 for 2001-2005 in Panel A and Period 2 for 2006-2010 in Panel B. The exchange rate exposure coefficients are estimated each year for firms whose stock return data are available for at least 36 months. The estimated exposure coefficients are then counted toward the number of firm-year observations in each period.

[Insert Table 3 around here]

As shown in Panel A, the average exchange rate exposure for all sample firms in Period 1 is -0.54, indicating that an increase in the real exchange rate of KRW/USD (that is, the devaluation of Korean won) is accompanied by a decrease in firms' stock returns. When the exchange rate exposures are classified by the sign of the exposure, approximately 74% (= 1,606/2,181) of sample firm-year observations carry a negative sign of exchange rate exposure coefficient. When examining the absolute values of the exposure coefficient, firms with a negative coefficient exhibit a greater degree of exchange rate exposure than firms with a positive coefficient (0.89 vs. 0.43).

Approximately 9% (= 200/2,181) of sample firm-year observations show significant exposure coefficients at least at the 10% level with an average coefficient of -1.93. An exposure coefficient greater than 1.0 in the absolute term indicates a greater change in equity value (and stock returns) associated with a change in the same unit of exchange rate. This is mainly due to the magnified effect of exchange rate changes associated with the leverage effect of debt financing (Wei & Starks, 2013).

During Period 2 of 2006-2010 that encompasses the global financial crisis, as shown in Panel B, almost 95% (= 2,163/2,279) of sample firm-year observations carry a negative exposure coefficient, which is a sharp increase from 74% in Period 1 of 2001-2005. Among these firms, approximately 61% (= 1,314/2,163) show significance at least at the 10% level. A closer examination reveals that there is no firm-year observation with a positive and significant exposure coefficient in Period 2. These results strongly indicate that the equity values (and stock returns) of the majority of non-financial firms in Korea were significantly negatively affected by the sharp changes in KRW/USD in Period 2.

The results in Table 3 show that the signs of the majority of the exchange rate exposure coefficients

change to negative ones during the crisis compared to the previous period. Hence, we conduct further analyses on these firms and report the results in Panels C and D of Table 3, which contrasts change firms to no change firms during Period 2 relative to Period 1. In Period 1, the average exchange rate exposure coefficient of no change firms is -0.72, whereas the average exposure coefficient of change firms -0.41. On the contrary, in Period 2, the average exposure coefficient of change firms becomes substantially more negative (-1.01) than that of no change firms (-0.42), indicating that exchange rate exposures of change firms increase substantially in Period 2.

[Insert Table 4 around here]

In order to offer further insights into the changes in firms' exchange rate exposures in Period 2, we provide a summary of the distributions of exchange rate exposures of sample firms in Table 4. Sixty-two firms have positive but insignificant exchange rate exposures in Period 1 but show negative and significant exposures in Period 2. Two firms have positive and significant exposures in Period 1 and still significant but negative exposures in Period 2. 180 firms exhibit the same negative signs, but their exposures turn from insignificant in Period 1 to significant in Period 2, whereas 16 firms carry the same negative exposures but show the opposite way of significance in Period 1 turning to insignificance in Period 2. Hence, according to the criteria for change firms as presented in Table 4, a total of 260 (= 62 + 2 + 180 + 16) firms belong to the 'change firms' category. Excluding 16 firms whose exchange rate exposures turn from significant to insignificant out of 260 firms, 244 firms experience changes in their exchange rate exposures in a way to a strengthened negative direction.

[Insert Table 4 around here]

4.3. Summary statistics for change firms and no change firms

Table 5 reports the summary statistics of characteristics of change firms and no change firms in Period 1. The ratio of derivatives transaction amount to total assets is significantly higher for change firms than no change firms, indicating that firms engaging in more derivatives transactions in Period 1 are likely to experience greater changes in exchange rate exposures. The debt to total assets ratio is also significantly

higher for change firms; hence, firms with higher financial leverage are likely to have greater changes in their exchange rate exposures. On the contrary, the import ratio and the exchange rate pass-through ratio are smaller for change firms. It is also shown that the mean values of Tobinq, R&D ratio, and total risk are significantly higher for no change firms, whereas the mean value of the operating cash flow ratio is significantly higher for change firms.

[Insert Table 5 around here]

The overall results in Table 5 show that firms experiencing significant changes in their exchange rate exposures between Period 1 and Period 2 (change firms) significantly outnumber and exhibit distinctively different characteristics than those experiencing no such changes (no change firms). Compared to no change firms, change firms tend to engage in more derivatives transactions, have a higher debt ratio but a lower import ratio and a lower exchange rate pass-through ratio. The two groups also exhibit differences in operating cash flow ratio, R&D ratio, and total risk. It is further shown graphically in Figure 1 that the derivatives use by change firms is significantly higher than that by no change firms throughout our study period of 2001-2010. While the derivatives use by both change firms and no change firms increases during 2006-2008 compared to prior years, their usage by change firms increases sharply over the same period, recording the highest transaction amount and more than twice that of no change firms in 2008 (5.85 vs. 3.4% relative to total assets).

[Insert Figure 1 around here]

4.4. Pearson correlation coefficients between derivatives transaction and other variables

As a way to further examine the differences in characteristics between change firms and no change firms, we measure Pearson correlation coefficients of firms' derivatives transaction amount with other variables and report the results in Table 6. In Period 1, *Derivative* for change firms is positively and significantly (at least at the 5% level) related to *Export, Nfcdebt, Fsize,* and *Debt,* whereas *Fsize* for no change firms is the only variable that is positively and significantly (at least at the 5% level) related to *Derivative*. These results indicate that larger firms with a higher export ratio and a higher foreign currency

debt ratio are more likely to use derivatives products to manage their exchange risk. In Period 2, while most of these variables carry the same signs and significance levels as in Period 1, two variables of *Trisk* and *EREXP* for change firms reveal distinctively different coefficients. Although preliminary, the negative coefficient of *EREXP* and the positive coefficient of *Trisk* with *Derivatives* cast doubts about the effectiveness of derivatives use by Korean firms to manage exchange rate risk during Period 2. On the contrary, the insignificant *EREXP* for no change firms in Period 2 suggests that these firms become proactive by making the necessary adjustments to their derivatives positions according to the sudden changes in exchange rates.

[Insert Table 6 around here]

4.5. Determinants of exchange rate exposures for change firms and no change firms

We now turn to the results of estimating regression equation (2) for change firms by period by employing the exchange rate exposure coefficients estimated from regression equation (1) as the dependent variable of *EREXP* as reported in Table 7. We are particularly interested in what firm attributes contribute to the exchange rate exposures for change firms and whether there are differences in these attributes between the two periods.

