Measurement and Management of Exchange Rate Exposure: New Approach and Evidence

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Abstract

We examine the effectiveness of firms' operating and financial activities in managing their exchange rate exposure. Unlike previous studies, we measure the expected exchange rate exposure which reflects exchange rate risk associated with firms' basic business activities prior to the usage of exposure management activities and compare it with the observed exchange rate exposure which reflects the effects of firms' exposure management activities as well. Our results show that the effectiveness of exposure management activities depends on the underlying characteristics (e.g., direction) of the firm's inherent expected exchange rate exposure. While firms with positive expected exchange rate exposure reduce their exposure through currency derivatives, internal transactions with foreign subsidiaries, and the issuance of foreign currency denominated debt, firms with negative expected exchange rate exposure do so only through exchange rate pass-through activities. Our analysis of firms with significant observed exchange rate exposure further offers evidence that structured currency forward contracts (e.g., currency KIKO contracts) deteriorate firms' exchange rate exposure.

1.   Introduction

A large body of studies has examined the measurement of exchange rate exposure and its effect on firm value with inconclusive evidence on the existence of exchange rate exposure.   Adler and Dumas (1984) show that a firm's exchange rate exposure can be measured from a regression model of the firm's exposed asset prices expressed in the domestic currency against the foreign currency.   Jorion (1990, 1991) measures the exchange rate exposure using stock returns but fails to show evidence that exchange risk is an important determinant of firm value.   Subsequent studies have estimated exchange rate exposure using regression models of stock returns and exchange rate changes.   While a few of these studies report relatively significant levels of exchange rate exposure (e.g., He and Ng, 1998, Dominguez and Tesar, 2006) and exchange risk premium (e.g., Dumas and Solnik, 1995; Kwon, Bae, and Chung, 2004), the majority of these studies offer evidence that is not in supportive of the existence of exchange rate exposure or the need to manage exchange rate risk.

As possible explanations for the lack of strong evidence on exchange rate exposure, earlier studies offered several factors including the measurement problems associated with the estimation of exchange rate exposure and the delayed effects of exchange rate changes (see, e.g., Bartov and Bodnar, 1994).   Bartram and Bodnar (2007) demonstrate, however, that correcting and considering these factors still do not lead to an increase in the significance levels of the estimated regression coefficients of exchange rate exposure.   Instead, they note that the evidence of insignificant regression coefficients of exchange rate exposure reported in previous studies is not surprising at all.   They argue that it is not due to the estimation problem but mainly due to firms' management of exchange rate exposure.   Bartram, Brown, and Minton (2010) offer evidence supporting the Bartram and Bodnar's view by reporting that firms indeed manage a large portion of their exchange rate exposure.

In this paper, we examine two main issues pertaining to exchange rate exposure−the measurement of exchange rate exposure and the effectiveness of firms' managing activities of exchange rate exposure.   Our paper, however, takes a very different approach to examine these issues from

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previous studies. As Bartram and Bodnar (2007) and Bartram, Brown, and Minton (2010) point out, an effort to measure a firm's exchange rate exposure using the firm's observed stock returns would fail to uncover the existence and the true level of the firm's exchange rate exposure. Because a firm's observed stock returns would already have reflected the outcome of the firm's activities for exposure management, an examination of observed stock returns is more likely to reveal insignificant exchange rate exposure for the firm.

In order to overcome this measurement problem, we separately measure expected exchange rate exposure, which reflects a firm's exposure level related to the firm's basic business activities prior to the firm's usage of any exposure management activity, and observed exchange rate exposure, which reflects the effects of a firm's other activities for exposure management as well. We then compare the observed exchange rate exposure with the expected exchange rate exposure and analyze their difference. Our logic is that because this difference captures the outcome of a firm's exposure management activities, its analysis will reveal the true effectiveness of activities firms use to manage exchange rate exposure by controlling external factors that might affect the firm's exchange rate exposure. That is, if the observed exchange rate exposure is excluded from the expected exchange rate exposure, one can isolate the exchange rate exposure associated with the firm's exposure management activities. Hence, the significantly large expected exchange rate exposure relative to the observed exchange rate exposure would indicate a substantial reduction in the firm's exchange rate exposure and thus the effectiveness of an exposure management activity.

Our paper is the first of its kind to empirically measure expected exchange rate exposure for a comparison to observed exchange rate exposure. Although Bodnar and Marston (2002) develop a theoretical model of the expected exchange rate exposure using a firm's import ratio as one of its determinants, no existing study has empirically measured the expected rate exposure.[1] This is primarily because data on a firm's import ratios are regarded as the firm's trade secrets and thus are not publicly

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[1] A firm's import ratio is the ratio of expenses of imported materials for final products to total operating expenses.

available.   In this paper, we proxy a firm's import ratio by the input-output ratio of imported goods derived from the firm's input-output tables.

Firms' management of exchange rate exposure generally involves both operating and financial activities.   The operating activities include domestic-currency invoicing, matching and offsetting, and exchange rate pass-through, among others.   In particular, several studies offer evidence supporting that firms pass through their exchange rate exposure to sales prices with and without the adjustment of mark-ups, especially in the face of decreasing local currency value (Allayannis and Ihrig, 2001; Campa and Goldberg, 1999; Gagnon and Knetter, 1995; Knetter, 1989, 1993, 1994; Krugman, 1987; Manon, 1995).[2]   The financial activities for exposure management include the use of currency derivatives, financings through foreign-currency denominated debt, and internal transactions with foreign subsidiaries, among others.   Existing studies offer inconclusive evidence on the effectiveness of the foreign currency denominated debt in managing exchange rate exposure (see, e.g., Bae and Kwon, 2011; Bartram, Brown, and Minton, 2010; Clark and Judge, 2009).   Similarly, the existing literature shows mixed evidence on the effectiveness of currency derivatives.   While several studies (e.g., Allayannis and Weston, 2001; Allayannis and Ofek, 2001; Bartram, Brown, and Minton, 2010; Clark and Judge, 2009; Graham and Rogers, 2002; Guay, 1999) document positive hedging effects of financial derivatives, a good number of other studies cast doubt on their effectiveness in exposure management (e.g., Bali, Terrence, and Martell, 2007; Guay and Kothari, 2003; Hentschel and Kothari, 2001).

In this paper, we examine both operating and financial activities of exposure management and argue that the mixed evidence on the effectiveness of exposure management activities is largely attributed to the failure to consider the underlying characteristics of exchange rate exposure for each individual

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[2] Through a survey of large euro-area companies, Döhring (2008) shows that many firms make use of operational hedges including matching foreign currency revenues with expenditures in the same currency and the international diversification of sourcing, production, and sales.

firm.[3]   Because exchange rate exposure can be either positive or negative, which would require different exposure management activities, it is important to identify the correct directions of a firm's exchange rate exposure for the effectiveness of exposure management activities.

We focus on manufacturing companies in Korea, one of the premier developing countries. Korean manufacturing firms have long depended on international trades and foreign capital with steady increases in their foreign business operations and foreign direct investments over the last decade or so, which have made their firm values highly sensitive to exchange rate changes.[4]   In addition, following the adoption of a new accounting system in early 2000's that requires Korean firms to report gains and losses in asset values associated with exchange rate changes in the current year's balance sheet, the financial performance of Korean firms is affected to a greater extent by the changes in exchange rates in the same year.   Consequently, with the larger swings in the exchange rates recently, Korean firms have had much greater needs to manage their exchange rate risk than ever.   It is well documented that Korean firms manage their exchange rate exposure using various activities including exchange rate pass-through, internal transactions with foreign subsidiaries, and derivatives products (see, e.g., Jung and Kwon, 2007). In this regard, Korean manufacturing firms offer an invaluable opportunity to investigate the relationship between exchange rate exposure and various activities of exposure management.

The results of our paper support the notion that the effectiveness of exposure management activities depends on the underlying characteristics (e.g., direction) of the firm's inherent exchange rate exposure, that is, the expected exchange rate exposure in our paper.   To be more specific, firms with positive expected exchange rate exposure are shown to reduce their exposure through the sell transactions of currency forwards/futures, internal transactions with foreign subsidiaries, and the issuance of foreign currency denominated debt, whereas firms with negative expected exchange rate exposure do so only

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[3] Other factors that may contribute to the mixed evidence include differences in sample firms, time periods, and/or measurement model specifications.
[4] Since the Asian financial crisis in late 1997, Korean firms have been exposed to an unprecedented level of foreign exchange risk primarily due to the adoption of the flexible exchange rate system in late 1990s.

through exchange rate pass-through (with and without mark-ups) associated with exchange rate changes. In addition, our analysis of firms with significant observed exchange rate exposure offers evidence that structured currency forwards deteriorate firms' exchange rate exposure. Our results also show that while some firms tend to over-manage exchange rate exposure, the majority of firms properly use hedging activities to manage exchange rate exposure. The overall results of our paper suggest that for the effective management of exchange rate exposure firms need to consider both the underlying characteristics (e.g., direction) of exchange rate exposure and the plausible conditions in the product market that they may face before they engage in exposure management activities. Relying simply on the regression results from a pooled sample without considering this notion would likely yield very limited and unreliable empirical implications.

Our paper is organized as follows. Section 2 presents the research design and data including methods to measure the expected exchange rate exposure and the observed exchange rate exposure. Section 3 reports the empirical results, with the summary and conclusions in Section 4.

2.   Research Design and Data

2.1.   *Measurement of expected exchange rate exposure*

We measure the expected exchange rate exposure inherent in the firm's basic business activities by the estimation models used by Bodnar and Marston (2002). A firm's value can be expressed using current and future cash flows as follows:

$$V = \sum_{t=1}^{\infty} \frac{CF_t}{(1+\rho)^t} \tag{1}$$

where V = firm value; CF_t = expected future cash flows, measured as the difference between income after taxes and net investment); ρ = discount rate. Assuming constant cash flows and zero net investment for simplicity, the firm value will be represented by:

$$V = \frac{CF}{\rho} = \frac{(1-\tau)}{\rho}\pi \tag{2}$$

where τ = corporate tax rate; π = income before taxes.

