Currency Derivatives for Hedging: New Evidence on Determinants, Firm Risk, and Performance

Sung C. Bae[a*], Hyeon Sook Kim[b], Taek Ho Kwon[c]

July 2017

* Corresponding author; Tel) 419-372-8714; E-mail) bae@bgsu.edu

[a] Bae is Professor at the Department of Finance, College of Business Administration, Bowling Green State University in Bowling Green, OH, USA; Tel) 419-372-8714; E-mail) bae@bgsu.edu.
[b] Kim is a doctoral student at the School of Business, Chungnam National University, Daejon, Korea and a Researcher at Public Procurement Service, Government Complex, Daejon, Korea; Tel) 82-70-4056-7475; E-mail) khsvega@korea.kr.
[c] Kwon is Professor at the School of Business, Chungnam National University in Daejon, Korea; Tel) 82-42-821-5533; E-mail) thk5556@cnu.ac.kr.

The authors acknowledge helpful comments from Yufen Fu, Jane Ihrig, Amalia Di Iorio, and Wendy Rotenberg on the earlier version of the paper. The usual disclaimer applies.

Currency Derivatives for Hedging: New Evidence on Determinants, Firm Risk, and Performance

Abstract

We explore pertinent issues related to the usage of currency derivatives for hedging. Employing firm-level data for Korean firms during 2005-2010, we show that firms with a higher export ratio, more FC debt, and higher exchange rate exposure are likely to use more transactions of currency derivatives, but firms with a higher import ratio and more intra-firm transactions with foreign subsidiaries are likely to engage in less transactions. 2SLS regression analyses reveal that while more usage of currency derivatives does not lead to lower firm risk, such transactions, particularly sell transactions, bring in higher firm values measured by Tobin's q and industry-adjusted q. Our results further show that currency derivatives use by firms with high exchange rate exposures is associated with lower firm risk but lower firm value as well, indicating that lower firm risk resulting from hedging with currency derivatives is not materialized into higher firm value for these firms. This evidence suggests that when firms have relatively low and manageable exchange rate exposures, currency derivatives would work as an effective tool in hedging firm risk and protecting firm values.

JEL Classification: F31; G15

Key words: Currency derivatives for hedging; Determinants; Firm risk, Performance; Value; Korean firms

1. Introduction

Corporate management of foreign exchange rate exposure generally involves financial activities as well as operating activities.[1] The financial activities for hedging include currency derivatives, financings through foreign-currency (FC) denominated debt, and internal transactions with foreign subsidiaries, among others. Existing studies offer mixed evidence on the effectiveness of currency derivatives. While several studies show positive hedging effects of financial derivatives (e.g., Allayannis and Ofek, 2001; Allayannis and Weston, 2001; Bartram, Brown and Conrad, 2011; Bartram, Brown and Minton, 2010; Clark and Judge, 2009; Graham and Rogers, 2002; Guay, 1999), other studies cast doubt on their effectiveness in exposure management (e.g., Bali, Hume, and Martell, 2007; Guay and Kothari, 2003; Hentschel and Kothari, 2001).

In this paper, we revisit the current literature on currency derivatives by exploring two pertinent issues to the usage of currency derivatives for hedging: (1) What firm-specific factors influence the different level of currency derivatives use; and (2) whether hedging with currency derivatives reduces firm risk and enhances firm performance.

First, we examine what firm attributes contribute to the usage of currency derivatives for hedging. As the degree of a firm's hedging need would depend on various firm attributes such as levels of FC income and payment, positions of FC assets and liabilities relative to domestic-currency assets and liabilities, the extent of exporting and importing activities, FC borrowing, firm size, foreign exchange risk, among others, we differentiate buy and sell transactions of currency derivatives and examine how firm-specific factors are related to each of these transactions. In this analysis, we further compare the determinants of currency derivatives use among firms with different levels of exchange rate exposure. Existing studies show that firms with greater foreign exchange rate exposures are more likely to use currency derivatives (e.g., Bae

[1] Operating activities for managing exchange rate exposure include domestic-currency invoicing, matching and offsetting, and exchange rate pass-through, among others.

and Kwon, 2013; Geczy, Minton and Schrand, 1997).[2] As our dataset enables us to measure the *expected* exchange rate exposure which reflects inherent exchange rate risk associated with firms' business activities prior to the usage of hedging tools and thus differentiate firms with different levels of the expected exchange rate exposure, we are able to make new inferences about the nature of hedging activities with currency derivatives for our sample firms. We use this classification to investigate how firm characteristics explain the currency derivatives use for hedging.

Second, we investigate the effects of hedging with currency derivatives use on firm risk and performance. The effectiveness of hedging with currency derivatives rests on two aspects of outcome. The first one is the risk management aspect of whether the usage of currency derivatives lowers firms' exchange rate exposures associated with variabilities of cash flows and stock returns through the optimal hedge ratio. The second one is the firm performance aspect of whether this hedging activity affects firm performance and value positively through the reduced firm risk. In order to assess the effectiveness of hedging with currency derivatives, it is crucial to examine both aspects of hedging activities in a coherent manner.

While there is evidence supporting that firms use currency derivatives for hedging purposes, not for investing or speculating purposes,[3] extant studies offer mixed evidence on the effectiveness of currency derivatives in reducing firms' foreign exchange risk. In a study of S&P 500 non-financial firms, Allayannis and Ofek (2001) report that firms' usage of currency derivatives reduces their exchange rate exposures. Nydahl (1999) and Chang and Lin (2005) offer similar evidence on the effects of currency derivatives on firm risk for firms in Sweden and Taiwan, respectively. On the contrary, several studies report no clear relationship between the usage of currency derivatives and foreign exchange risk. Based on their findings that the amount of currency derivatives possessed by most of U.S. firms in their study is

[2] Geczy, Minton and Schrand (1997) show that firms with greater growth opportunities, tighter financial constraints and economies of scale in hedging activities are also more likely to use currency derivatives.