As shown in Models 1 and 2 in Table 7, the estimated regression coefficient of *Derivative* in Period 1 is negative but insignificant, indicating that Korean firms use derivatives products to manage their foreign exchange risk effectively. Three firm variables of *Debt, Age, Rnd* are negatively and significantly related to *EREXP*, while *Conowner, Forowner,* and *Pass* are positively and significantly related to *EREXP*. The regression estimates in Period 2 show similarities and differences compared to those in Period 1. While almost same variables carry same signs and significance levels in both periods, a notably different variable is *Derivative*, which is negatively and significantly related to *EREXP*. This latter result on *Derivative* strongly indicates that a more usage of derivatives products is related to lower (or more negative) exchange rate exposures, thus aggravating the negative exchange rate exposures of Korean firms in Period 2.

[Insert Table 7 around here]

We further estimate logistic regression models to examine the potential differences in determinants of *EREXP* between change firms and no change firms for Period 1 and Period 2 in Models 3 and 4, respectively, of Table 7. The dependent variable of *dEREXP* has a value of 1 for change firms and 0 for no change firms. In Period 1, *Derivative* has a positive and significant regression coefficient of 2.041, indicating that firms using more derivatives products in Period 1 are likely to experience significant changes in their exchange rate exposures in Period 2 than firms using less derivatives products in Period 1. It is also shown that while *Debt* carries a positive and significant regression coefficient, *Age*, *Rnd*, and *Pass* all have negative and significant coefficients. Hence, a high debt ratio magnifies the effect of exchange rate changes on stock returns due to the leverage effect. On the contrary, maturity (*Age*) and competitiveness (*Rnd* and *Pass*) would lower the possibility of significantly changing firms' exchange rate exposures. Similar results are obtained in Period 2. Among others, *Derivative* continues to exhibit a positive and significant regression coefficient. This result indicates that firms' derivatives positions are maintained even after their exchange rate exposures have significantly changed in Period 2. Considering that derivatives products are transactions with limited periods, this result also supports the notion that firms' derivatives positions contribute to the significant changes in the firms' exchange rate exposures.

4.6. Effects of changes in exchange rate exposures on firm value

The ultimate goal of managing exchange rate exposures is to protect firm values from exchange risk. Hence, if firms manage their exposures effectively, their firm values would be immune to exchange rate changes. If firms' exchange rate exposures change abruptly in an unexpected direction due to sudden changes in external environments, however, they may then bring in negative impacts on firm values. Applying these relationships to our research issue suggests that if firms using derivatives products to manage their exposures prior to a crisis experience sudden changes in their exchange rate exposures during the crisis, these changes may affect firm values negatively. In order to examine this issue, we estimate the regression equation (3) and report the results for the sample of change firms in two periods in Table 8.

[Insert Table 8 around here]

Looking first at the results in Period 1, *dEREXP* has a negative and significant (at the 1% level) regression coefficient regardless of the presence of control variables. These findings indicate that change firms are associated with lower firm values than no change firms. The estimation results in Period 2 are similar to those in Period 1 including the negative and significant regression coefficients of *dEREXP*. The absolute values of the regression estimates of *dEREXP* in Period 2 are, however, substantially larger than those of *dEREXP* in Period 1. Hence, the negative effects of changes in exchange rate exposures on firm values of change firms are more pronounced in Period 2 than in Period 1.

Table 8 also shows that *Derivative* does not show significance, indicating that firms' derivatives transactions themselves do not have direct impacts on firm values. Considering the significant and positive association between *Derivative* and *dEREXP* as shown in Table 7, however, the usage of derivatives products may bring in a negative impact on firm values indirectly through an increase in exchange rate exposures, which we test in the next subsection.

4.7. Analysis of the cause of lower firm values for change firms in Period 2

In order to further investigate if the lower values of change firms observed in Period 2 are due to the usage of derivatives products for operating and/or financing hedges, we employ two interaction variables of *Derivative_d x Export_d* for operating hedge and *Derivative_d x Nfcdebt_d* for financing hedge in the regression equation (3) for the sample of change firms in Period 2. *Export_d* is equal to 1 for firms with the export ratio higher than the median value and 0 otherwise; *Nfcdebt_d* is equal to 1 for firms with the net foreign currency debt ratio higher than the median value and 0 otherwise; and *Derivative_d* is equal to 1 for firms with the derivatives contract ratio higher than the median value and 0 otherwise.

Table 9 shows that while the interaction variable of *Derivative_d x Export_d* has a negative but insignificant regression coefficient, *Derivative_d x Nfcdebt_d* exhibits a negative and significant (at the 10% level) coefficient in Period 2. Furthermore, F-tests indicate that the sum of the coefficients on *Nfcdebt_d* and *Derivative_d x Nfcdebt_d* is negative and significant at the 1% level. These results suggest that the lower firm values of change firms in Period 2 are at least in part attributable to the firms' usage of

derivatives products to hedge exchange rate exposures associated with foreign currency debt financing. Hence, in spite of using derivatives products for hedging firms' financing risk associated with foreign currency debt financing, Korean firms appear to have failed to properly protect their firm values from sudden changes in exchange rates during the global financial crisis. Our results are consistent with the evidence in Allayannis, Brown, & Klapper (2003).

[Insert Table 9 around here]

4.8. Robustness tests

We perform several robustness tests to investigate if our empirical results are sensitive to alternative model specifications.

4.8.1. Valuation effects of changes in exchange rate exposures using industry-adjusted Tobin's q

In the estimation of regression equation (2), we have employed industry dummies to control for the industry effects, assuming that the industry effects stay the same in a given period. The industry effects may, however, vary by year. In order to take into account this variation, we re-estimate regression equation (2) using industry-adjusted Tobin's q as an alternative measure of firm value, whose results are reported in Table 10. The industry-adjusted Tobin's q is measured as the difference between a firm's Tobin's q in a given year and the median Tobin's q in the industry in the same year.

[Insert Table 10 around here]

The overall results on the estimates of variables in Table 10 are qualitatively similar to those in Table 8 with respect to their signs and significance levels, but with lower adjusted R-square values than those in Table 8. Among others, the regression coefficient of *dEREXP* is negative and significant at the 1% level with other control variables in the regression models in both periods (Models 2 and 4). Furthermore, the absolute value (0.081) of the regression coefficient of *dEREXP* in Period 2 (Model 4) is more than twice that (0.034) in Period 1 (Model 2). These results confirm our earlier findings that firm values of change firms are lower than those of no change firms and that the negative valuation effect is more pronounced in Period 2 than in Period 1.

4.8.2. Valuation effects using industry-adjusted Tobin's q and interaction variables

Employing the industry-adjusted Tobin's q as dependent variable, we further estimate regression equation (2) with two interaction variables of *Derivative_d x Export_d* and *Derivative_d x Nfcdebt_d* to uncover the cause of lower firm values for change firms. Table 11 shows the regression estimates. Compared to those in Table 9 using the raw values of Tobin's q, the regression estimates in Table 11 are qualitatively identical. Among others, the interaction variable of *Derivative_d x Nfcdebt_d* carries a negative and significant (at the 10% level), whereas *Derivative_d x Export_d* shows a negative but insignificant regression coefficient. These regression results offer confirmatory evidence that while firms' usage of derivatives products does not directly hurt firm values, a possible mismanagement of derivatives positions to hedge financing risk associated with foreign currency debt financing would affect firm values negatively.