If we denote the exchange rate of local currency relative to foreign currency as *Err*, then a change in firm value relative to a change in the exchange rate, that is, exchange rate exposure, can be expressed as *dV/dErr*. With a constant corporate tax rate of τ and a constant discount rate of ρ, the exchange rate exposure can be expressed as:

$$dV/dErr = [(1-\tau)/\rho]d\pi/dErr \tag{3}$$

Changes in exchange rates typically affect firms engaging in the following types of business activities: (1) producing domestically and exporting to foreign countries; (2) producing or selling final products using imported raw materials; and (3) producing same or different products in foreign subsidiaries. As a way to consider all these types of business activities, we take the case of a multinational enterprise that produces and sells both domestically and in foreign countries products made of domestic or foreign raw materials. Then, the elasticity of its firm value in terms of operating profits to a change in the exchange rate is measured by:

$$\delta = h_1 + (h_1 - h_2)(\frac{1}{r} - 1) \tag{4}$$

where r = operating profit margin; h_1 = the proportion of operating profits designated in foreign currencies out of total operating profits; h_2 = the proportion of operating expenses designated in foreign currencies out of total operating expenses.

Equation (4) shows that the expected exchange rate exposure inherent in the firm's basic business activities can be measured using the firm's export ratio, import ratio, and operating profit margin. In equation (4), the relationship between foreign sales ratio and the ratio of expenses of imported materials to total operating expenses is a basic factor in determining the existence of a firm's exchange rate exposure, and the firm's operating profit margin plays a role in the determination of the magnitude of

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exchange rate exposure.   In equation (4), if a firm's foreign sales relative to total sales are greater than the expenses of imported materials relative to total operating expenses, the firm will be exposed to greater exchange rate exposure where its value increases (decreases) as the exchange rate goes up (down).   It is also shown that this expected exchange rate exposure becomes bigger as the firm's ability to generate profits, or the operating profit margin, is lower.

2.2.   Measurement of observed exchange rate exposure

We measure the observed exchange rate exposure present in the firm's stock returns by employing the following market model (Jorion, 1990):

$$Sr_{i,t} = \alpha_{0,i} + \alpha_{1,i} Mr_t + \alpha_{2,i} Err_t + \varepsilon_{i,t} \tag{5}$$

where Sr = a firm's stock returns; Mr = market returns; Err = a change in won/USD rate.   In equation (5), the estimated model coefficient of $\alpha_{2,i}$ captures the observed exchange rate exposure.

2.3.   Analysis of difference in expected and observed exchange rate exposure

The observed exchange rate exposure measured from the relation between a firm's stock returns and changes in the exchange rate represents the combined outcome of the expected exchange rate exposure that results from the firm's basic business activities and the effects of other activities (e.g., using foreign currency denominated debt and currency derivatives) on exchange rate exposure.   Therefore, it would be impossible to analyze separately what level of exchange rate exposure is inherent in the firm's basic business activities and whether the firm's other activities to manage exchange rate exposure are effective by examining the observed exchange rate exposure alone.   In order to correctly measure the effects of the firm's managing activities of exchange rate exposure, it is necessary to first estimate the expected exchange rate exposure inherent in the firm's basic business activities separately.   Then, if the observed exchange rate exposure is excluded from the expected exchange rate exposure, one can isolate the exchange rate exposure associated with the firm's managing activities of exchange rate exposure.

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Hence, if one analyzes the difference between the expected exchange rate exposure and the observed exchange rate exposure, called exchange rate exposure difference (EDIF), one should be able to find the relationship between managing activities of exchange rate exposure and the firm's exchange rate exposure. Because EDIF reflects the outcome of the firm's managing activities of exchange rate exposure, an analysis of EDIF by controlling external factors that might affect the firm's exchange rate exposure will reveal the effectiveness of the types of activities firms use to manage exchange rate exposure. In Figure 1, the two types of exchange rate exposure are presented in relation to the firms' exposure management activities.

Firms with insignificant observed exchange rate exposure are likely to have managed effectively their exchange rate exposure by considering external conditions (Bartram and Bodnar, 2007; Bartram, Brown and Minton, 2010). Hence, if one measures EDIF of firms with insignificant observed exchange rate exposure and estimates regression models of EDIF as dependent variable and firms' managing activities of exchange rate exposure as explanatory variables, one would be able to find the effectiveness of the types of activities used for managing exchange rate exposure. Based on this discussion, we estimate the following regression model (for simplicity we omit the subscript t for year):

$$EDIF_i = b_0 + b_1 FWD_i + b_2 NSFWD_i + b_3 NFCFIN_i + b_4 PASS_i + b_5 INTR_i + b_6 DIVER_i$$
$$+ b_7 Ln(FSIZE)_i + b_8 RND_i + \sum_{j=1}^{J} b_{8+j} IDUMMY_{j,i} + \sum_{y=1}^{Y} b_{8+J+Y} YDUMMY_{y,i} + \eta_i \tag{6}$$

where $EDIF$ = exchange rate exposure difference, measured by the difference between expected and observed exchange rate exposure. In regression model (6), *FWD, NSFWD, NFCFIN, PASS, INTR* are testing variables, representing firms' activities of exposure management, and the other variables are used as control variables. A brief description of explanatory variables along with their measurements is given below:

FWD represents the transaction (buy and sell) amount of currency derivatives including currency

forwards, currency futures, and currency risk insurance.[5] We construct *FWD* by separating buy transactions (equivalent to long positions) and sell transactions (equivalent to short positions), yielding two variables of *FWD-Buy* and *FWD-Sell*.

NSFWD represents the net position in structured forward contracts, measured by the difference between short and long position in structured forward contracts. The short (long) position in structured forward contracts combines buying (selling) put options and selling (buying) call options, making a position identical to selling (buying) currency forward. A currency KIKO (knock-in knock-out) option is an example of the structured forward contract and was one of the instruments widely used for hedging exchange rate (in particular, US dollars) risks in the Korean financial markets until late 2008.[6]

NFCFIN represents net amount of foreign currency financing, measured by the difference between total foreign currency financing and swap transaction amount. Total foreign currency financing is the sum of foreign-currency denominated short-term debt and long-term debt, liquidity long-term debt, and foreign currency denominated bonds, whereas swap transaction amount includes currency swaps and currency interest swaps denominated in foreign currencies.

PASS represents a firm's exchange rate pass-through ratio. Because data on a firm's exchange rate pass-through ratio are not publicly available, no existing studies have attempted to measure this ratio empirically. In this paper, we estimate each firm's pass-through ratio using the pass-through ratios of sales items for the industry to which the firm belongs in response to the exchange rate changes as reported

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[5] Currency risk insurance is a part of export insurance system offered by Korea Trade Assurance Corporation (KTAC) since 2000 for exporting firms and importing firms of raw materials and works in a similar way to the currency forward contract offered by financial institutions. It recovers a firm's losses and collects the firm's profits associated with exchange rate changes by comparing the exchange rate guaranteed by KTAC and the actual exchange rate at the settlement time.

[6] The KIKO option is designed to offer positive payoffs to the option holder when the Korean won moderately appreciates up to a certain predetermined rate against USD; in exchange, the option holder is obligated to take negative payoffs when the won value depreciates significantly (see Khil and Suh, 2010). As the won depreciated unexpectedly during the global financial crisis in 2007 and 2008, however, the KIKO option incurred substantial losses to the option holders, known as KIKO disaster. According to the Korean Financial Services Commission, as of June 2008, 519 firms held the KIKO options in the outstanding amount of USD10.1 billion, and 68 firms holding overhedged KIKO positions (amounts of KIKO options exceeding their export amounts) reported financial losses of USD384 million, which far exceeded financial gains of USD142 million from their USD export revenues.

by the Bank of Korea.[7]   As an example, let's assume that a firm produces two products, A and B with sales of $10 million and $20 million, respectively.   If the pass-through ratios of sales items A and B in the industry are 50% and 20%, respectively, (as reported by the Bank of Korea based on 3-digit KSIC industry classifications), then the firm's pass-through ratio is computed as 30% (=100/300 x 50% + 200/300 x 20%).

INTR represents the degree of internal transactions of each firm with foreign subsidiaries, measured by the amount of internal transactions relative to the firm's total sales.

DIVER represents the degree to which a firm's operations are diversified into other lines of business.   *DIVER* is included in the regression model to consider the firm's potential effect on the relation between a firm's derivatives transactions and its risk level (Bartram, Brown, and Conrad, 2009). For *DIVER*, we employ the widely-used Caves weighted index of diversification based on the firm's sales (Caves et al., 1981).   A higher value of *DIVER* indicates a greater diversification of a firm's operations.

FSIZE represents firm size, and is measured by the sum of the market values of common stock and preferred stock and the book value of debt.   *FSIZE* enters the regression in a natural log form.

RND is a firm's research and development intensity ratio, measured by the ratio of total research and development expenses to sales.

IDUMMY is industry dummies, spanning twenty-two industries from food and beverage (KSIC 10) to publishing (KSIC 58).   *IDUMMY* is included to consider the potential differences in industries with respect to the risk level and the ease of hedging (Jin and Jorion, 2006).   The industry classification is based on two-digit KSIC.   Since firms may change their industry classifications as time goes by, the sales item with the highest actual sales is used to identify the firm's major industry.

YDUMMY is year dummies and included to control for fixed-time effects such as sudden rebounds and adjustments in exchange rates during the sample period.

The variables of *FWD* (*FWD-Buy* and *FWD-Sell*), *NSFWD*, and *NFCFIN* are measured as

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[7] This measurement approach is similar to the one for the measurement of a firm's import ratio.

relative to firm size, whereas *PASS, INTR, DIVER,* and *RND* are measured as relative to the firm's sales.

2.4   Data

The sample firms in our paper consist of all Korean industrial firms except for financial firms listed on the Korea Exchange for the period of 2007-2009.   2007 year was when the exchange rates of Korean won against USD steadily decreased (i.e., the value of won increased).   In contrast, the exchange rates of Korean won against USD increased rapidly due to the global financial crisis throughout the second half of 2008, continued to increase in early 2009, and then declined in late 2009.

The data for export ratios and operating margin ratios necessary to estimate the expected exchange rate exposure are collected from TS2000, the database of Korean Listed Companies Council. The data on stock returns necessary to estimate the observed exchange rate exposure are collected from the KCMI-SD database of Korean Capital Market Institute.   We estimate the observed exchange rate exposure on the annual basis using daily stock returns.   For exchange rate changes, we use changes in nominal exchange rates, rather than changes in real exchange rates, considering the relatively smaller changes in daily inflation rates.

For each firm's derivatives transactions, we collect and examine related information from the firm's business reports and audit reports.   Regarding the firm's exchange rate pass-through ratio, we rely on the firm's sales reports and the industry report on pass-through ratios classified by sales items as reported by the Bank of Korea.