[3] See, e.g., Allayannis and Ofek (2001) and Brown (2001).

economically trivial, Guay and Kothari (2003) cast doubts on the effectiveness of currency derivatives in reducing firm risk. Hentschel and Kothari (2001) argue that there exists no direct relationship between currency derivatives use and foreign exchange risk.

Regarding the effects of hedging with currency derivatives on firm value, the literature offers rationales in supportive of both positive and negative valuation effects. On the one hand, several studies have advanced rationales for the positive effects of corporate hedging with derivatives on firm value: reduced corporate tax liability generated by less volatile profits (Graham and Smith, 1999; Mayers and Smith, 1987; Smith and Stulz, 1985); reduced cost of underinvestment associated with a reduction in the agency conflict between bondholders and shareholders (Bessembinder, 1991; Froot, Scharfstein and Stein, 1993; Mayers and Smith, 1987); reduced financial distress costs that also facilitate higher leverage (Leland, 1998; Smith and Stulz, 1985). On the other hand, other studies have referred to rationales for the negative or no valuation effects of hedging with currency derivatives: ineffective and complex risk management program (Copeland and Joshi, 1996; Hagelin and Pramborg, 2004); managerial motives to invest in value-reducing projects with protected capital (Tufano, 1998); failure to implement optimal hedge ratios and excessive costs of using currency derivatives (Bae, Kim and Kwon, 2016); underdeveloped derivatives markets and constraints in managing foreign exchange risk (Allayannis, Brown and Klapper, 2003; Clark and Judge, 2009).

Empirically, existing studies offer mixed evidence too. In a study of large U.S. nonfinancial firms for 1990-1995, Allayannis and Weston (2001) report that FC hedging is associated with higher firm value. Carter, Rogers and Simkins (2006) also find that firm value is positively related to hedging future jet fuel requirements of 28 U.S. airline companies in such a way that airlines hedging their fuel costs command 5-10% higher firm value than their counterparts. Hagelin (2010) and Clark and Mefteh (2010) offer similar evidence for firms in Sweden and France, respectively. In contrast, Guay and Kothari (2003) question the validity of the Allayannis and Weston (2001) results and demonstrate that derivative positions held by nonfinancial firms are small in economic magnitude, making it difficult to interpret the implications of

previous research. Jin and Jorion (2006) find no evidence of any significant positive effect of derivatives hedging on firm value for 119 U.S. oil and gas producers. Bartram, Brown and Fehle (2009) report no valuation effects for currency derivatives users, though their results show a significant positive valuation effect for firms using all derivatives but without any financial price pressure.

In light of the rationales and empirical evidence for and against value creation through hedging with currency derivatives, the mixed results suggest that there might be a more complicated relationship between currency derivatives use and value creation. For example, firms often fail to employ optimal hedge ratios or proper transactions of currency derivatives for hedging, thus either over- or under-hedging their exchange rate exposures. Then, the consequence would be such that while currency derivatives use may reduce foreign exchange risk, this reduction in risk may not necessarily lead to an increase in firm value due to the non-optimal hedge and/or excessive costs of hedging (Bae, Kim and Kwon, 2016). To this end, our paper takes empirical approaches distinctively different from those in the existing studies. First, we employ both accounting-based and market-based measures of firm risk and performance due to the notion that accounting- and market-based measures often lead to different evidence and implications. In all analyses, we conduct 2SLS regressions in order to control for potential endogeneity issues that firms with higher risk and/or better performance may more likely engage in hedging with currency derivatives. Second, we employ risk-adjusted performance measures in addition to conventional performance measures in order to consider the level of firm risk associated with firms' hedging activities, which supposedly affect both firm risk and performance. In this way, our paper will offer comprehensive evidence on hedging-firm performance relations. Third, we investigate the effect of hedging with currency derivatives on firm performance and value for subgroups of firms divided by (high and low) levels of *expected* exchange rate exposure. It is reasonably expected that firms would engage in different levels of transactions of currency derivatives for hedging based on their own inherent levels of exchange rate exposures.

Our paper focuses on firms in manufacturing and service industries in Korea, one of the premier developing countries, for empirical evidence. Korean firms have long depended on international trades

and foreign capital over the last decades, which have made their firm values highly sensitive to exchange rate changes. In addition, the current accounting system has also contributed to the exchange rate exposure of Korean firms as it requires firms to report the translation gains and losses in asset values associated with exchange rate changes in the concurrent year's balance sheet. Consequently, with 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 employ various hedging tools including derivatives products, exchange rate pass-through, and internal transactions with foreign subsidiaries, among others (see, e.g., Jung and Kwon, 2007). In this regard, Korean firms are ideal research targets for the examination of the effectiveness of currency derivatives for hedging.

Our firm-level data over the period of 2005-2010 reveal that sample Korean firms on average engage in the transactions of currency derivatives equivalent to 3.75% of total assets and are more geared to hedge long positions, or receipts, of foreign currencies by taking short positions in currency forwards. Our regression results show that firms with a higher export ratio, more FC debt, and higher exchange rate exposure are likely to use more transactions of currency derivatives, but firms with a higher import ratio, more intra-firm transactions with foreign subsidiaries are likely to engage in less transactions of currency derivatives. Our results also show that firms tend to take more short positions of currency derivatives when they have less intra-firm transactions with foreign subsidiaries but take more long positions when they have more FC debt.