[Insert Table 11 around here]

4.9. Additional tests with changes in an alternative exchange rate of KRW/JPY

Our analyses have so far dealt with the exchange rate exposures of Korean firms resulting from changes in the KRW/USD exchange rate. Considering that most export and import transactions of Korean firms are settled in U.S. dollars, the most-used currency in international transactions, our study of KRW/USD exchange rate is clearly justified. Nevertheless, positioning both as major trade partners and as direct competitors of Japanese firms, Korean firms have for decades engaged in hefty export and import trades with Japanese firms in many sectors including electronics, automobiles, semi-conductors, shipbuilding, and mechanics.[10] Accordingly, a change in KRW/JPY exchange rate would have two opposing effects. On the one hand, a devaluation of Japanese yen (or a decrease in the KRW/JPY exchange rate) will strengthen the competitiveness of Japanese firms' exporting activities, thus hurting Korean firms'

[10] Over the last decade, Korea has recorded a trade deficit with Japan in the range of $20 billion to $35 billion per year. As of June 2018, Korea's export to Japan was $27.8 billion (3rd largest), and Korea's import from Japan amounted to over $60.5 billion (2nd largest), resulting in a trade deficit of $32.7 billion with Japan (*Trading Economics*: https://tradingeconomics.com/south-korea/balance-of-trade).

businesses. On the other hand, the devaluation of JPY will lower costs of materials (mostly intermediary goods) that Korean firms import from Japanese firms, leading to an increase in the competitiveness of Korean firms. Hence, given the close and long-standing business relationships between Korea and Japan, an extended study of our main research issues to the KRW/JPY rate is worthy.

In this regard, we investigate whether changes in the KRW/JPY exchange rate surrounding the global financial crisis bring in greater exposures and thus lower firm values for Korean firms and whether the usage of derivatives products contributes to these associations in a similar manner to the KRW/USD rate. Our results will not only offer new empirical evidence on these issues, but also suggest if our main results are limited to the KRW/USD exchange rate or can be generalized to other currencies as well that are closely related to Korean firms' overseas businesses.

We first estimate regression equation (1) using changes in KRW/JPY real exchange rate, which is measured by the KRW/JPY nominal rate adjusted by the changes in consumer price indexes of Korea and Japan on an annual basis. While we perform full analyses with the KRW/JPY exchange rate in a similar fashion to those with the KRW/USD rate, we report main results from estimating regression equations (2) and (3) in Tables 12 through 14 for brevity's sake.[11]

Table 12 presents the regression estimates from regression equation (2) on the determinants of exchange rate exposures associated with changes in the KRW/JPY rate. Compared to the regression results in Table 7, the regression estimates in Table 12 show many similarities and some differences with respect to signs and significance levels. More importantly, the regression coefficient of *Derivative* is not significant in either Period 1 or Period 2, indicating that unlike KRW/USD exchange rate, the derivatives use by Korean firms does not have a significant impact on the exchange rate exposures resulting from the changes in the KRW/JPY rate. In contrast, *Derivative* carries a positive and significant regression coefficient in Period 1 in the logit regression of *dEREXP* (Model 3). Hence, this result strongly indicates that Korean firms using more derivatives products in Period 1 are likely to experience significant changes in their

[11] The full results are available from the authors upon request.

exchange rate exposures (and thus belonging to the 'change firms' group), whose evidence is consistent with our earlier evidence with the KRW/USD rate. In contrast, *Derivative* exhibits an insignificant regression estimate in Period 2 (Models 2 and 4), different from that with the KRW/USD rate reported in Table 7. This result with the KRW/JPY rate seems to be largely due to the substantially smaller transaction amount of yen-related derivatives products.

[Insert Table 12 around here]

Table 13 reports the regression estimates on the effects of exchange rate exposures to the KRW/JPY rate on firm values for change firms relative to no change firms. While *dEREXP* does not carry a significant regression coefficient in Model 2, it has a negative and significant (at the 1% level) regression coefficient with control variables in Model 4, the latter of which is consistent with the regression estimate of *dEREXP*, though a smaller absolute value, using the KRW/USD rate reported in Table 8.

[Insert Table 13 around here]

Lastly, Table 14 shows the regression results on the possible cause of the lower firm values of change firms using two interaction variables of *Derivative_d x Export_d* (for operating hedge) and *Derivative_d x Nfcdebt_d* (for financing hedge). Similarly to the results with the KRW/USD rate reported in Table 9, *Derivative_d x Export_d* has a negative and insignificant regression coefficient, but *Derivative_d x Nfcdebt_d* carries a negative and significant (at the 10% level) regression coefficient of -0.066. Hence, Korean firms' usage of derivatives products for hedging financing risk stemming from foreign currency debt financing affects firm values negatively for change firms during the crisis.

[Insert Table 14 around here]

5. Conclusion

This study examines the effects of sudden changes in exchange rates caused by a financial crisis on firms' exchange rate exposures and firm values for firms that use derivatives products to hedge such exposures. To this end, we employ data for non-financial firms in Korea for the 2001-2005 period of relatively stable exchange rates and for the 2006-2010 period, characterized by significant volatilities of

exchange rates due to the global financial crisis.

Our results show that most Korean firms experience significantly larger changes in exchange rate exposures resulting from the sudden changes in the KRW/USD exchange rate during the post-crisis period than during the pre-crisis period and that these changes are closely related to their usage of derivatives products. Our results also reveal that firms experiencing significant changes in their exposures are associated with lower firm values than firms experiencing no such changes during our sample period. We further repot that the lower values of firms experiencing significant changes in their exchange rate exposures are mainly attributed to their usage of derivatives for hedging financing risk resulting from foreign currency debt financing, but not to the derivatives use for hedging operating risk associated with foreign currency revenues from exporting activities. We extend our empirical analyses to an alternative exchange rate of KRW relative to Japanese yen and report similar results to those with the KRW/USD exchange rate.

Overall, the results of our study offer strong evidence that derivatives products used for the purpose of hedging exchange rate exposures may work in the environments of relatively stable exchange rate changes, but may fail to protect firm values when firms fail to make timely and proper adjustments to their derivatives positions in the face of sudden and sharp changes in exchange rates during financial crises.

References

Adler, M., & Dumas, B. (1984). Exposure to currency risk: Definition and measurement. *Financial Management*, 13, 41-50.

Allayannis, G., & Ofek, E. (2001). Exchange rate exposure, hedging, and the use of foreign currency derivatives. *Journal of International Money and Finance* 20, 273-296.

Allayannis, G., Brown, G. W., & Klapper, L. F. (2003). Capital structure and financial risk: Evidence from foreign debt use in East Asia. *Journal of Finance*, 58, 2667–-2709.