3.   Empirical Results

3.1.   Measures of expected exchange rate exposure and observed exchange rate exposure

Table 1 reports mean values of expected and observed exchange rate exposures, estimated from equations (4) and (5), respectively, and other variables of interest, by industry.   For each firm, the exposure is measured on an annual basis and then pooled together to produce an average value over the

three-year period. Equation (4) used to estimate the expected exchange rate exposure assumes a firm's maximization of its operating profits. Hence, it is reasonably expected that for low-performing firms in a given year, the estimated expected exchange rate exposure would have a little practical meaning. Accordingly, we exclude firms whose operating profit margins in a given year are less than 25% of the average of all sample firms in the same year.[8] In Table 1, we include firms whose firm-year observations are less than six into the industry classification of 'Other'. Panel A (B) of Table 1 shows results for firms whose estimated coefficients of the observed exchange rate exposure are statistically insignificant (significant) at the 10% level. In each Panel, sub-Panel 1 (2) reports firms with positive (negative) expected exchange rate exposure.

The firms in Panel A.1 are characterized by the relationship that their values increase (decrease) when the exchange rate goes up (down) based on the expected exchange rate exposure. Looking at the currency forward/futures positions (*FWD-Buy* and *FWD-Sell*), sell positions are larger by about five times than buy positions (0.057 vs. 0.011) in all industries except for the three industries of KSIC 17 (pulp, paper, and paper goods manufacturers), KSCI 21 (medicine and medical supplies manufacturers) that engage in buying currency derivatives only, and KSIC 46 (wholesalers and merchandise brokers) that has the same ratio of buy and sell positions of currency derivatives. The largest sell transactions of currency derivatives are done by KSIC 31 (other transportation equipment manufacturers) with its transactions of sell positions being about 9 times those of buy positions (0.884 vs. 0.101).

The foreign currency financing amount is on average about 3.6% of firm size in all industries, with its highest ratio of 12.1% in KSIC 13 (textile manufacturers). The magnitude of currency swaps and currency interest swaps for the sample firms is about 37% (= 0.013/0.036) of foreign currency financing amount. KSIC 17 shows the largest net foreign currency debt of 11.6%, while KSIC 31 has the largest net foreign currency assets of -10.2%, relative to firm size.

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[8] We perform robustness tests later to examine the effects of different thresholds of operating profit margin on our results.

When industries are ranked by their effectiveness of managing exchange rate exposure (that is, the higher the expected exchange rate exposure, the greater the effectiveness), KSIC 46 captures the top place, followed by KSIC 13, KSIC 31, and so on. To be more specific, for KSIC 46, the transaction amount of buying currency forward/futures is the same as that of selling currency derivatives, indicating that currency forward/futures are little effective in managing exchange rate exposure for firms in this industry. On the contrary, this industry has a lower ratio of swap transactions to foreign currency financing amount and possesses net foreign currency debt. In addition, the observed exchange rate exposure has the same positive sign as the expected exchange rate exposure, suggesting no over-management of exchange rate exposure.

Firms in KSIC 13 possess substantially greater sell transaction amount of currency forward/futures than their buy transaction amount, and relatively large amount of foreign currency financing, satisfying the condition to reduce the positive exchange rate exposure. On the other hand, the possession of relatively larger foreign currency assets weakens these firms' ability to reduce the positive exchange rate exposure. Combined together, these activities lead to negative observed exchange rate exposure for firms in KSIC 13, implying an over-management of exposure.

For firms in KSIC 31, the sell transaction amount of currency forward/futures is almost 9 times their buy transaction amount, and the swap transaction amount relative to foreign currency financing is low, leading to a favorable condition to reduce the expected exchange rate exposure. On the other hand, this industry holds relatively large foreign currency assets, which weaken the reduction of exchange rate exposure. Combined with the negative observed exchange rate exposure, the results suggest an over-management of exchange rate exposure for firms in KSIC 13.

Panel A.2 shows results for firms that are characterized by decreases (increases) in their firm values when the exchange rate goes up (down). Overall, these firms have substantially larger transaction amount of buying currency forward/futures than selling currency forward/futures (25 times), engage swap transactions equal to about 47% of foreign currency financing amount, and possess net foreign currency

debt. Among industries, KSIC 35 (electricity, gas, steam, and air conditioner supplier) has the smallest average value of the expected exchange rate exposure (-20.571), engage in buy transactions of currency derivatives only, and trade larger amount of swap contracts than foreign currency financing.

In summary, Panels A.1 and A.2 show important findings that firms with positive expected exchange rate exposure engage in larger sell transactions of currency forward/futures, use larger foreign currency financing, and carry net foreign currency assets, while firms with negative expected exchange rate exposure have larger transaction amount of buying currency derivatives and carry net foreign currency assets. On the other hand, there is little difference in the swap transaction amount between firms with positive exchange rate exposure and firms with negative expected exchange rate exposure.

Viewing from the notion that firms in Panel 1 have insignificant observed exchange rate exposure, the results indicate that firms use currency forward/futures properly in managing exchange rate exposure. Because firms with positive expected exchange rate exposure possess foreign currency financing, they consider management of exchange rate exposure when using foreign currency financing. In contrast, firms with negative exchange rate exposure also carry foreign currency financing, suggesting that the purpose of using foreign currency financing is not limited to the management of exchange rate exposure, and their foreign currency assets and debt are not set up to help firms manage their exchange rate exposure.

Panel B reports results for firms with significant observed exchange rate exposure. As can be seen in Panel B.1, firms with positive expected exchange rate exposure carry negative observed exchange rate exposure, which suggests over-management of exchange rate exposure. While the ratios of buying and selling currency forward/futures for these firms are similar to those for firms with insignificant observed exchange rate exposure (Panel A.1), their magnitudes of the net position of structured forward contracts are much larger. These results suggest that firms' having negative exchange rate exposure is related to the transactions of structured forward contacts including the currency KIKO contracts.

When the expected exchange rate exposure is negative, firms on average have higher foreign

currency financing ratio and swap transaction ratio than firms with insignificant observed exchange rate exposure (Panel A.2). The net foreign currency debt is about twice that of firms in Panel A.2. The results show that compared to firms with insignificant observed exchange rate exposure (Panel A), firms with significant observed exchange rate exposure (Panel B) do not properly use exposure-related activities to reduce the negative expected exchange rate exposure.

Because the expected exchange rate exposure estimates the effects of exchange rate changes on firm value by assuming that the expected exchange rate exposure regards the overall exchange rate changes as permanent, the expected exchange rate exposure tends to estimate the degree of exchange rate exposure larger than the observed exchange rate exposure does. Hence, it may be unreasonable to directly compare the magnitudes of coefficients of the expected and observed exchange rate exposures. However, the direction of the expected exchange rate exposure provides useful information on the firm's management of exchange rate exposure. The results in Panel A of Table 1 suggest that firms consider the direction of the expected exchange rate exposure in managing exchange rate exposure. In other words, the expected exchange rate exposure we estimate and report in our paper is indeed a useful tool to separate and explain the characteristics and behavior of firms' management of exchange rate exposure.

Table 2 further shows mean values of variables by year. Across the three years of 2007-2009, the expected exchange rate exposure does not exhibit a significant change, regardless of its positive or negative sign. In contrast, the observed exchange rate exposure reveals much greater swings across the three years. For the case of positive observed exchange rate exposure, both the number of firms and the average exchange rate exposure decline substantially in 2008 and then increase in 2009 but to a much less extent. On the other hand, while the number of firms with negative observed exposure increases to the highest level of 299 in 2008, the average exposure declines gradually over the three years. Hence, during 2008 when the won/USD exchange rate soared substantially, more Korean firms experience losses in their firm values, but the average exchange rate exposure for these firms is lower than in 2007. Hence, these findings show evidence contradictory to the general belief that the magnitude of value losses to

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firms with exchange rate exposure would increase when exchange rates go up. Table 2 also shows that more firms engage in buy- and sell-transactions of currency derivatives (*FWD-Buy* and *FWD-Sell*), structured forward contracts (NSFWD), and swap contracts (SWAP) in 2008 than in 2007 or 2009.

The overall results in Table 2 indicate that unlike the expected exchange rate exposure and variables related to exposure management, the observed exchange rate exposure exhibits significant swings with respect to both number of firms and average exchange rate exposure year by year, suggesting that as the observed exchange rate exposure shows different changes than the expected exposure, it is necessary to examine these two exchange rate exposures separately. This notion also suggests the possibility that the changes in the observed exchange rate exposure are caused by factors other than the widely-known variables related to exposure management.

3.2.   Characteristics of firms with insignificant observed exchange rate exposure

Table 3 reports mean and median values of the expected and observed exchange rate exposures, firm characteristics, and variables representing exposure management activities for firms with insignificant observed exchange rate exposure. The results are shown for three samples, a full sample and two subsamples consisting of firms with positive exchange rate exposure and negative exchange rate exposure. For the *IMPORT* (input-output ratio of imported goods or import ratio) variable, we use the estimated input-output ratio of imported goods, which is computed by comparing each firm's current sales (collected from TS2000) to the input-output ratios of imported intermediary goods (that appear on the input-output statement reported by the Bank of Korea). For example, if a firm produces goods belonging to the manufacturers of pulp, paper, and paperboard (KSIC 171), we use the relevant industry's input-output ratio of imported intermediary goods, 25.56% (2007 year basis), as a proxy for the firm's input-output ratio of imported goods. If a firm is diversified and thus produces multiple goods, we compute and employ the weighted average of the input-output ratios of imported intermediary goods for the multiple goods as the firm's IMPORT ratio. For example, if a firm produces two products, A and B,

in the amount of $10 million and $20 million, respectively, and the costs for the imported intermediary goods to produce A and B are 30% and 20%, respectively, relative to the total production costs, then the firm's input-out ratio, IMPORT, is computed as 23.3% (= 100/300 x 30% + 200/300 x 20%).

Looking first at the mean values for the full sample, the expected and observed exchange rate exposure carry positive and negative signs, respectively. While the expected exchange rate exposure is a large number of 2.540, the observed exchange rate exposure has a very small absolute value of 0.020. Considering that the observed exchange rate exposure reflects the outcome of exposure management, however, the finding that the observed exchange rate exposure has a different sign than the expected exchange rate exposure suggests an over-management of exchange rate exposure.

Most variables representing firm characteristics such as export ratio, import ratio, exchange rate pass-through ratio, firm size, R&D expenses, internal transactions with foreign subsidiaries, and diversification index have higher ratios for firms with positive exposure than for firms with negative exposure. For example, while the mean export ratio is 26.5% for the full sample, there is substantial difference in this ratio between firms with positive expected exchange rate exposure (50.3%) and firms with negative exposure (3.5%). There is little difference in the input-output ratio of imported goods between the two samples.