Our 2SLS regression analyses show that while more usage of currency derivatives by Korean firms does not lead to lower firm risk, such transactions, particularly sell transactions, bring in higher market-based firm values measured by Tobin's q and industry-adjusted q. Our results further show that currency derivatives use by high EXE firms is associated with lower firm risk but also with low, indicating that the lower firm risk resulting from hedging with currency derivatives for high EXE firms is not materialized into higher firm value. This evidence may be attributed to the mismanagement of hedging strategies either due to the implementation of non-optimal hedges (e.g., under- or over-hedges) or due to the excessive costs

associated with hedging. The flipped side of this evidence is that when firms have relatively low and manageable EXE, currency derivatives work as an effective tool in hedging foreign exchange risk and protecting firm values. A robustness test using market-based risk-adjusted performance measures offers confirmatory evidence on the positive, though weak, effect of currency derivatives use on firm performance.

Our paper is organized as follows. Section 2 presents the research design and data including regression models to investigate the two main research issues of our paper. Section 3 reports empirical results, with the summary and conclusion in Section 4.

2. Research Design and Data

2.1. Analysis of determinants of currency derivatives contracts

As the first research issue, we examine firm attributes that contribute to firms' usage of currency derivatives for hedging in the following regression model. These firm attributes include variables representing FC inflows and outflows associated with exporting and importing activities, profitability and liquidity positions, FC borrowing, firm risk including cash flow volatility, beta risk and foreign exchange risk, tax liabilities, and other firm characteristics such as firm size, growth potential, and age, among others.

$$\begin{aligned} FCDEV_i &= \alpha_0 + \alpha_1 EXPORT_i + \alpha_2 IMPORT_i + \alpha_3 NFCDEBT\,(or FCFDEBT)_i + \alpha_4 INTTR_i \\ &+ \alpha_5 DIVER_i + \alpha_6 FSIZE_i + \alpha_7 MB_i + \alpha_8 EBITDA_i + \alpha_9 LEV_i + \alpha_{10} OCFVOL_i + \alpha_{11} BETA_i \\ &+ \alpha_{12} TAX_i + \alpha_{13} AGE_i + \alpha_{14} PastFCDEV_i + \sum_{j=1}^{J} \alpha_{14+j} YEAR_{j,i} + \sum_{y=1}^{Y} \alpha_{14+J+y} IND_{y,i} + \mu_i \end{aligned} \quad (1)$$

In regression model (1), the dependent variable of *FCDEV* represents the total transaction amount of currency derivatives including forwards, futures, risk insurance, options, and swaps, relative to total assets. Considering that transactions of currency forwards and currency swaps often last longer than a year, the previous year's *FCDEV*, *PastFCDEV*, is also included in the regression model to examine whether the currency year's *FCDEV* is affected by the previous year's.

Korean firms are more geared to hedge their long positions, or receipts, of foreign currencies mainly resulting from their exporting activities, by taking short positions in currency derivatives, especially

currency forwards. If property hedged, this strategy of hedging with short currency forwards would be effective and offer protection with the guaranteed pre-determined amount of local currency. In this regard, we differentiate buy and sell transactions of currency derivatives and investigate the potentially different firm-specific factors related to each type of transactions in regression model (1) with *FCDEV-Buy* and *FCDEV-Sell* as dependent variables in place of *FCDEV*, where *FCDEV-Buy* and *FCDEV-Sell* represent buy transactions (equivalent to long positions) and sell transactions (equivalent to short positions) of currency derivatives, respectively.

As firms with greater exchange rate exposures are more likely to use currency derivatives (Bae and Kwon, 2013; Geczy, Minton and Schrand, 1997), we further compare the determinants of the usage of currency derivatives between firms with high and low levels of exchange rate exposure. A brief description of explanatory variables along with their measurements is given below:

The first group of variables are related to firms' overseas business activities. *EXPORT* represents export ratio and is measured as a proportion of total export amount to total sales. *IMPORT* represents a firm's import ratio. Because data on a firm's import ratio are regarded as the firm's trade secrets and thus are not publicly available, we proxy a firm's import ratio by relating the firm's sales composition to the imported input share of sales of the sector or industry where the produced goods belong. The imported input shares of sector sales are collected from the input-output tables reported by the Bank of Korea.[4] *NFCDEBT* represents net amount of FC financing, measured by the difference between total FC debt and total FC assets, where total FC debt is the sum of FC-denominated short-term debt and long-term debt, liquidity long-term debt, and FC-denominated bonds. *FCFDEBT* represents FC-denominated financial

[4] For example, if a firm produces goods belonging to the pulp, paper, and paperboard sector (KSIC 17), the sector's imported input share of 25.56% (2007 year basis) is used as a proxy for the firm's import ratio. If a firm is diversified with multiple goods, the weighted average of the imported input shares of sector sales for the multiple goods is used as the firm's import ratio. For instance, a firm's sales consist of $30 million in sector A and $20 million in sector B. Then the shares of sectors A and B of total sales are 60% and 40%, respectively. If the imported input shares of sector sales in the sectors A and B are 0.1 and 0.2, respectively, as reported in the Input-Output Table, then the firm's imported ratio is proxied as 14% (= 60% * 0.1 + 40% * 0.2).

debt, relative to total assets. *INTTR* 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.