Allayannis, G. & Weston, J.P. (2001). The use of foreign currency derivatives and firm market value, *Review of Financial Studies* 14, 243-276.

Bae, S. C., & Kwon, T. H. (2013). Asymmetric foreign exchange exposure, option trade, and foreign currency denominated debt: Evidence from Korea. *Asia-Pacific Journal of Financial Studies* 42, 314-339.

Bae, S. C., Kim, H. S., & Kwon, T. H. (2018). Currency derivatives for hedging: New evidence on determinants, firm risk, and performance. *Journal of Futures Markets*, 38, 446-467.

Bartram, S., G.W. Brown & Fehle F.R. (2009). International evidence on financial derivatives usage, *Financial Management* 38, 185-206.

Bodnar, G.M., & Wong, M.H.F. (2003). Estimating exchange rate exposures: Issues in model structure. *Financial Management*, 32, 35-67.

Brush, T. H., Bromiley, P., & Hendrickx, M. (2000). The free cash flow hypothesis for sales growth and firm performance. *Strategic Management Journal*, 21, 455-472.

Carter, D.A., Rogers, D.A., & Simkins, B.J. (2006). Hedging and value in the U.S. airline industry, *Journal of Applied Corporate Finance* 18, 21-33.

Caves, R., Porter, M., Spence, A., & Scott, J. (1980). Competition in the open economy: A model applied to Canada. Harvard University Press, Boston, MA.

Choi, J., & Prasad, A. (1995). Exchange rate sensitivity and its determinants: Firm and industry analysis of US multinationals. *Financial Management*, 24, 77-88.

Clark, E., & Mefteh, S. (2010). Foreign currency derivatives use, firm value and the effect of the exposure profile: evidence from France, *International Journal of Business* 15, 183-196.

Dominguez, K., & Tesar, L. (2006). Exchange rate exposure. *Journal of International Economics,* 68, 188-218.

Eiteman, D. K., Atonehill, A. I., & Moffett, M. H. (2016). *Multinational Business Finance*, 14th edition, Global Edition, Pearson Education Ltd.

Geczy, C., Minton, B.A., & Schrand, C. (1997). Why firms use currency derivatives. *Journal of Finance* 52, 1323-1354.

Guay, W., & Kothari, S. (2003). How much do hedge with derivatives? *Journal of Financial Economics,* 70, 423-461.

He, J., & Ng, L. (1998). The foreign exchange exposure of Japanese multinational corporations. *Journal of Finance,* 53, 733-753.

Jin, Y., & Jorion, P. (2006). Firm value and hedging: Evidence from U.S. oil and gas producers. *Journal of Finance,* 61, 893-919.

Jorion, P. (1990). The exchange-rate exposure of U.S. multinationals, *Journal of Business* 63, 331-345.

Jung, S.C., & Kwon, T.H. (2007). Do firms' currency derivatives transactions reduce their exchange rate exposure, *Journal of Korean Academy of International Business*, 18, 37-63.

Kedia, S., & Mozumdar, A. (2003). Foreign currency denominated debt: an empirical examination. *Journal of Business*, 76, 521-546.

Miller, K. D., & Reuer, J. J. (1998). Asymmetric corporate exposures to foreign exchange rate changes. *Strategic Management Journal,* 19, 1183-1191.

Mora, N., Neaime, S., & Aintablian, S. (2013). Foreign currency borrowing by small firms in emerging markets: When domestic banks intermediate dollars. *Journal of Banking & Finance*, 37, 1093-1107.

Nance, D.R., Smith, Jr., C.W., & Smithson, C.W. (1993). On the determinants of corporate hedging. *Journal of Finance,* 48, 267-284.

Trading Economics: https://tradingeconomics.com/south-korea/balance-of-trade.

Wei, K. D., & Starks, L. T. (2013). Foreign exchange exposure elasticity and financial distress. *Financial Management*, 42, 709-735.

Wikipedia: https://en.wikipedia.org/wiki/Financial_crisis.

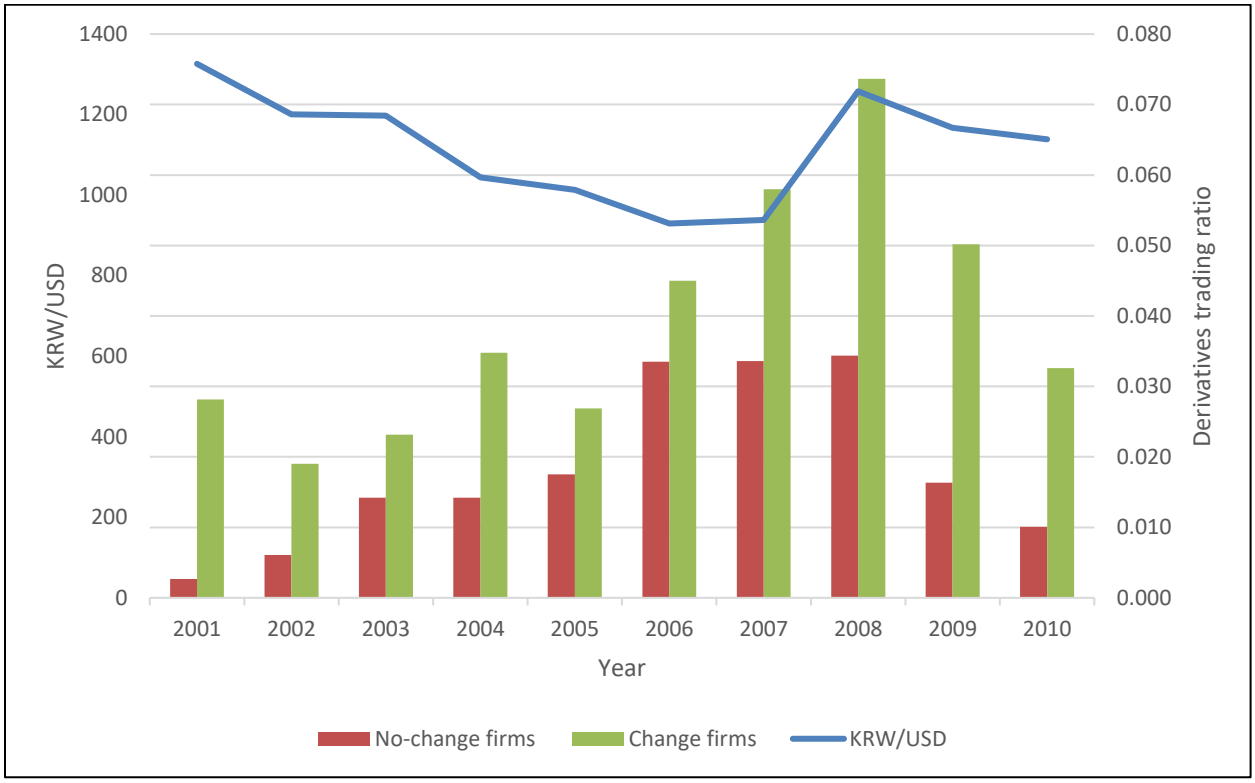

Figure 1. Annual trends of KRW/USD and derivatives ratios for change firms vs. no change firms
Source: The Bank of Korea and Company Annual Reports