Regarding currency derivatives, firms with positive (negative) exchange rate exposure on average engage in more transactions of selling (buying) currency forward/futures. For the full sample, firms use more transactions of selling currency derivatives than buying such contracts. The net position of structured forwards is shown to be a net sell position for the three samples; for example, firms with positive expected exchange rate exposure hold about 0.4% of such contracts relative to firm size. Foreign currency financing amount is about 3.6% of firm size for firms with positive expected exchange rate exposure and about 2.3% for firms with negative expected exchange rate exposure. There is little difference in the magnitude of swap contracts based on the direction of expected exchange rate exposure. While firms in the full sample own about 1% of net foreign currency debt relative to firm size, firms with

positive expected exchange rate exposure have net foreign currency assets but firms with negative expected exchange rate exposure possess net foreign currency debt.

Comparing firms with significant observed exchange rate exposure to firms with insignificant observed exchange rate exposure, the following characteristics can be obtained.

First, for firms with positive expected exchange rate exposure, firms with significant observed exchange rate exposure have greater coefficients of expected exchange rate exposure and smaller coefficients of observed exchange rate exposure than firms with insignificant observed exchange rate exposure, suggesting the possibility of over-managing exchange rate risk. While there is little difference in currency derivatives transactions, firms with significant observed exchange rate exposure tend to have more foreign currency financing, use less swap transactions, and hold a net position of structured forwards about 2.75 times that of firms with insignificant expected exchange rate exposure. These differences explain at least in part the large negative observed exchange rate exposure.

Second, when firms have negative expected exchange rate exposure, firms with significant observed exchange rate exposure have smaller coefficients of observed exchange rate exposure than firms with insignificant observed exchange rate exposure. This result confirms the notion that there is lack of an effective management of exchange rate exposure. For firms with significant exposure, the size of their buy and sell transactions of currency derivatives is the same, indicating no effects of exposure management through currency derivatives. In addition, these firms possess relatively larger amount of net foreign currency debt. These results are consistent with our findings of large negative observed exchange rate exposure.

Table 4 reports mean values of expected (EX) and observed (OB) exchange rate exposures for several categories classified by different relations between these two exposures by year. Similarly to Table 3, the results in Table 4 are for firms with insignificant observed exchange rate exposure which thus manage their exposure relatively well. The categories of +EX>+OB and –EX<-OB are where observed exposure is less than expected exposure (in absolute value), hence indicating an effective exposure

management.　The total number of firms belonging to these categories is 136 (36.3% out of 375) in 2007, 115 (29.4% out of 264) in 2008, and 155 (40.3% out of 385) in 2009.　It is particularly interesting to see that the number of firms for the category of +EX>+OB declines substantially to 32 in 2008, less than half of 69 in 2007.

The categories of +EX, -OB and –EX, +OB are where firms overmanage their exchange rate exposure.　While the number of firms gradually increases for +EX, -OB, it declines substantially to 26 in 2008 (from 101 in 2007).　Hence, as the exchange rate increases significantly in 2008, the degree of overmanagement of exchange rate exposure by Korean firms seems to have been eased to some extent.

The findings in Table 4 indicate that the characteristics of the observed exchange rate exposure reflected in the firms' stock returns can vary significantly depending on the direction of the expected exchange rate exposure.　Similarly to Table 2, the results in Table 4 also suggest that it would be necessary to investigate not only the observed and expected exposures separately but also the directions of these exposures as well.

3.3　　Pearson correlation coefficients

Table 5 shows Pearson correlation coefficients of variables of interest for firms with insignificant observed exchange rate exposure.　Panels A and B report results for firms whose expected exchange rate exposure is positive and negative, respectively.

The results in Panel A show that the expected exchange rate exposure is highly positively correlated with *EP* (export ratio), *IT* (internal transaction ratio), and *FS* (sell transactions of currency forward/futures).　The highly positive coefficient (0.645) of *EP* indicates that a firm's export ratio explains a large portion of the positive expected exchange rate exposure, whereas the highly positive coefficient (0.229) of *FS* suggests that the sell transactions of currency derivatives are related to the firms' exposure management activities.　*IP* (import ratio) is highly positively correlated with *PT* (pass-through ratio) with the correlation coefficient of 0.837, implying that firms using relatively large amount of

imported goods for their production tend to pass through the effects of exchange rate exposure to their pricing policies. The highly positive coefficient of 0.243 between *FS* and *FL* (buy transactions of currency forward/futures) implies that currency derivatives are not merely used for the purpose of managing firms' exchange rate exposure. The highly positive coefficient of 0.503 between *FF* (foreign currency financing) and *FD* (net foreign currency debt) suggests that foreign currency financing is mostly done with foreign currency debt.

Turning to results in Panel B, the expected exchange rate exposure is highly negatively corrected with *IP* and *PT*. Considering the negative sign of expected exchange rate exposure, these results indicate that the greater the expected exchange rate exposure, higher input-output ratios of imported goods and/or the more transactions of exchange rate pass-through lead to greater expected exchange rate exposure. Unlike firms with positive expected exchange rate exposure reported in Panel A, *EP* is highly positively correlated with *SF* (net sell position of structured forwards) (correlation coefficient = 0.347). Hence, firms whose firm value declines in response to an increase in the exchange rate tend to take greater short positions in (that is, selling) structured forwards when they increase export activities. This evidence suggests that firms do not use structured forwards solely for the purpose of managing their exchange rate exposure.[9] *FD* and *SW* (swap transactions) are highly positively correlated to each other (correlation coefficient = 0.340), showing that firms with relatively large amount of net foreign currency debt also engage in large transactions of swap contracts.

In summary, comparing the results in Panels A and B of Table 5, the expected exchange rate exposure and the variables necessary for the estimation of expected exchange rate exposure have in general the expected relationships postulated in equation (5), but the relationships among these variables vary significantly based on the direction (positive or negative) of the expected exchange rate exposure. Viewing from these findings, if one analyzes the variables altogether without taking into account the

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[9] During our sample period, the majority of structured currency forward contracts are the currency KIKO option contracts.

direction of the expected exchange rate exposure, the analysis would not produce meaningful results on the relationship between the expected exchange rate exposure and its related variables.

3.4.   Regression results of difference in exchange rate exposure

Table 6 presents regression results of difference in exchange rate exposure (*EDIF*) as dependent variable estimated from equation (6) by two subgroups of firms based on the direction of the expected exchange rate exposure and a pooled group.   We offer the results for pure manufacturing firms spanning from KSIC 10 (food manufacturers) to KSIC 31 (transportation equipment manufacturers) by excluding firms in KSIC 35 (electricity, gas, etc.) through KSIC 58 (publishers), as well as for the full sample.   It is important to note that because *EDIF* is computed as the difference between the expected and observed exchange rate exposure, *EDIF* will have a larger value when the expected exchange rate exposure is positive and the observed exchange rate exposure is smaller (that is, the more effective the exposure management activity is).   In contrast, when the expected exchange rate exposure is negative and the observed exchange rate exposure is smaller, *EDIF* will have a smaller value (or a larger absolute value). In other words, when the expected exchange rate exposure is positive, the larger the *EDIF* is, the more effective the exposure management activity is.   When the expected exchange rate exposure is negative, the smaller the *EDIF* is (that is, the larger the absolute value of the negative *EDIF*), the more effective the exposure management activity is.

If the signs of the observed exchange rate exposure change are different from those of the expected exchange rate exposure, it would be difficult to explain the relationship between *EDIF* and the exposure management activities in a consistent manner, but one still should be able to examine the relationship between firms' exchange rate exposure and activities that firms use to manage their exposure. In addition, as we postulate in this paper, when the observed exchange rate exposure is not significant, the analysis of the relationship between *EDIF* and its related variables allows us to examine whether firms properly use various exposure management activities.   Accordingly, the results on Table 4 can be

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interpreted as the evidence on the relationship between the exchange rate exposure of firms that have performed their exposure management properly and their exposure management activities.

For firms with positive expected exchange rate exposure, *EDIF* is significantly positively related to *FWD-Sell*, *NFCFIN*, and *INTTR* at least at the 5% level for the full sample, suggesting effective managements of these activities in reducing exchange rate exposure. Firm size is significantly negatively related to *EDIF*, indicating that a larger firm is more passive in managing exchange rate exposure. On the other hand, *NSFWD* is positively related to *EDIF*, but the relationship is not significant at the 10% level. This finding offers interesting evidence that like exporting firms, firms whose values decline in response to a decrease in the exchange rate do not gain much from the usage of the structured currency forward/futures contracts in managing exchange rate exposure.

Viewing from the notion that the positive expected exchange rate exposure means taking a long position in foreign currency contracts, this result is difficult to interpret because the short potions in structured forwards should result in the reduction in firms' exchange rate exposure. One possible explanation is that among the firms that use structured forwards, some firms use such contracts without considering their overall positions in the exchange rate exposure. Another possibility is that because the structured forward contracts (including KIKO contracts) Korean firms use are designed to be cancelled when the exchange rate declines below a certain level, these types of derivatives are not effective in managing exchange rate exposure resulting from long positions of a foreign currency. If the market responds by expecting this notion, then the usage of the structured forwards would have little effect on the exchange rate exposure.

The results for firms with negative expected exchange rate exposure show that *NFCFIN* has a positive and significant (at the 10% level) effect on *EDIF*, hence reflecting the positive relationship between exchange rate exposure difference and net foreign currency debt. *NSFWD* is significantly positively related to *EDIF* at the 1% level, hence increasing the exchange rate exposure. This result is not surprising because the net position of structured forwards has a similar benefit-loss structure to the

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sell transaction of currency derivatives. The positive and significant regression coefficient of *FSIZE* indicates that the larger the firm size, the more passive the firm's management of exchange rate exposure, which is the same finding for firms with positive expected exchange rate exposure.

EDIF is significantly negatively related to *PASS* at the 1% level; hence, a firm's pass-through activity works in the direction of reducing the difference in exchange rate exposure, or decreasing the observed exchange rate exposure.   This evidence on the effectiveness of the firm's pass-through activity in reducing exchange rate exposure is different from that for firms with positive expected exchange rate exposure.   This finding indicates that similarly to importing firms, firms whose values decline when the exchange rate increases manage their exchange rate exposure by passing through exchange rate changes to product pricing.

FWD-Buy carries a positive but insignificant (at the 10% level) regression coefficient.   Hence, the buy transactions of currency forward/futures have little effect on the reduction of exchange rate exposure.   Considering the benefit-loss structure of the buy transactions of currency derivatives in response to exchange rate changes, this result is somewhat surprising.   This evidence can be explained by the notions that the size of the buy transactions of currency derivatives is not large enough to affect firm values and/or that some firms engage in buy transactions of currency derivatives for purposes other than managing exchange rate exposure.