The second group of variables are related to firms' domestic business activities. *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 effect of the firm's diversification on the relation between a firm's derivatives transactions and its risk level reported in previous studies (e.g., Bartram et al., 2009). For *DIVER*, we employ the widely-used Caves weighted index of diversification based on the firm's sales (Caves et al., 1980). A higher value of *DIVER* indicates a greater diversification of a firm's operations. *FSIZE* represents firm size, and 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. *MB* is the market to book value ratio and proxies growth potential. It is expected that a firm with higher growth potential is more likely to engage in hedging with currency derivatives in order to preserve the value of internally-generated funds. *EBITDA* represents a firm's profitability ratio, measured by the sum of EBIT, depreciation, and amortization divided by total assets. *LEV* is total debt to total assets ratio. *OCFVOL*, a measure of firm risk, represents volatility of operating cash flows. *BETA* represents market risk. *CR* represents current ratio. *TAX* represents tax payment divided by pre-tax income, and enters the regression model to examine whether hedging with currency derivatives is related to lower corporate tax liability (Graham and Smith, 1999; Mayers and Smith, 1987; Smith and Stulz, 1985).

The last group of variables include year and industry dummies. *YEAR* is year dummies and included to control for fixed-time effects such as sudden rebounds and adjustments in exchange rates during the sample period. *IND* is industry dummies, spanning twenty-two industries from food and beverage (KSIC 10) to publishing (KSIC 58) based on two-digit KSCI, and is included to consider the potential differences in industries with respect to the risk level and the ease of hedging (Jin and Jorion, 2006). Since firms may change their industry classifications as time goes by, the sales item with the highest actual sales is used to identify the firm's major industry.

2.2. Measurement of exchange rate exposures

Existing studies have estimated exchange rate exposures using regression models of observed stock returns and exchange rate changes, but the majority of these studies offer weak evidence on the existence of exchange rate exposure or the need to manage exchange rate risk (e.g., Dominguez and Tesar, 2006; Dumas and Solnik, 1995; He and Ng, 1998; Jorion, 1990, 1991; Kwon, Bae and Chung, 2005). As Bodnar and Marston (2002) and Bartram, Brown and Minton (2010) point out, however, this approach to the measurement of a firm's exchange rate exposure would fail to uncover the true level of the firm's exchange rate exposure. Because a firm's observed stock returns would have already reflected the outcomes of the firm's hedging activities, an examination of the observed stock returns is more likely to reveal insignificant exchange rate exposure for the firm. In order to overcome this measurement problem, we measure *expected* exchange rate exposure, which reflects a firm's exposure level inherent in its basic business activities prior to the use of hedging tools, by the estimation model developed by Bodnar and Marston (2002).[5] If the exchange rate exposure is expressed in the form of elasticity, the elasticity of a firm value, δ, in terms of net profit, π, to a change in the exchange rate, Er, can be presented by:[6]

$$\delta = \frac{d \ln \pi}{d \ln Er} = h_1(R/\pi) - h_2(M/\pi) = (h_1/r) - h_2((1/r) - 1) = h_1 + (h_1 - h_2)(\frac{1}{r} - 1) \qquad (2)$$

In equation (2), the expected exchange rate exposure inherent in the firm's basic business activities is determined by three firm attributes: (a) foreign sales or export ratio (h_1); (b) foreign expenses (that is, costs of imported materials for final products) or import ratio (h_2); and (3) profit margin r. The relationship between export ratio and import ratio is a key factor in determining both the magnitude and the direction of a firm's exchange rate exposure, and the firm's profit margin plays a role in the determination

[5] Employing Bodnar and Marston's (2002) model, Bartram, Brown and Minton (2010) empirically measure the expected exchange rate exposures of automobile companies, but their analysis fails to consider the direction of the expected exchange rate exposure.

[6] For the detailed derivation of equation (2), see Bodnar and Marston (2002).

of the magnitude of exchange rate exposure. In equation (2), if a firm's export ratio is greater than its import ratio, the firm will be exposed to a greater exposure where the firm's value increases (decreases) as the exchange rate goes up (down). It is also shown that the expected exchange rate exposure becomes bigger as the firm's ability to generate profits, or the profit margin, is lower.

2.3. Analysis of the effects of currency derivatives on firm risk

As hedging with currency derivatives aims to mitigate volatility of uncertain cash flows to changes in exchange rates, we assess the effects of currency derivative on firm risk by examining the volatilities of profitability and performance measures. Unlike previous studies, we employ both accounting-based and market-based measures of firm risk in order to obtain full and complete evidence on the hedging-firm risk relation. For accounting-based risk measures, we use two volatility measures of profitability of ROE and ROA, *ROEVOL* and *ROAVOL*. For market-based risk measures, we employ the volatility of Tobin's q (*QVOL*) and the volatility of industry-adjusted Tobin's q (*IQVOL*).[7]

Due to the potential endogeneity issue that firms with high or low risk may merely use currency derivatives for hedging more often, we perform 2SLS regression analyses to uncover the unbiased hedging-firm risk relation for Korean firms which used currency derivatives for hedging purposes during our sample period. In the 1st stage, we estimate a regression model of $FCDEV_{t+1}$ using $FCDEV_t$ as an instrument variable and other variables as control variables including firm size (*FSIZE*), market to book ratio (*MB*), Profitability ratio (*EBITDA*), product diversification (*DIVER*), total debt ratio (*LEV*), Beta risk (*BETA*), and year (*YEAR*) and industry (*IND*) dummy variables. The instrument variable of $FCDEV_t$ is selected based on the following criteria: (a) its largest and significant (at the 1% level) regression coefficient (0.716) in the regression model of the determinants of *FCDEV* (regression equation (1)); (b) its t-value (8.10) being