Table 1. Definitions and measurements of variables

Variables	Definitions	Measurement
Dependent variables		
EREXP	Exchange rate exposure	Estimated regression coefficient of *exr* in regression equation (1)
Tobinq	Tobin's q ratio	(MV of common stock + BV of preferred stock + BV of debt) / total assets
Explanatory variables related to determinants of exchange rate exposures (regression equation (2))		
Derivative	Derivatives ratio	Derivatives trading amount / total assets
Export	Export ratio	Export revenue / total sales
Import	Import ratio	Proxied by sector import share (imported raw materials / sector sales)
Nfcdebt	Net foreign currency debt	(FC debt – FC assets) / total assets
Forsub	Intra-firm transactions with foreign subsidiaries	(Sales + purchases + profits + costs) / total sales
Divindex	Diversification index	Caves' diversification index
Fsize	Firm size	ln(MV of common + BV of preferred stock + BV of debt)
Debt	Debt ratio	Total debt / total assets
Age	Years in business	ln(current year – founding year +1)
Rnd	R&D ratio	R&D expenses / total assets
Conowner	Controlling shareholder ownership	Common shares held by largest shareholder / total common shares
Forowner	Foreign investor ownership	Common shares held by foreign investors / total common shares
Pass	Pass-through ratio	Proxied by the sector transfer pricing of sales items matching with the firm's compositions of sales items
Dind	Industry dummy	Twenty-two industries based on 2-digit KSIC codes.
Additional explanatory variables exclusively related to firm value (regression equation (3))		
dEREXP	Exchange rate exposure change dummy	1 for firms whose exchange rate exposures change between two periods and 0 otherwise
Opcf	Operating cash flow	(operating income + depreciation) / total assets
Sg	Sales growth	(Sales in t – sales in t-1) / sales in t-1
Trisk	Total risk	ln(standard deviation of daily stock returns)

Table 2. Summary statistics of variables

Variables	Mean	Min	0.25	Median	0.75	Max
Tobinq	0.94	0.32	0.71	0.85	1.06	3.00
Derivative	0.03	0.00	0.00	0.00	0.01	0.98
Export	0.27	0.00	0.01	0.17	0.49	1.00
Import	0.19	0.00	0.09	0.17	0.25	0.74
Nfcdebt	0.03	0.00	0.00	0.01	0.05	0.31
Forsub	0.07	0.00	0.00	0.00	0.07	0.96
Divindex	0.23	0.00	0.01	0.11	0.35	1.67
Fsize	19.29	16.57	18.19	18.94	20.03	23.92
Opcf	0.05	-0.22	0.03	0.05	0.08	0.23
Sg	0.08	-0.29	0.02	0.07	0.13	1.12
Debt	0.45	0.05	0.31	0.46	0.59	0.91
Age	3.62	1.69	3.43	3.64	3.85	4.39
Rnd	0.01	0.00	0.00	0.00	0.02	0.10
Conowner	0.40	0.04	0.30	0.40	0.50	0.82
Forowner	0.10	0.00	0.01	0.04	0.13	0.65
Pass	0.03	0.00	0.00	0.02	0.05	0.28
Trisk	-3.49	-4.33	-3.68	-3.50	-3.31	-2.67

Note. This table reports descriptive statistics for sample Korean firms during 2001-2010. The whole sample includes 2,381 firm-year observations. See Table 1 for definitions and measurements of variables.

Table 3. Distributions of exchange rate exposure coefficients

	Mean	Min	0.25	Median	0.75	Max	No. of firm-year obs.
Panel A. By sign of EREXP for Period 1 (2001-2005)							
Positive EREXP	0.43	0.01	0.15	0.33	0.53	2.32	575
Negative EREXP	-0.89	-4.89	-1.25	-0.66	-0.35	0.00	1606
Average for whole sample	-0.54	-4.89	-1.05	-0.43	0.03	2.32	2181
EREXP significant at least at 10% level	-1.93	-4.89	-2.62	-1.92	-1.32	1.93	200
Panel B. By sign of EREXP for Period 2 (2006-2010)							
Positive EREXP	0.23	0.01	0.06	0.13	0.26	1.04	116
Negative EREXP	-0.78	-2.18	-1.04	-0.73	-0.46	-0.01	2163
Average for whole sample	-0.73	-2.18	-1.02	-0.70	-0.41	1.04	2279
EREXP significant at least at 10% level	-1.02	-2.18	-1.21	-0.96	-0.75	-0.36	1314
Panel C. By change in sign of EREXP for Period 1 (2001-2005)							
No change in sign	-0.72	-4.89	-1.28	-0.56	0.03	2.32	1028
Change in sign	-0.39	-3.27	-0.77	-0.39	0.03	1.98	1153
Panel D. By change in sign of EREXP for Period 2 (2006-2010)							
No change in sign	-0.42	-1.78	-0.60	-0.39	-0.22	1.04	1085
Change in sign	-1.01	-2.18	-1.19	-0.96	-0.74	-0.36	1194

Note. This table reports distributions of exchange rate exposure coefficients (EREXP) for sample Korean firms during 2001-2010. The whole sample includes 2,381 firm-year observations. *EREXP* is measured as the estimated regression coefficient of *exr* from regression equation (1).

Table 4. Classification of exchange rate exposure coefficients

Classification	No change in sign or significance	Change in sign & no change in significance	No change in sign & change in significance	Change in sign & significance	Total No. of firms
Panel A. Positive EREXP					
Insignificant EREXP	11	49	0	62	122
Significant EREXP	0	2	0	0	2
Panel B. Negative EREXP					
Insignificant EREXP	107	14	180	0	301
Significant EREXP	24	0	16	0	40

Note. This table reports classification of sample firms according to their exchange rate exposure coefficients (EREXP). *EREXP* is measured as the estimated regression coefficient of *exr* from regression equation (1).