The regression results for pure manufacturing firms are qualitatively similar to those from full sample firms except for the significance levels of some estimated regression coefficients.

For a comparison purpose, Table 6 also reports the regression estimates for the pooled group by ignoring the direction of the expected exchange rate exposure.   While some variables show regression estimates for the pooled group similar to those for the two subgroups, a few other variables such as *NSFWD, NFCFIN, PASS, INTTR*, and *DIVER* reveal noticeable differences in their regression estimates between the pooled group and the two subgroups.   For example, *NFCFIN* has a positive and insignificant regression coefficient for the pooled group but positive and significant coefficients for the

two subgroups.   Hence, if relying on the regression results for the pooled group, one would be misled to the conclusion of no significant effect of a firm's foreign debt financing.   Similarly, the insignificant regression coefficient of *PASS* for the pooled group would undermine the evidence that firms with negative expected exposure manage their exposure by the exchange-rate pass-through activity, as shown for the subgroup of firms with negative expected exposure.

The regression results in Table 6 offer confirmatory evidence that the effectiveness of several activities firms use for their exposure management varies depending upon the direction of the firms' expected exchange rate exposure.   Relying simply on the regression results from a pooled sample without considering this notion would likely yield very limited and unreliable empirical implications. Our results strongly suggest that it is necessary to consider the characteristics (directions) of firms' exchange rate exposure in order to properly analyze the relationship between exchange rate exposure and exposure management activities.

3.5.   *Regression results of difference in exchange rate exposure by year*

Our sample period of 2007–2009 is characterized by the trends of a decline, then a drastic increase, and finally a decline in the exchange rate of Korean won relative to USD.   The exchange rates were W929.90, W936.10, W1259.50, and W1164.50 at the end of years 2006 through 2009, respectively. Hence, it is plausible that the reversal and sudden changes of exchange rates during our sample period affect the relationship between exchange rate exposure and firm value differently.   In order to examine this possibility, we estimate equation (6) on an annual basis and report the results by year in Table 7.

For firms with positive expected exchange rate exposure, *FWD-Sell* is significantly positively related to *EDIF* in all three years, indicating that the sell transactions of currency forward/futures work in the direction of reducing exchange rate exposure.   Unlike 2007 and 2009, however, the significance level of the estimated coefficient of *FWD-Sell* is noticeably lower in 2008 when exchange rates changed drastically.   This can happen when the product market and the financial market respond asymmetrically

to the changes in exchange rates. When a firm attempts to hedge the positive exchange rate exposure (if the exchange rate increases (decreases), firm value also increases (decreases)) in the product market by taking a short potion in the financial assets (e.g., derivatives), the loss in the product market caused by a decline in the exchange rate would be offset by a profit in the financial assets or vice versa in the normal situation. The response to the changes in exchange rates in the product markets is, however, not to the entire part but can be only to the permanent part of the exchange rate changes (Bartov and Bodnar, 1994). That is, even if the exchange rate increases (or decreases), firms do not adjust their production or pricing immediately by considering the total portion of the exchange rate increase (or decrease). Instead of reflecting the total portion, firms tend to consider only the permanent portion of exchange rate changes into the production or pricing. In contrast, profit and loss from the transactions of financial assets are made to the entire portion of exchange rate changes regardless of whether exchange rate changes are permanent or temporary.

Viewing from this perspective, when the exchange rate goes up, the profit in the product market can be obtained in the amount just to cover the portion of the exchange rate changes perceived as permanent by the market, and the corresponding loss in the financial market is realized against the entire exchange rate changes. When exchange rates change abruptly, however, the proportion of permanent exchange rate changes to total changes can be different from the past. Hence, with drastic exchange rate changes, the extent to which the loss (or profit) from the product market and the profit (or loss) from the financial market are offset to each other can be different from the past and thus the performance of the exposure management. The asymmetric response of the product and financial markets to exchange rate changes indicates that for firms with positive expected exchange rate exposure, their profits from the product market resulting from exchange rate increases in 2008 may not be enough to offset the losses from the sell transactions of currency derivatives. Accordingly, the relationship between the product market and the financial market observed for 2007 discontinues for 2008, leading to an insufficient effect in the reduction of exchange rate exposure through the sell transactions of currency derivatives.

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In sum, the analysis of the effect of buy transactions of currency derivatives on the reduction of exchange rate exposure in Table 7 shows that the effectiveness of currency derivatives for firms with positive exchange rate exposure can vary depending on the degree of responses in their product markets where the firms do their businesses to exchange rate changes. In addition, firms' market-up adjustments can be a key factor of the hedging effect when firms manage exchange rate risk through the financial market. Especially, when managing exposure using derivatives contracts, the effects of exposure management can vary depending on the period of sudden changes in exchange rates or the normal period.

The regression coefficient of *NSFWD* is not significant at the 10% level for firms with positive expected exchange rate exposure. For firms with negative expected exchange rate exposure, however, the regression coefficient of *NSFWD* in 2007 is positive and significant at the 1% level, hence increasing the exchange rate exposure. This result demonstrates the relationship between the normal situation about the KIKO incident and the exchange rate exposure. In 2008 the regression coefficient of *NSFWD* is also positive but insignificant at the 10% level. In 2009 only a few firms among firms with negative expected exchange rate exposure took net short positions of structured currency derivatives; hence, these firms were excluded from the estimation. This can be explained by the notion that after the problems with KIKO contracts were brought up, firms in the KOSPI market disposed a good number of KIKO contracts.

For firms with positive expected exchange rate exposure, *NFCFIN* works for the reduction of exchange rate exposure only in 2009. For firms with negative expected exchange rate exposure, the positive and significant effect of *NFCFIN* on exchange rate exposure (hence increasing exchange rate exposure) exists only in 2009. For firms with negative expected exchange rate exposure, *PASS* shows a significant effect in reducing exchange rate exposure only in 2009. A possible reason for the insignificant effect of *PASS* in 2007 is that firms whose values increase when the exchange rate declines (that is, firms with negative expected exchange rate exposure) do not have strong desires to manage exchange rate exposure through the exchange rate pass-through activity. The insignificant effect of

PASS on exchange rate exposure in 2008 can be explained by the notion that firms needed a certain period of time in order to pass through the effect of exchange rate changes to pricing policies.   That is, firms that are used to pass through increases in exchange rates to pricing policies had difficulty in managing exchange rate exposure due to abrupt changes in exchange rates in 2008.

3.6.   Analysis of determinants of buy and sell transactions of currency derivatives contracts

        The regression results in Tables 6 and 7 show that currency forward/futures contracts (*FWD-Sell* and *FWD-Buy*) work in the direction of reducing exchange rate exposure, suggesting that firms make good uses of currency forward/futures in the exposure management.   Accordingly, it is worthwhile to analyze the factors that affect the choice of currency forward/futures contracts (that is, buy vs. sell transactions).   We explore this issue by examining how extensively and effectively firms use currency forward/futures in managing exchange rate exposure from the following equation (8):

$$FWD_i = c_0 + c_1 EXPORT_i + c_2 IMPORT_i + c_3 NFCFIN_i + c_4 PASS_i + c_5 INTTR_i + c_6 DIVER_i$$
$$+ c_7 Ln(FSIZE)_i + c_8 RND_i + \sum_{j=1}^{J} c_{8+j} IDUMMY_{j,i} + \sum_{y=1}^{Y} c_{8+J+Y} YDUMMY_{y,i} + \mu_i$$

$$(8)$$

where *FWD* = *FWD-Sell* or *FWD-Buy*; *EXPORT* = export ratio; *IMPORT* = import ratio; and other variables are defined in the same manner as equation (7).

        Table 8 reports the regression results of the determinants of currency forward/futures transactions by two subsamples of buy and sell transactions.   The second and third columns report results from the ordinary least square (OLS) regression model, while the fourth and fifth columns report results from the Tobit regression model to take into account the values of the dependent variable not being less than zero. We focus on the regression results from the Tobit model.

        For firms with positive expected exchange rate exposure, the larger the export ratio (*EXPORT*), the larger the firm size (*Ln(FSIZE)*), then the more sell transactions of currency derivatives (*FWD-Sell)* firms engage in.   However, *IMPORT* and *INTTR* show the opposite relationships with the sell

transactions of currency derivatives.

For firms with negative expected exchange rate exposure, *FWD-Buy* is positively and significantly related to *NFCFIN*, *INTPR*, and *FSIZE*. On the contrary, *FWD-Buy* is not significantly related to *IMPORT*, a key factor that determines the direction of the expected exchange rate exposure. The explanatory power of the regression model using *FWD-Buy* as dependent variable is substantially lower than that of the regression model using *FWD-Sell* (0.141 vs. 0.315), failing to show the evidence that firms use sell transactions of currency forward/futures contracts in managing the expected exchange rate exposure.

3.7.   Robustness tests

Our analyses so far have been performed for the sample that excludes firms whose operating profit margins are below 25% of the average operating profit margin of all firms. This considers the notion that because the model for the expected exchange rate exposure is developed under the assumption of firms' profit maximization, it would be difficult to give a meaningful interpretation to the expected exchange rate exposure of firms with low operating performance. Furthermore, this also considers the technical issue that when a firm's operating profit margin (*r*) in equation (4) is extremely low, the value of the expected exchange rate exposure will be computed as a significantly amplified value.

It is ideal to define ex-ante the minimum level of a firm's operating profit margin in order to use properly the computed expected exchange rate exposure in the analysis of exchange rate exposure. Because the model for the expected exchange rate exposure assumes that the firm's operating profit margin is given, however, it is impossible to define the appropriate level of operating profit margin in the model. In order to help understand the level of operating profit margin that can give a meaningful interpretation to the computed expected exchange rate exposure, we examine the relationship between exchange rate exposure and several activities of exposure management at various levels of operating profit margin. For this purpose, we first construct two subsamples from all sample firms by excluding

firms whose operating profit margins are less than 10% and 15% of the average of all firms. We then estimate regression model (6) for the two subsamples. The average operating profit margin for the sample firms is 7.38% for the entire three-year sample period and 7.06%, 7.86%, and 7.37% in 2007, 2008, and 2009, respectively.