[7] Lee and Li (2012) also use the volatility of Tobin's q as a proxy variable of market-based risk in their study of diversification-firm value relation.

greater than the threshold (absolute) value of 3.0 in the 1st stage; and (c) significant F-values of all 1st stage regressions. We then estimate the following regression model in the 2nd stage using the pre-estimated $FCDEV_{t+1}$ as the key test variable:

$$RISK_{i,t+1} = c_0 + c_1 FCDEV_{i,t+1} + c_2 FCDEV_{i,t+1}\, x\, EXED_{i,t} + c_3 EXED_{i,t} + c_4 FSIZE_{i,t} + c_5 MB_{i,t} + c_6 EBITDA_{i,t} + c_7 DIVER_{i,t} + c_8 LEV_{i,t} + c_9 BETA_{i,t} + c_{10} Option_{i,t} + c_{11} Swap_{i,t} + \sum_{j=1}^{J} c_{11+j} YEAR_{j,i} + \sum_{y=1}^{Y} c_{11+J+y} IND_{y,i} + \mu_{i,t} \quad (3)$$

In regression model (3), the dependent variable of *RISK* is represented by *ROEVOL* and *ROAVOL* as accounting-based volatility measures of profitability and *QVOL* and *IQVOL* as market-based volatility measures of firm value. The key test variable in equation (3) is *FCDEV*, the transaction amount of currency derivatives relative to total assets. In order to assess the effects of buy vs. sell transactions of currency derivatives on firm risk, we also employ transactions of *FCDEV-Sell* and *FCDEV-Buy* in place of *FCDEV* as key test variables after these two variables are estimated from the 1st stage regression models using past year's *FCDEV-Sell* and *FCDEV-Buy* as instrument variables in the similar manner as *FCDEV*.

We further examine the potential difference in the hedging-firm risk relation between firms with high exchange rate exposure and firms with low exposure by including an interactive variable of *FCDEV x EXED*, where *EXED* is an indicator variable with a value of 1 for firms with higher-than-median expected exchange rate exposures and 0 otherwise.

2.4. Analysis of the effects of currency derivatives on firm performance

We examine whether the usage of currency derivatives leads to better firm performance. Similar to the analyses of the hedging-firm risk relation, we conduct 2SLS regressions to control for the potential endogeneity issue on the hedging-firm performance relation that firms with good or bad performance may merely engage in hedging with currency derivatives more often. In the 1st stage, a regression model of $FCDEV_{t+1}$ is estimated using $FCDEV_t$ as an instrument variable and a set of control variables including firm size (*FSIZE*), sales growth (*SG*), R&D ratio (*RND*), total debt ratio (*LEV*), firm age (*AGE*), foreign

investor ownership (*FOR*), controlling shareholder ownership (*OWN*), and year (*YEAR*) and industry (*IND*) dummy variables. In the 2nd stage, the estimated $FCDEV_{t+1}$ enters as key test variable into the following regression model of firm performance.

$$PERF_{i,t+1} = \beta_0 + \beta_1 FCDEV_{i,t+1} + \beta_2 FCDEV_{i,t+1} x\ EXED_t + \beta_3 EXED_t + \beta_4 FSIZE_{i,t} + \beta_5 EBITDA_{i,t} + \beta_6 SG_{i,t} + \beta_7 RND_{i,t} + \beta_8 LEV_{i,t} + \beta_9 AGE_{i,t} + \beta_{10} FOR_{i,t} + \beta_{11} OWN_{i,t} + \sum_{j=1}^{J} \beta_{11+j} YEAR_{j,i} + \sum_{y=1}^{Y} \beta_{11+J+y} IND_{y,i} + \eta_{i,t} \quad (4)$$

In regression equation (4), the dependent variable, *PERF*, is firm performance, represented by *ROE* and *ROA* as accounting-based measures of profitability and *Q* (Tobin's q) and *IQ* (industry-adjusted Tobin's q) as market-based measures of firm value. The key test variable is $FCDEV_{t+1}$, the aggregate transaction amount of currency derivatives, relative to total assets. We also test the effects of *FCDEV*'s two components, *FCDEV-Sell* (sell transaction amount of currency forwards) and *FCDEV-Buy* (buy transaction amount of currency forwards), on firm performance by replacing $FCDEV_{t+1}$. A positive and significant regression coefficient of β_1 would indicate an implementation of optimal hedges of currency derivatives through which the usage of currency derivatives leads to better firm performance.[8] A positive and significant β_1, however, may also suggest over-hedged transactions which generate excess profits from the transactions of currency derivatives, more than necessary to offset the changed value of the exposed underlying assets or cash flows (e.g., FC income, FC payment, etc.). A negative and significant regression coefficient of β_1 would indicate that a firm engage in inefficient over-hedged transactions which generate excess losses from the currency derivatives transactions. Finally, an insignificant regression coefficient of β_1 would imply that while the currency derivatives transactions do not incur excess losses, they still fail to lead to better firm performance but merely reduce foreign exchange risk through optimal hedges.

[8] As noted in the earlier section, better firm performance from the currency derivatives use may be attributed to: (1) mitigation of the underinvestment problem and thus reduction in agency costs between bondholders and shareholders (Bessembinder, 1991; Froot, Scharfstein and Stein, 1993; Mayers and Smith, 1987); (2) reduced corporate tax liability resulting from less volatile profits (Graham and Smith, 1999; Mayers and Smith, 1987; Smith and Stulz, 1985); and (3) reduced financial distress costs that also facilitate higher leverage (Leland, 1998; Smith and Stulz, 1985).