Table 5. Difference tests of firm characteristics between no change firms and change firm

	No change firms (1) (firm-year obs.=1,028)		Change firms (2) (firm-year obs.=1,153)		Difference tests (1) – (2)	
Variables	Mean	Median	Mean	Median	t-statistic	z-statistic
EREXP	-0.723	-0.557	-0.385	-0.386	-8.94**	-7.10***
Tobinq	0.884	0.783	0.834	0.779	3.17***	0.87
Derivative	0.009	0.000	0.026	0.000	-3.10***	-3.66***
Export	0.276	0.135	0.281	0.189	-0.34	-0.74
Import	0.195	0.181	0.164	0.151	5.45***	5.35***
Nfcdebt	0.031	0.000	0.035	0.006	-1.81	-4.99***
Forsub	0.064	0.000	0.061	0.000	0.55	-1.27
Divindex	0.141	0.000	0.133	0.000	0.71	0.69
Fsize	18.957	18.730	19.182	18.765	-3.46***	-3.55***
Opcf	0.052	0.054	0.060	0.057	-2.95***	-2.31**
Sg	0.056	0.052	0.077	0.052	-1.92*	-1.07
Debt	0.438	0.420	0.491	0.491	-6.38***	-6.98***
Age	3.585	3.584	3.531	3.555	1.14	2.30**
Rnd	0.011	0.004	0.009	0.004	3.40***	1.01
Conowner	0.388	0.383	0.399	0.396	-1.55	-1.76*
Forowner	0.086	0.010	0.096	0.017	-1.52	1.88*
Pass	0.041	0.016	0.033	0.013	3.47***	3.50***
Trisk	-3.451	-3.444	-3.489	-3.481	2.54**	2.43**

Note. This table reports means, medians, and difference test results for change firms and no change firms in Period 1 of 2001-2005. See Table 1 for definitions and measurements of variables.

Table 6. Pearson correlation coefficients of variables with derivatives trading ratio

Variables	Period 1 (2001-2005)		Period 2 (2006-2010)	
	Change firms	No change firms	Change firms	No change firms
EREXP	-0.014	0.017	-0.124***	0.012
Export	0.150***	0.008	0.228***	0.132***
Import	0.030	-0.014	-0.015	0.063*
Nfcdebt	0.086***	0.031	0.106***	0.100**
Forsub	0.008	0.023	0.004	0.029
Divindex	0.042	0.015	0.015	-0.017
Fsize	0.118***	0.086***	0.185***	0.031
Opcf	-0.034	0.049	0.044	0.063**
Sg	0.001	0.015	0.026	0.071**
Debt	0.079***	-0.018	0.179***	0.065**
Age	-0.011	0.023	-0.047	-0.085***
Rnd	-0.019	0.024	-0.035	0.015
Conowner	-0.053**	-0.031	-0.089	0.054
Forowner	0.033	0.053*	0.050	0.018
Pass	0.050*	0.016	0.010	0.050*
Trisk	-0.004	-0.057*	0.119***	0.036

Note. This table reports Pearson correlation coefficients of variables with firms' derivatives trading ratio (*Derivative*) for sample Korean firms during 2001-2010. See Table 1 for definitions and measurements of variables. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Table 7. Determinants of exchange rate exposures and changes in exposures by period

	Dependent variable = *EREXP* (OLS)		Dependent variable = *dEREXP* (Logit regression)	
	Period 1	Period 2	Period 1	Period 2
Variables	Model 1	Model 2	Model 3	Model 4
Derivative	-0.021	-0.191***	2.041**	1.246***
	(-0.208)	(-2.631)	(2.427)	(2.736)
Export	0.070	0.080*	-0.024	-0.028
	(0.798)	(1.713)	(-0.095)	(-0.120)
Import	-0.181	0.091	-0.289	-0.425
	(-0.962)	(1.177)	(-0.547)	(-0.991)
Nfcdebt	0.421	-0.055	0.640	-0.986
	(1.336)	(-0.338)	(0.683)	(-1.117)
Forsub	0.035	-0.061	-0.190	0.745**
	(0.253)	(-1.050)	(-0.440)	(2.247)
Divindex	0.028	-0.026	-0.204	-0.002
	(0.387)	(-1.033)	(-1.052)	(-0.014)
Fsize	0.020	-0.035***	0.033	0.047
	(1.014)	(-4.475)	(0.682)	(1.157)
Debt	-0.955***	-0.456***	1.378***	1.649***
	(-7.964)	(-8.064)	(4.545)	(5.620)
Age	-0.122**	0.128***	-0.402***	-0.536***
	(-2.129)	(4.117)	(-2.729)	(-3.245)
Rnd	-2.438*	3.077***	-15.317***	-20.485***
	(-1.850)	(5.294)	(-3.921)	(-6.094)
Conowner	0.786***	0.082	0.462	0.049
	(5.674)	(1.262)	(1.411)	(0.151)
Forowner	0.372**	0.177**	0.455	-0.271
	(2.001)	(2.277)	(0.932)	(-0.610)
Pass	1.045**	0.809***	-4.826***	-2.577**
	(2.257)	(4.409)	(-3.782)	(-2.114)
Constant	-0.230	-0.176	0.453	0.658
	(-0.621)	(-1.001)	(0.462)	(0.675)
Year/Industry dummies	Yes	Yes	Yes	Yes
No. of obs.	2,181	2,279	2,077	2,178
Adjusted R-square	0.227	0.304	0.108	0.111

Note. This table reports regression estimates for determinants of exchange rate exposures (*EREXP*) for sample Korean firms during 2001-2010. *EREXP* is measured as the estimated regression coefficient of *exr* in regression equation (1). *dEREXP* is equal to 1 for change firms and 0 for no change firms with regard to *EXERP*. See Table 1 for definitions and measurements of variables. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Table 8. Effects of changes in exchange rate exposures on firm value by period for change firms

	Period 1 (2001-2005)		Period 2 (2006-2010)	
Variables	Model 1	Model 2	Model 3	Model 4
dEREXP	-0.051***	-0.034***	-0.100***	-0.080***
	(-3.020)	(-2.821)	(-5.001)	(-5.619)
Derivative		-0.006		0.007
		(-0.174)		(0.147)
Export		-0.139***		-0.133***
		(-4.389)		(-4.072)
Import		-0.156**		-0.114*
		(-2.323)		(-1.892)
Nfcdebt		-0.380***		-0.363***
		(-4.281)		(-3.287)
Forsub		-0.046		-0.012
		(-0.840)		(-0.248)
Divindex		-0.014		-0.017
		(-0.413)		(-0.799)
Fsize		0.090***		0.115***
		(14.470)		(16.792)
Opcf		0.245		1.114***
		(1.508)		(5.273)
Sg		0.070**		0.051
		(2.016)		(1.069)
Debt		0.263***		0.281***
		(5.389)		(5.204)
Age		-0.158***		-0.114***
		(-7.474)		(-4.418)
Rnd		3.707***		2.753***
		(5.565)		(3.655)
Conowner		-0.168***		-0.272***
		(-4.111)		(-5.698)
Pass		0.155		0.525***
		(0.914)		(2.671)
Trisk		0.280***		0.310***
		(11.149)		(5.864)
Constant	0.884***	0.518***	1.058***	0.475**
	(62.729)	(4.082)	(66.467)	(2.366)
Year/Industry dummies	Yes	Yes	Yes	Yes
No. of obs.	2,181	2,181	2,279	2,279
Adjusted R-square	0.004	0.510	0.011	0.506

Note. This table reports regression estimates for the effects of changes in exchange rate exposures (*EREXP*) on firm value for sample Korean firms during 2001-2010. The dependent variable is *Tobinq*, a proxy for firm value. The main test variable is *dEREXP* that has the value of 1 for change firms and 0 for no change firms with regard to *EREXP*. See Table 1 for definitions and measurements of variables. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Table 9. Operating vs. financing hedge for change firms in period 2