Table 9 shows the results. Overall, the results from sample firms with different thresholds of operating profit margin offer confirmatory evidence to that reported earlier. Firms with positive expected exchange rate exposure reveal a reduction in exchange rate exposure resulting from the sell transactions of currency forward/futures (*FWD-Sell*). In contrast, firms with negative expected exchange rate exposure do not show such a reduction in exchange rate exposure with the buy transactions of currency derivatives, as evidenced by the insignificant regression coefficient of *FWD-Buy*. For firms with negative expected exchange rate exposure, *NSFWD* is significantly positively related to exchange rate exposure difference, indicating that the short position of structured forwards brings in a negative effect in the reduction of exchange rate exposure. On the other hand, these firms manage their exchange rate exposure using transfer pricing activities. *INTTR* is significantly positively related to the reduction of exchange rate exposure for firms with both positive and negative expected exchange rate exposure. The regression coefficient of *DIVER* is negative but significant (at the 10% level0 only for firms with positive expected exchange rate exposure. The results from the second sample (by excluding firms whose operating profit margins are less than 15% of the average of all firms) are similar to those from the first sample in Table 7.[10]

4.   Summary and Conclusions

In examining the relationship between firms' exchange rate exposure and their various activities for exposure management, we take a different approach from those in the existing literature. We

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[10] Though not reported in our paper, the analyses using sample firms with different threshold levels of operating profit margin of higher than 15% show results similar to those reported in this paper.

measure separately the expected exchange rate exposure that is determined by firms' basic business activities and the observed exchange rate exposure that reflects the effectiveness of firms' activities in managing their exposure.

Employing Korean industrial firms during 2007-2009, our results show that firms with positive expected exchange rate exposure obtain the benefits of reducing their exchange rate exposure through the sell transactions of currency forward/futures, internal transactions with foreign subsidiaries, and foreign currency financing. In contract, firms with negative exchange rate exposure are able to reduce their exchange rate exposure only through passing through exchange rate changes to their product pricing (e.g., mark-ups). The analysis of firms with significant observed exchange rate exposure offers evidence supporting the widely-believed notion that the structured currency forwards contracts (including the currency KIKO contracts) is a key factor that worsens firms' exchange rate exposure. We also find that Korean firms in general properly use several operating and financial activities in managing their exchange rate exposure. On the other hand, a good number of firms are shown to fail to use such activities properly, and some firms over-hedge their exchange rate exposure, indicating that it is necessary to take a systematic approach for the management of exchange rate exposure.

The results of our paper strongly suggest that in order to assess the effectiveness of operating and financial activities for exposure management, it is important to consider the fundamental characteristics (e.g., direction) of firms' exchange rate exposure. Furthermore, the effectiveness of exposure management activities in the financial markets can vary depending on the relationship between the responses of the product market and the financial market to the changes in exchange rates.

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Expected exchange rate exposure	+	Effectiveness of managing exchange rate exposure	=	Observed exchange rate exposure
↑		↑		↑
Determined by basic production, marketing, and other business activities		Involves activities to manage exchange rate exposure such as pricing adjustments, financing through foreign currency denominated debt, internal transactions with foreign subsidiaries; financial derivatives transactions		Shows the sensitivity of changes in firm value as determined by the stock market reflecting the permanent portion of exchange rates changes

<Figure 1>   Two Types of Exchange Rate Exposure

Table 1. Exchange rate exposure and related variables

This table reports mean values of expected and observed exchange rate exposures, estimated from equations (4) and (5), respectively, and other variables of interest, by industry. *FWD-Buy* and *FWD-Sell* represent buy- and sell-transaction amount, respectively, of currency derivatives including currency forwards, currency futures, and currency risk insurance. *NSFWD* is the net position in structured forward contracts, measured by the difference between short position and long position in such contracts. *FCFIN* represents foreign currency financing, measured by the sum of FC-denominated short-term and long-term debt, liquidity long-term debt, and FC-denominated bonds. *SWAP* represents swap contracts and includes currency swaps and currency interest swaps denominated in foreign currencies. *NFCDEBT* represents net foreign currency debt and is the difference between foreign currency debt and foreign currency assets. *FWD-Buy, FWD-Sell, NSFWD, FCFIN, SWAP, NFCDEBT* are measured as relative to firm size.

Panel A. Firms with insignificant observed exchange rate exposure									
Panel A.1. Firms with positive expected exchange rate exposure									
KSIC	Expected ER exposure	Observed ER exposure	FWD-Buy	FWD-Sell	NS-FWD	FCFIN	SWAP	NFC-DEBT	No. of firms
10	2.935	-0.009	0.002	0.005	0.000	0.082	0.009	0.044	16
13	12.794	-0.047	0.0006	0.119	0.000	0.121	0.0	-0.074	10
17	3.720	-0.279	0.003	0.000	0.000	0.078	0.010	0.116	8
20	6.529	0.008	0.002	0.012	0.005	0.041	0.013	0.021	62
21	2.247	0.032	0.009	0.000	0.000	0.012	0.010	-0.026	10
22	8.762	0.067	0.006	0.021	0.005	0.016	0.016	-0.052	25
23	3.225	0.034	0.002	0.030	0.000	0.034	0.003	0.008	7
24	2.912	-0.066	0.000	0.030	0.007	0.053	0.064	0.043	35
26	10.468	0.049	0.000	0.005	0.000	0.028	0.002	-0.053	26
28	9.764	-0.117	0.002	0.023	0.001	0.020	0.013	-0.025	16
29	6.433	-0.063	0.002	0.078	0.006	0.014	0.007	-0.050	30
30	8.706	0.000	0.000	0.017	0.009	0.022	0.004	-0.037	46
31	11.904	-0.258	0.101	0.884	0.000	0.008	0.001	-0.102	14
41	5.203	-0.041	0.019	0.066	0.000	0.006	0.009	-0.026	30
46	13.449	0.013	0.012	0.012	0.000	0.035	0.001	0.004	21
Other	7.161	-0.055	0.030	0.033	0.003	0.052	0.014	0.019	64
Total	7.288	-0.031	0.011	0.057	0.004	0.036	0.013	-0.009	420
Panel A.2. Firms with negative expected exchange rate exposure									
10	-1.136	-0.064	0.001	0.000	0.000	0.086	0.025	0.095	40
14	-1.482	-0.107	0.000	0.000	0.000	0.006	0.001	0.011	13
17	-1.814	-0.148	0.000	0.000	0.008	0.049	0.055	0.093	15
19	-1.975	-0.197	0.000	0.000	0.000	0.008	0.000	-0.025	8
20	-1.915	-0.014	0.000	0.0018	0.000	0.012	0.006	0.014	45
21	-1.352	0.044	0.002	0.000	0.000	0.003	0.008	0.017	56
23	-1.403	-0.075	0.000	0.000	0.000	0.014	0.004	0.017	17
24	-1.701	-0.007	0.493	0.005	0.019	0.076	0.006	0.059	19
25	-0.480	0.203	0.014	0.002	0.000	0.053	0.000	0.064	11
26	-6.531	0.142	0.059	0.012	0.000	0.019	0.033	0.009	7
35	-20.571	-0.026	0.013	0.000	0.000	0.004	0.010	0.023	13
41	-0.737	-0.044	0.000	0.0001	0.000	0.0018	0.002	-0.001	41
46	-0.649	0.089	0.000	0.000	0.000	0.010	0.018	-0.010	14

KSIC	Expected ER exposure	Observed ER exposure	FWD-Buy	FWD-Sell	NS-FWD	FCFIN	SWAP	NFC-DEBT	No. of firms
47	-0.431	0.119	0.000	0.000	0.000	0.004	0.013	0.013	27
49	-2.720	-0.056	0.000	0.000	0.000	0.017	0.018	0.016	9
58	-0.806	0.123	0.000	0.000	0.000	0.000	0.001	0.000	16
Other	-1.914	-0.045	0.001	0.002	0.000	0.025	0.009	0.027	83
Total	-2.054	-0.009	0.024	0.001	0.001	0.023	0.011	0.027	434

Panel B. Firms with significant observed exchange rate exposure

Panel B.1. Firms with positive expected exchange rate exposure

KSIC	Expected ER exposure	Observed ER exposure	FWD-Buy	FWD-Sell	NS-FWD	FCFIN	SWAP	NFC-DEBT	No. of firms
20	4.557	-0.206	0.003	0.015	0.008	0.066	0.014	0.042	15
24	3.387	-0.385	0.004	0.018	0.018	0.080	0.014	0.084	16
26	14.119	0.080	0.000	0.002	0.00003	0.010	0.003	-0.047	14
28	7.475	-0.224	0.008	0.048	0.000	0.041	0.029	-0.008	14
29	4.870	-0.305	0.008	0.328	0.023	0.005	0.000	-0.065	9
30	16.527	-0.205	0.000	0.053	0.017	0.021	0.008	-0.048	10
41	3.189	0.006	0.003	0.004	0.000	0.011	0.004	-0.008	8
46	13.092	-0.738	0.046	0.023	0.000	0.046	0.007	0.021	11
Other	8.173	-0.070	0.016	0.063	0.015	0.067	0.007	0.005	53
Total	8.244	-0.186	0.011	0.056	0.011	0.049	0.010	0.004	150

Panel B.2. Firms with negative expected exchange rate exposure

KSIC	Expected ER exposure	Observed ER exposure	FWD-Buy	FWD-Sell	NS-FWD	FCFIN	SWAP	NFC-DEBT	No. of firms
10	-0.810	-0.290	0.009	0.001	0.000	0.120	0.041	0.145	13
17	-1.572	-0.225	0.000	0.000	0.000	0.068	0.056	0.112	7
20	-1.993	-0.339	0.000	0.001	0.000	0.039	0.039	0.078	11
21	-0.753	-0.213	0.000	0.000	0.000	0.001	0.018	0.034	7
24	-2.563	-0.164	0.002	0.012	0.000	0.079	0.010	0.065	9
41	-0.753	-0.322	0.000	0.000	0.000	0.000	0.003	0.002	17
46	-0.634	-0.336	0.005	0.000	0.000	0.027	0.028	0.030	13
Other	-5.075	-0.081	0.000	0.003	0.000	0.020	0.012	0.028	43
Total	-2.592	-0.211	0.002	0.002	0.000	0.037	0.021	0.050	120

Table 2. Characteristics of exchange rate exposure and related variables by year

This table reports mean values of expected and observed exchange rate exposures and key variables related to exposure management by year. *FWD-Buy* and *FWD-Sell* represent buy- and sell-transaction amount, respectively, of currency derivatives including currency forwards, currency futures, and currency risk insurance. *NSFWD* is the net position in structured forward contracts, measured by the difference between short position and long position in such contracts. *FCFIN* represents foreign currency financing, measured by the sum of FC-denominated short-term and long-term debt, liquidity long-term debt, and FC-denominated bonds. *SWAP* represents swap contracts and includes currency swaps and currency interest swaps denominated in foreign currencies. *NFCDEBT* represents net foreign currency debt and is the difference between foreign currency debt and foreign currency assets. *FWD-Buy, FWD-Sell, NSFWD, FCFIN, SWAP, NFCDEBT* are measured as relative to firm size.