In examining the hedging-firm performance relation, we further investigate whether the valuation effects of hedging with currency derivatives would differ based on a firm's level (high and low) of exchange rate exposure by adding an interactive variable of $FCDEV_{t+1}$ x $EXED_t$.

Table 1 summarizes the definitions and measurement of variables used in regression models.

2.5. Data

The sample firms in our study consist of all Korean industrial firms listed on the Korea Exchange for the period of 2005-2010. Hence, our sample includes firms in the manufacturing and service industries which were exposed to exchange rate risk and engaged in exporting and importing activities. We chose our sample period of 2005-2010 as this period is characterized by greater volatility of Korean won (KRW) against USD and thus is more suitable for a study of assessing the effectiveness of hedging with currency derivatives than pre-2005 and post-2010 periods. In addition, our sample period allows us to examine the effect of the global financial crisis in late 2007 on hedging with currency derivatives.

For each firm's currency derivatives transactions, we obtain the transaction amount of currency derivatives trading by examining the section of "transactions (purchases and sales) of financial derivatives" in each firm's annual operating reports during the sample period. We collect the data for export ratios and operating margin ratios necessary to estimate the expected exchange rate exposure 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. 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. Usage of currency derivatives by Korean firms

Table 2 reports the transaction amount (relative to total assets) by types of currency derivatives by Korean firms during our sample period of 2005-2010. The transactions of currency forwards, currency futures, and currency risk insurance are further broken down into buy (long) and sell (short) transactions.[9]

Our sample firms on average engage in the transactions of currency derivatives equivalent to 3.75% of total assets. Among several types of currency derivatives, currency forwards represent the largest transaction amount of 1.47% relative to total assets, of which short currency forwards (1.23%) are substantially more used than long currency forwards (0.24%) by sample firms. Hence, these findings indicate that Korean firms are more geared to hedge their long positions, or receipts, of foreign currencies generated mainly from their exporting activities, by taking short positions in currency forwards. This strategy would offer protection with the guaranteed pre-determined amount of local currency.

When sample firms are divided by the levels of expected exchange rate exposure (EXE), high EXE firms on average engage in significantly larger transaction amounts of currency derivatives than low EXE firms (5.37% vs. 2.13%). This finding is consistent with evidence in existing studies that firms with greater exchange rate exposures are more likely to use currency derivatives (e.g., Bae and Kwon, 2013; Geczy, Minton and Schrand, 1997). Looking into different types of currency derivatives, high EXE firms use significantly larger transaction amounts of currency forwards, currency risk insurance, and currency options than low EXE firms, whereas low EXE firms engage in larger transaction amounts of currency swaps than high EXE firms.

It is also shown that sample Korean firms incur an average loss of 0.08% of total assets from currency derivatives transactions during our sample period, and that high EXE firms incur significantly

[9] Currency risk insurance is a part of export insurance system offered by Korea Trade Assurance Corporation (KTAC) since 2000 for exporting and importing firms and works in a similar way to the currency forward contracts 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.

larger transaction losses than low EXE firms (0.14% vs. 0.01%). These findings suggest the possibilities of ineffective and complex risk management programs (Copeland and Joshi, 1996; Hagelin and Pramborg, 2004), implementation of non-optimal hedges and excessive costs of currency derivatives use (Bae, Kim and Kwon, 2016); and/or constraints in managing foreign exchange risk (Allayannis, Brown and Klapper, 2003; Clark and Judge, 2009).

3.2. Summary statistics

Table 3 reports mean and median values of key measures of firm risk and performance, other firm characteristics related to hedging activities, and expected exchange rate exposure (*EXE*) for the full sample and two subsamples of firms with high and low EXE.

Comparing two subsamples of firms based on levels of EXE, striking differences are observed for most of the firm-attribute variables. High EXE firms exhibit higher values of firm value volatilities (*QVOL* and *IQVOL*), profitability (*ROE* and *ROA*), export ratio (*EXPORT*), import ratio (*IMPORT*), FC debt (*FCFDEBT*), intra-firm transactions (*INTTR*), sales growth (*SG*), debt ratio (*LEV*), and market risk (*BETA*). In contrast, low EXE firms carry higher values of profitability volatilities (*ROEVOL* and *ROAVOL*), firm values (*Q* and *IQ*), operating profitability (*EBITDA*), market to book value ratio (*MB*), current ratio, tax liability (*TAX*), R&D ratio (*RND*), and foreign investor ownership (*FOR*). Interestingly, there is little difference in firm size (*FSIZE*), product diversification (*DIVER*), firm age (*AGE*), or controlling shareholder ownership (*OWN*) between the two groups of firms.

3.3. Regression results on the determinants of currency derivatives use

Table 4 reports regression results on the determinants of total-, sell-, and buy-transaction amounts of currency derivatives, *FCDEV, FCDEV-Sell*, and *FCDEV-Buy*, respectively. We estimate Tobit regression models to take into account the values of the dependent variables not being less than zero.

For firms' total transaction amounts of currency derivatives for hedging, *FCDEV* is significantly

positively related to *EXPORT*, *FCFDEBT*, *FSIZE*, *EBITDA*, *LEV*, *BETA*, and *Past FCDEV*, but is significantly negatively to *IMPORT*, *INTTR*, and *MB*. Hence, a firm with a higher export ratio, more FC debt, a larger size, higher operating profitability, a higher debt ratio, and higher market risk is likely to engage in more transactions of currency derivatives for hedging. A firm with higher *FCDEV* in the previous year, *Past FCDEV*, is also likely to use more transactions of currency derivatives in the current year. On the contrary, a firm with a higher import ratio, more intra-transactions with foreign subsidiaries, and a higher market to book ratio is likely to engage in lower transaction amounts of currency derivatives. The negative relation of *INTTR* with *FCDEV* suggests that intra-transactions of Korean firms with their foreign subsidiaries play a role as an effective hedging tool by reducing the need for hedging with currency derivatives.