Variables	Model 1	Model 2	Model 3
Derivative_d	-0.037**	-0.026	0.021
	(-2.014)	(-0.574)	(0.659)
Export_d	-0.048**	-0.046*	-0.045**
	(-2.105)	(-1.819)	(-1.983)
Derivative_d x Export_d		-0.013	
		(-0.281)	
Import	-0.053	-0.052	-0.043
	(-0.837)	(-0.819)	(-0.703)
Nfcdebt	-0.413***	-0.414***	
	(-3.464)	(-3.487)	
Forsub	-0.102**	-0.101**	-0.090**
	(-2.214)	(-2.210)	(-1.998)
Divindex	-0.014	-0.014	-0.005
	(-0.599)	(-0.608)	(-0.222)
Fsize	0.116***	0.115***	0.122***
	(14.158)	(14.139)	(14.962)
Debt	0.364***	0.364***	0.399***
	(7.341)	(7.342)	(8.415)
Age	-0.114***	-0.114***	-0.104***
	(-4.361)	(-4.357)	(-4.082)
Rnd	2.995***	2.996***	2.943***
	(3.922)	(3.921)	(3.887)
Conowner	-0.291***	-0.291***	-0.311***
	(-5.842)	(-5.821)	(-6.221)
Forowner	0.053	0.053	0.009
	(0.754)	(0.754)	(0.120)
Pass	0.423**	0.420**	0.490**
	(2.067)	(2.045)	(2.450)
Nfcdebt_d			-0.098***
			(-4.953)
Derivative_d x Nfcdebt_d			-0.067*
			(-1.773)
Constant	-0.779***	-0.778***	-0.919***
	(-4.613)	(-4.608)	(-5.473)
No. obs.	2,279	2,279	2,279
R-square	0.449	0.449	0.458

Note. This table reports regression estimates on the interactions of export revenues (*Export*) and foreign currency debt (*Nfcdebt*) with derivatives trading (*Derivative*) for change firms in Period 1. The dependent variable is *Tobinq*, a proxy for firm value. The main test variables are *Derivative_d x Export_d* and *Derivative_d x Nfcdebt_d*, where all dummy variables are equal to 1 if higher than the median value and 0 otherwise. See Table 1 for definitions and measurements of variables. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Table 10. Robustness test using industry-adjusted Tobin's q

	Period 1 (2001-2005)		Period 2 (2006-2010)	
Variables	Model 1	Model 2	Model 3	Model 4
dEREXP	-0.014	-0.034***	-0.050***	-0.081***
	(-0.954)	(-2.777)	(-2.855)	(-5.521)
Derivative		-0.021		0.028
		(-0.456)		(0.588)
Export		-0.133***		-0.132***
		(-4.344)		(-4.020)
Import		-0.037		-0.137**
		(-0.547)		(-2.279)
Nfcdebt		-0.413***		-0.353***
		(-4.263)		(-3.170)
Forsub		-0.044		-0.025
		(-0.802)		(-0.502)
Divindex		-0.027		-0.014
		(-0.780)		(-0.661)
Fsize		0.086***		0.113***
		(14.202)		(16.481)
Opcf		0.251		0.995***
		(1.612)		(4.891)
Sg		0.063*		0.032
		(1.910)		(0.734)
Debt		0.281***		0.284***
		(5.904)		(5.330)
Age		-0.158***		-0.114***
		(-7.528)		(-4.348)
Rnd		3.443***		2.689***
		(5.322)		(3.764)
Conowner		-0.172***		-0.269***
		(-4.299)		(-5.598)
Pass		0.181		0.568***
		(1.100)		(2.961)
Trisk		0.253***		0.275***
		(10.252)		(5.500)
Constant	-0.054***	-0.273**	-0.033**	-0.752***
	(-4.511)	(-2.134)	(-2.349)	(-3.871)
Year/Industry dummies	Yes	Yes	Yes	Yes
No. of obs.	2,181	2,181	2,279	2,279
Adjusted R-square	0.000	0.358	0.004	0.350

Note. This table reports regression estimates for the effects of changes in exchange rate exposures (*EREXP*) on firm value for sample Korean firms during 2001-2010. The dependent variable is *industry-adjusted Tobinq*, a proxy for firm value. The main test variable of *dEREXP* has the value of 1 for change firms and 0 for no change firms with regard to *EREXP*. See Table 1 for definitions and measurements of variables. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Table 11. Robustness test using industry-adjusted Tobin's q for operating vs. financing hedge

Variables	Model 1	Model 2	Model 3
Derivative_d	-0.035*	-0.027	0.024
	(-1.901)	(-0.603)	(0.728)
Export_d	-0.053**	-0.051**	-0.049**
	(-2.327)	(-2.039)	(-2.218)
Derivative_d x Export_d		-0.010	
		(-0.210)	
Import	-0.086	-0.085	-0.076
	(-1.376)	(-1.361)	(-1.255)
Nfcdebt	-0.398***	-0.399***	
	(-3.354)	(-3.374)	
Forsub	-0.111**	-0.111**	-0.100**
	(-2.422)	(-2.419)	(-2.215)
Divindex	-0.011	-0.011	-0.003
	(-0.502)	(-0.510)	(-0.116)
Fsize	0.113***	0.113***	0.120***
	(14.235)	(14.227)	(15.055)
Debt	0.351***	0.351***	0.385***
	(7.233)	(7.234)	(8.338)
Age	-0.111***	-0.111***	-0.102***
	(-4.237)	(-4.230)	(-3.969)
Rnd	2.978***	2.978***	2.929***
	(4.095)	(4.095)	(4.054)
Conowner	-0.288***	-0.287***	-0.307***
	(-5.757)	(-5.739)	(-6.119)
Forowner	0.040	0.040	-0.003
	(0.586)	(0.586)	(-0.048)
Pass	0.486**	0.484**	0.552***
	(2.461)	(2.439)	(2.858)
Nfcdebt_d			-0.094***
			(-4.776)
Derivative_d x Nfcdebt_d			-0.068*
			(-1.790)
Constant	-1.712***	-1.712***	-1.849***
	(-10.316)	(-10.311)	(-11.230)
No. of obs.	2,279	2,279	2,279
Adjusted R-square	0.290	0.290	0.300

Note. This table reports regression estimates on the interactions of export revenues (*Export*) and foreign currency debt (*Nfcdebt*) with derivatives trading (*Derivative*) for change firms in Period 1. The dependent variable is *industry-adjusted Tobinq*, a proxy for firm value. The main test variables are *Derivative_d x Export_d* and *Derivative_d x Nfcdebt_d*, where all dummy variables are equal to 1 if higher than the median value and 0 otherwise. See Table 1 for definitions and measurements of variables. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Table 12. Determinants of exchange rate exposures to KRW/JPY rate