Variable		Year 2007		Year 2008		Year 2009	
		No. of firms	Mean	No. of firms	Mean	No. of firms	Mean
Expected ER exposure	Positive	178	7.935	196	7.238	196	7.482
	Negative	197	-2.382	168	-2.162	189	-1.957
Observed ER exposure	Positive	201	0.509	65	0.100	155	0.185
	Negative	174	-0.577	299	-0.223	230	-0.177
FWD	Buy	29	0.115	47	0.251	29	0.060
	Sell	52	0.161	69	0.198	63	0.176
NSFWD		14	0.095	18	0.091	8	0.082
FCFIN		145	0.060	168	0.079	181	0.082
SWAP		16	0.044	27	0.063	14	0.028
NFCDEBT		174	0.068	172	0.093	173	0.095
No. of firms		375		364		385	

Table 3. Summary statistics of variables for firms with insignificant observed exchange rate exposure

This table reports mean and median values of expected and observed exchange rate exposures, firm characteristics, and variables representing exposure management activities for firms with insignificant observed exchange rate exposure. *IMPORT* (import ratio proxied by input-output ratio of imported goods) and *PASS* (exchange rate pass-through ratio) are estimated by relating input-output worksheets and item-by-item transfer pricing, respectively to the firm's compositions of sales items. *FSIZE* (firm size) is measured by the natural log of the sum of the market values of common stock and preferred stock and the book value of debt. *RND* represents R&D expense ratio. *DIVER* (diversification index) is proxied by the Caves sales-based weighted index of diversification (Caves et al., 1981). *FWD-Buy* and *FWD-Sell* represent buy- and sell-transaction amount, respectively, of currency derivatives including currency forwards, currency futures, and currency risk insurance. *NSFWD* is the net position in structured forwards contracts, measured by the difference between short position and long position in such contracts. *FCFIN* represents foreign currency financing, measured by the sum of FC-denominated short-term and long-term debt, liquidity long-term debt, and FC-denominated bonds. *SWAP* represents swap contracts and includes currency swaps and currency interest swaps denominated in foreign currencies. *NFCDEBT* represents net foreign currency debt and is the difference between foreign currency debt and foreign currency assets. *FWD-Buy, FWD-Sell, NSFWD, FCFIN, SWAP, NFCDEBT* are measured as relative to firm size. *EXPORT, IMPORT, PASS, DIVER*, and *RND* are measured as relative to the firm's sales.

	Full sample		Firms with positive ER exposure		Firms with negative ER exposure	
Variables	Mean	Median	Mean	Median	Mean	Median
Expected ER exposure	2.540	-0.032	7.288	5.420	-2.054	-0.964
Observed ER exposure	-0.020	-0.048	-0.031	-0.049	-0.009	-0.048
EXPORT	0.265	0.112	0.503	0.497	0.035	0.005
IMPORT	0.156	0.119	0.159	0.125	0.153	0.110
PASS	0.323	0.307	0.350	0.329	0.297	0.269
INTTR	0.075	0.001	0.127	0.036	0.024	0.000
DIVER	0.261	0.059	0.271	0.065	0.251	0.057
FSIZE	19.724	19.321	19.976	19.463	19.480	19.191
RND	1.708	0.570	1.863	0.725	1.558	0.400
FWD-Buy	0.018	0.000	0.011	0.000	0.024	0.000
FWD-Sell	0.029	0.000	0.057	0.000	0.0009	0.000
NSFWD	0.002	0.000	0.004	0.000	0.001	0.000
FCFIN	0.029	0.000	0.036	0.003	0.023	0.000
SWAP	0.012	0.000	0.013	0.000	0.011	0.000
NFCDEBT	0.010	0.000	-0.009	-0.009	0.027	0.000

Table 4. Expected and observed exchange rate exposures based on their relations by year

This table reports mean values of expected (EX) and observed (OB) exchange rate exposures for several categories classified by different relations between these two exposures by year for firms with insignificant observed exchange rate exposure. Expected exchange rate exposure reflects a firm's exposure level related to its basic business activities prior to its usage of any exposure management activity, and observed exchange rate exposure reflects the effects of the firm's other activities for exposure management as well.

| Category | Year 2007 | | | Year 2008 | | | Year 2009 | | |
| | No. of firms = 375 | | | No. of firms = 364 | | | No. of firms = 385 | | |
	No. of firms	EX	OB	No. of firms	EX	OB	No. of firms	EX	OB
+EX>+OB	69	8.126	0.368	32	6.096	0.068	67	6.995	0.143
-EX<-OB	67	-2.612	-0.363	75	-2.501	-0.117	88	-2.293	-0.131
+EX<+OB	2	0.227	0.870	0	n/a	n/a	4	0.046	0.218
-EX>-OB	10	-0.287	-0.726	5	-0.100	-0.163	6	-0.080	-0.196
+EX, -OB	75	7.975	-0.421	83	6.800	-0.112	88	7.651	-0.136
-EX,+OB	101	-1.941	0.398	26	-1.210	0.071	56	-1.708	0.140

Table 5. Pearson correlation coefficients

EX = expected exchange rate exposure; OX = observed exchange rate exposure; EP = export ratio; IP = import ratio; PT = pass-through ratio; IT = internal transactions with foreign subsidiaries; DV = diversification index; FV = firm size; RD = R&D; FL = buy transactions of currency derivatives; FS = sell transactions of currency derivatives; SF = net position of structured forwards; FF = FC-denominated financing; SW = swap contracts; FD = net FC-denominated debt

Var	EX	OX	EP	IP	PT	IT	DV	FV	RD	FL	FS	SF	FF	SW	FD
Panel A. Firms with positive expected exchange rate exposure															
OX	-0.005	1.000													
EP	0.645	-0.040	1.000												
IP	-0.057	-0.087	0.406	1.000											
PT	-0.097	-0.054	0.277	0.837	1.000										
IT	0.349	0.149	0.354	0.035	-0.059	1.000									
DV	-0.079	0.002	-0.092	-0.085	-0.133	-0.079	1.000								
FV	-0.066	-0.052	0.150	0.194	0.048	-0.011	0.260	1.000							
RD	-0.084	0.011	-0.095	-0.061	-0.135	0.047	0.017	0.057	1.000						
FL	0.129	-0.045	0.064	-0.022	-0.066	-0.015	0.051	0.068	-0.029	1.000					
FS	0.229	-0.158	0.334	0.057	-0.001	-0.062	-0.062	0.277	-0.057	0.243	1.000				
SF	0.063	0.038	0.059	0.021	0.038	0.009	-0.032	-0.085	-0.019	-0.015	-0.028	1.000			
FF	0.111	-0.092	0.097	0.144	0.148	0.020	-0.070	-0.089	-0.135	-0.027	-0.047	0.019	1.000		
SW	-0.032	0.149	-0.041	0.066	0.097	-0.055	-0.013	-0.031	-0.034	-0.011	-0.033	0.010	-0.025	1.000	
FD	-0.176	-0.070	-0.145	0.227	0.206	-0.118	0.069	0.240	-0.041	-0.015	-0.266	-0.042	0.503	0.089	1.000
Panel B. Firms with negative expected exchange rate exposure															
OX	-0.013	1.000													
EP	0.094	-0.107	1.000												
IP	-0.764	-0.054	0.379	1.000											
PT	-0.608	-0.085	0.407	0.874	1.000										
IT	0.033	-0.037	0.264	0.111	0.124	1.000									
DV	0.072	-0.038	-0.028	-0.131	-0.140	0.003	1.000								
FV	0.016	-0.028	-0.122	-0.061	-0.151	0.021	0.029	1.000							
RD	0.127	0.032	-0.013	-0.054	-0.117	-0.038	-0.148	0.031	1.000						
FL	0.013	-0.036	-0.021	-0.004	0.023	-0.005	0.041	-0.025	-0.026	1.000					
FS	0.040	0.047	0.150	0.026	0.070	0.115	-0.082	-0.045	-0.020	-0.005	1.000				
SF	0.021	-0.013	0.347	0.120	0.138	-0.010	-0.043	-0.058	-0.040	-0.004	-0.011	1.000			
FF	0.053	-0.057	0.068	-0.041	0.174	0.009	0.002	-0.121	-0.155	0.194	-0.008	0.094	1.000		
SW	0.027	-0.084	0.024	-0.024	0.009	-0.054	-0.061	0.202	-0.074	-0.016	-0.027	-0.026	0.104	1.000	
FD	0.026	-0.047	-0.050	-0.071	0.099	0.021	-0.032	0.007	-0.118	0.154	-0.033	0.043	0.826	0.340	1.000

Table 6. Regression results of difference in exchange rate exposure

The dependent variable is *EDIF*, the difference between expected exchange rate exposure and observed exchange rate exposure. *FWD-Buy* and *FWD-Sell* are buy- and sell-transaction amount, respectively, of currency derivatives. *NSFWD* is net position in structured forward/futures contracts, measured by the difference between short position and long position in such contracts. *NFCFIN* is net foreign currency financing, measured by is the difference between foreign currency debt and foreign currency assets. *PASS* is exchange rate pass-through ratio, estimated by relating industry item-by-item pass-through ratios to the firm's composition of sales items. *INTTR* is the internal transactions with foreign subsidiaries. *DIVER* is diversification index, proxied by the Caves sales-based weighted index of diversification (Caves et al., 1981). *FSIZE* is firm size, measured by the natural log of the sum of the market values of common stock and preferred stock and the book value of debt. *RND* is R&D expense ratio. *FWD-Buy, FWD-Sell, NSFWD, NFCFIN* are measured as relative to firm size. *PASS, INTTR, DIVER*, and *RND* are measured as relative to firm's sales. *IDUMMY* and *YDUMMY* are dummy variables for industry and year, respectively, whose results are not reported here for brevity's sake. t-statistics are in parentheses.