Panel A of Table 4 also show some differences in the determinants between *FCDEV-Sell* and *FCDEV-Buy* transactions for the full sample. Firms tend to engage in greater amounts of sell transactions of currency derivatives when they have less FC debt (*NFCDEBT*), less intra-firm transactions with foreign subsidiaries (*INTTR*), higher operating profitability (*EBITDA*), and greater market risk (*BETA*). On the other hand, firms are likely to buy more amounts of currency derivatives when they have more FC debt, whose evidence is as expected because firms with more FC debt would need more FC to service their FC debt.

When firms are divided by the levels of exchange rate exposures, notable differences in their determinants are observed between high and low EXE firms, while there are also many similarities in Panels B and C. Those firm attributes that influence *FCDEV* of high vs. low EXE firms differently include *IMPORT*, *NFCDEBT*, *DIVER*, *OCFVOL*, *BETA*, and *TAX*. More specifically, firms with high EXE are likely to engage in more transactions of currency derivatives when they have greater product diversification (*DIVER*), higher volatility of operating cash flows (*OCFVOL*), and more tax liability (*TAX*). On the contrary, firms with low EXE tend to engage in more of such transactions when they import more (*IMPORT*), possess more FC debt than FC assets (*NFCDEBT*), and/or have higher market risk (*BETA*).

3.4. Regression results on the effects of currency derivatives use on firm risk

Table 5 reports the regression results from the 2nd stage regression models of the 2SLS analysis on the effects of currency derivatives usage on firm risk. Panels A and B show results using accounting-based volatility measures of *ROEVOL* and *ROAVOL* and market-based volatility measures of *QVOL* (volatility of Tobin's q) and *IQVOL* (volatility of industry-adjusted Tobin's q), respectively, as dependent variables.

Looking at the regression estimates of control variables, their relationships with firm risk are generally in line with our expectations. A firm with smaller size (*FSIZE*), higher market to book ratio (*MB*, or higher growth potential), lower operating profitability (*EBITDA*), higher debt ratio (*LEV*), higher market risk (*BETA*), and more transactions of currency options (*OPTIONS*) tends to have higher *ROEVOL* and *ROAVOL*. It is also worth noting that the indicator variable of *EXED* carries positive and significant (at least at the 5% level) regression estimates in all models, whose result indicates a strong positive relationship between exchange rate exposure and firm risk that the higher the expected exchange rate exposure, the higher the firm risk represented by volatility measures of profitability.

As shown in Models (1), (3), (5), and (7) in Panel A, none of the key test variables, *FCDEV*, *FCDEV-Sell*, or *FCDEV-Buy*, is significantly related to either *ROEVOL* or *ROAVOL*. Hence, the usage of currency derivatives by *Korean* firms does not reduce accounting-based volatility measures of profitability. Compared to low EXE firms, however, high EXE firms command lower firm risk of both measures of profitability volatility through the usage of currency derivatives, as evidenced by the negative and significant (at the 5% level) regression estimates of the interactive variable of *FCDEV x EXED*. In fact, lower firm risk associated with hedging for high EXE firms is attributed mainly to the sell (or short) transactions of currency derivatives, *FCDEV-Sell*, rather than the buy transactions of currency derivatives.

Panel B shows the effects of currency derivatives use on market-based risk measures of *QVOL* and *IQVOL*. Compared to those in Panel A, the regression models of market-based risk measures in Panel B

offer a better fit with higher explanatory power as evidenced by higher adjusted R-squared values. Overall, the regression results in Panel B for market-based risk measures are similar to those in Panel A for accounting-based risk measures, but a few notable differences are observed. On the one hand, *FCDEV* and *FCDEV-Buy* do not show any significant regression coefficient, indicating that the usage of currency derivatives by Korean firms does not lead to any meaningful reduction in market-based firm risk. On the other hand, *FCDEV-Sell* carries a significant (at least at the 10% level) but positive regression estimate in all regressions of *QVOL* and *IQVOL*. This result indicates that greater sell transaction amounts of currency derivatives by Korean firms fail to reduce firm risk but increase their volatilities of market value. This evidence raises the possibility of engaging in non-optimal (e.g., over-hedging) short hedging of currency derivatives by Korean firms. It is also shown that unlike the results in Panel A, there is no significant difference in the effects of firms' usage of currency derivatives on market-based risk measures between firms with high vs. low exchange rate exposures.

The evidence on the insignificant effects of *FCDEV* on both accounting- and market-based risk measures reported in Table 5 is somewhat surprising but consistent with the evidence of no clear relationship between currency derivatives use and foreign exchange risk reported in existing studies (Guay and Kothari, 2003; Hentschel and Kothari, 2001). As Guay and Kothari (2003) note, the transaction amounts of currency derivatives by Korean firms (3.75% relative to total assets as shown in Table 2) may be economically too small to produce any economically meaningful benefits of risk reduction.

3.5. *Regression results on the effects of currency derivatives use on firm performance*

We now turn to regression results on the relationships between firms' usage of currency derivatives and firm performance. Table 6 presents regression estimates from the 2nd stage regression models of the 2SLS analysis with dependent variables of two accounting-based measures of profitability, *ROE* and *ROA*, in Panel A, and two market-based measures of firm value, *Q* and *IQ* in Panel B.