Variables	Dependent variable = *EREXP* (OLS)		Dependent variable = *dEREXP* (Logit regression)	
	Period 1	Period 2	Period 1	Period 2
	Model 1	Model 2	Model 3	Model 4
Derivative	0.069	-0.085	1.841**	0.578
	(0.711)	(-1.406)	(2.022)	(1.492)
Export	0.247***	-0.038	0.506**	0.136
	(2.611)	(-0.875)	(1.966)	(0.564)
Import	0.039	0.131*	-0.667	0.329
	(0.190)	(1.774)	(-1.186)	(0.755)
Nfcdebt	0.544	0.079	1.942**	2.066**
	(1.538)	(0.502)	(2.157)	(2.476)
Forsub	-0.369**	0.034	-1.442***	-1.110***
	(-2.165)	(0.621)	(-3.166)	(-3.020)
Divindex	-0.093	-0.009	0.277	0.171
	(-1.312)	(-0.415)	(1.375)	(1.357)
Fsize	0.217***	-0.012*	0.269***	0.234***
	(10.366)	(-1.719)	(5.448)	(5.602)
Debt	-1.100***	-0.489***	-0.213	-0.326
	(-8.335)	(-9.521)	(-0.710)	(-1.126)
Age	-0.171***	0.056*	-0.114	-0.168
	(-2.812)	(1.905)	(-0.731)	(-0.965)
Rnd	1.437	2.897***	-2.241	-16.456***
	(0.982)	(5.442)	(-0.546)	(-4.596)
Conowner	0.808***	0.020	-0.637*	-0.675**
	(5.947)	(0.351)	(-1.956)	(-2.042)
Forowner	0.624***	0.253***	0.806	1.189***
	(3.570)	(3.929)	(1.622)	(2.607)
Pass	-0.194	0.563***	-1.886	-2.382*
	(-0.397)	(2.915)	(-1.364)	(-1.863)
Constant	-3.934***	-0.207	-4.776***	-3.857***
	(-9.820)	(-1.317)	(-4.799)	(-3.776)
Year/Industry dummies	Yes	Yes	Yes	Yes
No. of obs.	2,181	2,279	2,077	2,178
Adjusted R-square	0.331	0.285	0.141	0.148

Note. This table reports regression estimates for determinants of exchange rate exposures (*EREXP*) related to changes in KRW/JPY exchange rate for sample Korean firms during 2001-2010. *dEREXP* has the value of 1 for change firms and 0 for no change firms with regard to *EXERP*. See Table 1 for definitions and measurements of variables. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Table 13. Effects of exchange rate exposures to KRW/JPY rate on firm value

	Period 1 (2001-2005)		Period 2 (2006-2010)	
Variables	Model 1	Model 2	Model 3	Model 4
dEREXP	-0.010	-0.009	-0.040**	-0.062***
	(-0.611)	(-0.678)	(-2.029)	(-3.902)
Derivative		-0.009		-0.004
		(-0.240)		(-0.084)
Export		-0.139***		-0.130***
		(-4.357)		(-3.951)
Import		-0.155**		-0.101*
		(-2.298)		(-1.656)
Nfcdebt		-0.379***		-0.320***
		(-4.238)		(-2.859)
Forsub		-0.047		-0.039
		(-0.861)		(-0.810)
Divindex		-0.013		-0.017
		(-0.372)		(-0.772)
Fsize		0.090***		0.119***
		(14.191)		(17.293)
Opcf		0.232		1.072***
		(1.405)		(5.066)
Sg		0.069*		0.055
		(1.960)		(1.132)
Debt		0.249***		0.237***
		(5.098)		(4.335)
Age		-0.156***		-0.107***
		(-7.315)		(-4.061)
Rnd		3.838***		2.916***
		(5.718)		(3.952)
Conowner		-0.170***		-0.280***
		(-4.127)		(-5.761)
Pass		0.179		0.536***
		(1.061)		(2.707)
Trisk		0.286***		0.319***
		(11.439)		(6.092)
Constant	0.862***	0.512***	1.023***	0.339
	(68.182)	(4.062)	(70.867)	(1.635)
Year/Industry dummies	Yes	Yes	Yes	Yes
No. of obs.	2,181	2,181	2,279	2,279
Adjusted R-square	0.000	0.508	0.002	0.503

Note. This table reports regression estimates for the effects of changes in exchange rate exposures (*EREXP*) related to changes in KRW/JPY rate on firm value for sample Korean firms during 2001-2010. The dependent variable is *Tobinq*, a proxy for firm value. The main test variable of *dEREXP* has the value of 1 for change firms and 0 for no change firms with regard to EREXP. See Table 1 for definitions and measurements of variables. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Table 14. Operating vs. financing hedge of derivatives trading using KRW/JPY rate

Variables	Model 1	Model 2	Model 3
Derivative_d	-0.037**	-0.026	0.021
	(-1.989)	(-0.571)	(0.646)
Export_d	-0.048**	-0.046*	-0.045**
	(-2.084)	(-1.805)	(-1.968)
Derivative_d x Export_d		-0.013	
		(-0.275)	
Import	-0.053	-0.052	-0.044
	(-0.838)	(-0.820)	(-0.705)
Nfcdebt	-0.413***	-0.415***	
	(-3.467)	(-3.489)	
Forsub	-0.102**	-0.102**	-0.090**
	(-2.217)	(-2.213)	(-2.002)
Divindex	-0.014	-0.014	-0.005
	(-0.596)	(-0.605)	(-0.221)
Fsize	0.116***	0.115***	0.122***
	(14.161)	(14.142)	(14.959)
Debt	0.364***	0.364***	0.398***
	(7.333)	(7.333)	(8.395)
Age	-0.113***	-0.113***	-0.104***
	(-4.332)	(-4.327)	(-4.057)
Rnd	2.989***	2.989***	2.943***
	(3.911)	(3.910)	(3.883)
Conowner	-0.291***	-0.291***	-0.311***
	(-5.846)	(-5.824)	(-6.220)
Forowner	0.053	0.053	0.009
	(0.750)	(0.749)	(0.122)
Pass	0.423**	0.420**	0.490**
	(2.067)	(2.044)	(2.447)
Nfcdebt_d			-0.097***
			(-4.941)
Derivative_d x Nfcdebt_d			-0.066*
			(-1.742)
Constant	-0.781***	-0.780***	-0.920***
	(-4.619)	(-4.613)	(-5.468)
No. obs.	2,274	2,274	2,274
R-square	0.449	0.449	0.457

Note. This table reports regression estimates on the interactions of export revenues (*Export*) and foreign currency debt (*Nfcdebt*) with derivatives trading (*Derivative*) for change firms in Period 1 related to KRW/JPY rate. The dependent variable is *Tobinq*, a proxy for firm value. The main test variables are *Derivative_d x Export_d* and *Derivative_d x Nfcdebt_d*, where all dummy variables are equal to 1 if higher than their median values and 0 otherwise. See Table 1 for definitions and measurements of variables. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.