Variable	Full sample			Manufacturing industries		
	Positive expected exposure	Negative expected exposure	Pooled	Positive expected exposure	Negative expected exposure	Pooled
Constant	11.354***	-2.512	-5.821*	12.817***	-9.117***	-2.969
	(2.63)	(-1.21)	(1.75)	(2.72)	(-3.30)	(-0.81)
FWD-Sell	12.166***		14.745***	11.643***		13.751***
	(4.75)		(4.75)	(5.10)		(6.20)
FWD-Buy		0.042	0.129		0.078	0.211
		(0.58)	(0.26)		(1.03)	(0.42)
NSFWD	17.481	9.827***	18.533*	15.872	8.336**	17.837
	(1.33)	(2.77)	(7.70)	(1.22)	(2.45)	(1.64)
NFCFIN	4.154**	1.983*	4.329	3.216***	2.345**	2.504
	(2.00)	(1.88)	(1.56)	(2.50)	(2.04)	(1.46)
PASS	-0.363	-7.309***	-0.631	2.194	-4.662*	2.017
	(-0.09)	(-3.68)	(-0.19)	(0.49)	(-1.93)	(0.51)
INTTR	10.169***	0.515	13.159***	10.676***	1.128	13.108***
	(5.07)	(0.85)	(6.49)	(4.47)	(1.63)	(5.79)
DIVER	-0.265	-0.496*	-0.091	0.082	-0.331	0.782
	(-0.29)	(-1.74)	(-0.16)	(0.09)	(-0.87)	(1.19)
FSIZE	-0.465***	0.195**	0.269*	-0.549**	0.476***	0.083
	(-2.25)	(1.98)	(1.71)	(-2.93)	(3.44)	(0.48)
RND	-0.067	0.056	-0.030	-0.145	0.137	-0.035
	(-0.87)	(1.31)	(-0.57)	(-0.71)	(1.42)	(-0.23)
IDUMMY	Yes	Yes	Yes	Yes	Yes	Yes
YDUMMY	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.278	0.773	0.439	0.282	0.263	0.370
Sample size	420	434	854	325	260	585

Table 7. Regression results of difference in exchange rate exposure by year

The dependent variable is *EDIF*, the difference between expected exchange rate exposure and observed exchange rate exposure. *FWD-Buy* and *FWD-Sell* are buy- and sell-transaction amount, respectively, of currency derivatives. *NSFWD* is net position in structured forward contracts, measured by the difference between short position and long position in such contracts. *NFCFIN* is net foreign currency financing, measured by is the difference between foreign currency debt and foreign currency assets. *PASS* is exchange rate pass-through ratio, estimated by relating industry item-by-item pass-through ratios to the firm's compositions of sales items. *INTTR* is the internal transactions with foreign subsidiaries. *DIVER* is diversification index, proxied by the Caves sales-based weighted index of diversification (Caves et al., 1981). *FSIZE* is firm size, measured by the natural log of the sum of the market values of common stock and preferred stock and the book value of debt. *RND* is R&D expense ratio. *FWD-Buy, FWD-Sell, NSFWD, NFCFIN* are measured as relative to firm size. *PASS, INTTR, DIVER*, and *RND* are measured as relative to firm's sales. *IDUMMY* and *YDUMMY* are dummy variables for industry and year, respectively, whose results are not reported here for brevity's sake.

Variables	Firms with positive coefficients of expected exchange rate exposure			Firms with negative coefficients of expected exchange rate exposure		
	Year 2007	Year 2008	Year 2009	Year 2007	Year 2008	Year 2009
Constant	12.917	13.296	11.167*	-7.935*	-0.335	-1.063
	(1.58)	(1.32)	(1.68)	(-1.90)	(-0.08)	(-0.39)
FWD-Sell	16.289***	9.141*	10.124***			
	(2.86)	(1.72)	(2.68)			
FWD-Buy				24.505	0.197	-9.226
				(1.35)	(0.87)	(-0.32)
NSFWD	22.259	25.995	-7.940	11.353***	5.072	
	(1.36)	(0.28)	(-0.48)	(3.19)	(0.58)	
NFCFIN	2.794*	13.115	11.728	-1.425	0.160	4.630**
	(1.92)	(1.24)	(1.36)	(-0.85)	(0.08)	(2.39)
PASS	10.898	-10.697	-3.462	-2.723	-1.300	-13.251***
	(1.14)	(-1.33)	(-0.57)	(-1.15)	(-0.31)	(-4.21)
INTTR	12.328***	14.711***	5.711	2.798*	1.055	1.292
	(4.41)	(2.68)	(1.44)	(1.85)	(1.23)	(0.83)
DIVER	2.770*	-3.577**	-1.407	-0.324	-0.695	-0.963
	(1.68)	(-2.19)	(0.78)	(-0.77)	(-1.39)	(-1.54)
FSIZE	-0.875**	-0.085	-0.446	0.386*	-0.003	0.235*
	(-2.19)	(-0.21)	(-1.38)	(1.93)	(-0.02)	(1.82)
RND	0.014	-0.019	-0.248	0.052	-0.033	0.023
	(0.11)	(-0.22)	(-1.45)	(1.01)	(-0.81)	(0.43)
IDUMMY	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.273	0.312	0.299	0.780	0.861	0.736
No. of firms	146	115	159	178	106	150

Table 8. Regression results on the determinants of buy and sell transactions of currency derivatives

The dependent variable is *FWD-Buy* and *FWD-Sell*, representing buy- and sell-transaction amount, respectively, of currency derivatives. *EXPORT* is export ratio. *IMPORT* is import ratio, proxied by input-out ratio of imported goods, estimated by relating industry input-output worksheets to the firm's compositions of sales items. *NFCFIN* is net foreign currency financing, measured by is the difference between foreign currency debt and foreign currency assets. *PASS* is exchange rate pass-through ratio, estimated by relating industry item-by-item pass-through ratios to the firm's compositions of sales items. *INTTR* is the internal transactions with foreign subsidiaries. *DIVER* is diversification index, proxied by the Caves sales-based weighted index of diversification (Caves et al., 1981). *FSIZE* is firm size, measured by the natural log of the sum of the market values of common stock and preferred stock and the book value of debt. *RND* is R&D expense ratio. *FWD-Buy, FWD-Sell, NFCFIN* are measured as relative to firm size. *EXPORT, IMPORT, PASS, INTTR, DIVER*, and *RND* are measured as relative to firm's sales. *IDUMMY* and *YDUMMY* are dummy variables for industry and year, respectively, whose results are not reported here for brevity's sake.

Variables	OLS regression model		Tobit regression model	
	FWD-Sell (positive expected ER exposure)	*FWD-Buy* (negative expected ER exposure	*FWD-Sell* (Positive expected ER exposure	*FWD-Buy* (Negative expected ER exposure)
Constant	-0.131	0.096	-2.492***	-16.456***
	(-1.36)	(0.64)	(-7.66)	(-3.26)
EXPORT	0.154***	-0.802	0.910***	-2.896
	(4.22)	(-0.97)	(8.18)	(-0.60)
IMPORT	-0.022	0.553	-1.049**	1.868
	(-0.19)	(0.88)	(-2.45)	(0.49)
NFCFIN	0.000	1.433	0.251	11.467***
	(0.002)	(1.05)	(0.70)	(3.14)
PASS	-0.001	-1.123	0.007	-0.634
	(-0.01)	(-0.02)	(0.02)	(-0.16)
INTTR	-0.060*	-0.024	-0.666***	3.079*
	(-1.86)	(-0.20)	(-4.46)	(1.96)
DIVER	-0.053**	0.070	-0.101	0.796
	(-1.98)	(1.03)	(-1.50)	(0.98)
FSIZE	0.007	0.008	0.100***	0.587***
	(1.28)	(0.85)	(6.86)	(2.67)
RND	0.001	0.002	0.001	0.042
	(0.75)	(0.62)	(0.14)	(0.36)
IDUMMY	Yes	Yes	Yes	Yes
YDUMMY	Yes	Yes	Yes	Yes
Adjusted R^2 or Pseudo R^2	0.606	0.029	0.315	0.141
No. of firms	420	434	420	434

Table 9. Regression results for firms based on different thresholds of operating profit margin

The dependent variable is *EDIF*, the difference between expected exchange rate exposure and observed exchange rate exposure. *FWD-Buy* and *FWD-Sell* are buy- and sell-transaction amount, respectively, of currency derivatives. *NSFWD* is net position in structured forward contracts, measured by the difference between short position and long position in such contracts. *NFCFIN* is net foreign currency financing, measured by is the difference between foreign currency debt and foreign currency assets. *PASS* is exchange rate pass-through ratio, estimated by relating industry item-by-item pass-through ratios to the firm's compositions of sales items. *INTTR* is the internal transactions with foreign subsidiaries. *DIVER* is diversification index, proxied by the Caves sales-based weighted index of diversification (Caves et al., 1981). *FSIZE* is firm size, measured by the natural log of the sum of the market values of common stock and preferred stock and the book value of debt. *RND* is R&D expense ratio. *FWD-Buy, FWD-Sell, NSFWD, NFCFIN* are measured as relative to firm size. *PASS, INTTR, DIVER*, and *RND* are measured as relative to firm's sales. *IDUMMY* and *YDUMMY* are dummy variables for industry and year, respectively, whose results are not reported here for brevity's sake.

Variables	Sample by excluding firms whose operating profit margins are less than 10% of the average for all firms		Sample by excluding firms whose operating profit margins are less than 15% of the average for all firms	
	Firms with positive expected ER exposure	Firms with negative expected ER exposure	Firms with positive expected ER exposure	Firms with negative expected ER exposure
Constant	12.344***	-4.764*	7.929	-3.566
	(2.63)	(-1.72)	(1.20)	(-1.54)
FWD-Sell	10.226***		10.717***	
	(3.76)		(3.80)	
FWD-Buy		0.117		0.120
		(0.92)		(1.17)
NSFWD	9.7051	15.569***	13.724	16.595***
	(0.75)	(3.03)	(1.06)	(3.25)
NFCFIN	7.074**	1.783*	4.039*	1.587
	(2.03)	(0.98)	(1.84)	(1.04)
PASS	-0.441	-10.102***	-2.916	-10.128***
	(-0.06)	(-3.28)	(-0.46)	(-4.40)
INTTR	7.007***	1.284*	6.648***	1.045
	(2.55)	(1.75)	(2.70)	(1.53)
DIVER	-2.828*	-0.412	-2.826*	-0.338
	(-1.79)	(-1.29)	(-1.87)	(-1.12)
FSIZE	-0.347	0.354***	-0.097	0.248***
	(-0.93)	(2.73)	(-0.28)	(2.70)
RND	-0.112	-0.029	-0.125	-0.006
	(-1.07)	(0.32)	(-1.43)	(0.06)
IDUMMY	Yes	Yes	Yes	Yes
YDUMMY	Yes	Yes	Yes	Yes
Adjusted R^2	0.168	0.549	0.190	0.708
Sample size	461	471	448	462