As shown in Panel A, the three key test variables of *FCDEV, FCDEV-Sell* and *FCDEV-Buy* carry

insignificant regression estimates in all regression models except for *FCDEV-Buy* in Model (3). Accordingly, higher transaction amounts of currency derivatives do not lead to an increase in firm value, though not reducing firm value. While these results may be interpreted as implying effective hedging activities by Korean firms through which the gains (losses) from currency derivatives use effectively offset the losses (gains) on the values of the underlying exposed assets, these results offer strong evidence that more usage of currency derivatives fails to lead to value creation such as reduced costs of underinvestment, reduced tax liabilities, or reduced costs of financial distress, as noted for the benefits of currency derivatives use in the existing literature. It is also worthwhile to note that the 2nd stage regression models of *ROE* (Models 1 through 4) have substantially low explanatory power, as evidenced by the low adjusted R-squares (less than 0.067). Panel A further shows that there is little difference in the effect of currency derivatives use on accounting-based firm performance between high and low EXE firms.

Similarly to the evidence on firm risk in Table 5, the regression models of market-based performance in Panel B exhibit substantially higher adjusted R-squared values than those of accounting-based performance in Panel A. Hence, the regression models with identical explanatory variables explain a larger portion of the variation in the market-based performance measures than they do in the accounting-based performance measures.

The regression estimates of *FCDEV* are all positive and significant (at least at the 10% level) for the models of both *Q* and *IQ*, indicating a strong positive relationship between *FCDEV* and firm value. Hence, more usage of currency derivatives is associated with higher firm values in terms of both raw Tobin's q and industry-adjusted Tobin's q. *FCDEV-Sell* also carries a positive and significant regression coefficient in Models (3) and (4) of *Q* as dependent variable, but *FCDEV-Buy* has no significant regression estimate. Hence, only sell transactions of currency derivatives bring in a positive impact on firm value.

When *FCDEV* is combined with *EXED*, the interactive variable of *FCDEV x EXED* carries a negative and significant (at the 10% level) regression estimate. Hence, the currency derivatives use by firms with high exchange rate exposures does not enhance but decrease firm value. Given the observation

that firms with high exchange rate exposure engage in hedging with currency derivatives more frequently and in greater amounts, these results suggest that hedging with currency derivatives by Korean firms with high exchange rate exposures is often mismanaged either due to the implementation of non-optimal hedges (e.g., under- or over-hedges) or due to the excessive costs associated with hedging. These results also suggest that when firms have relatively low and manageable exchange rate exposures (that is, low EXE), currency derivatives transactions work as an effective tool in hedging receipts of foreign currency income and protecting firm value from exchange rate risk.

3.6. Robustness test of effects of currency derivatives on firm risk and performance

We perform a robustness test to ensure that our results on the effects of currency derivatives use on firm risk and performance are not sensitive to different model specifications. As firms' hedging activities with currency derivatives aim to enhance or at least preserve firm values by reducing firms' exposures to exchange rate changes, we employ risk-adjusted performance measures and examine the mutual effects of currency derivatives use on firm risk and performance. The risk-adjusted performance measures are widely used in investment performance evaluation such as the Sharpe ratio (Sharpe, 1996) and the Appraisal ratio (Brown et al., 2008).[10]

Table 7 reports 2nd stage regression results of accounting-based risk-adjusted performance measures of *ROE/ROEVOL* and *ROA/ROAVOL* in Panel A and market-based risk-adjusted performance measures of *Q/QVOL* and *IQ/IQVOL* in Panel B. Similarly to our earlier analyses of firm risk and firm performance, $FCDEV_{t+1}$, $FCDEV\text{-}Sell_{t+1}$, *and* $FCDEV\text{-}Buy_{t+1}$ are estimated using $FCDEV_t$, $FCDEV\text{-}Sell_t$, and $FCDEV\text{-}Buy_t$, respectively, as instrument variable and other variables as control variables in the 1st stage.

[10] Lee and Li (2012) use similar risk-adjusted performance measures to unveil diversification-firm performance relations.

In Panel A, none of *FCDEV*-related test variables carries a significant regression estimate and thus is significantly related to the accounting-based risk-adjusted performance measures of *ROE/ROEVOL* or *ROA/ROAVOL*, confirming our earlier evidence of little impact of currency derivatives use on accounting-based performance. For market-based risk-adjusted performance, *FCDEV* in Panel B exhibits a negative regression estimate in all models of (1), (2), (5), and (6), but shows a significant (at the 5% level) coefficient only in Model (5), indicating weak evidence of the positive effect of firms' usage of currency derivatives on market-based risk-adjusted performance. The interactive variable of *FCDEV x EXEC* shows a negative relationship with both *Q/QVOL* and *IQ/IQVOL*, but none of the estimated coefficient is statistically significant. Overall, the regression results in Table 7 are in general consistent with those on the hedging-firm performance relation reported in Table 6 that the usage of currency derivatives for hedging by Korean firms brings in a positive, though weak, effect on firm value.

4. Summary and Conclusions

In this paper, we have analyzed the usage of currency derivatives for hedging with respect to its firm-specific determinants and impacts on firm risk and performance. Employing firm-level data for Korean firms, we apply several research methodologies distinctively different from those in the existing literature. Our data show that sample Korean firms on average engage in the transactions of currency derivatives equivalent to 3.75% of total assets and that Korean firms are more geared to hedge their long positions, or receipts, of foreign currencies by taking short positions in currency forwards. A preliminary analysis also shows that firms with high exchange rate exposures (EXE) engage in significantly larger transactions of currency derivatives than firms with low EXE, consistent with evidence in existing studies.

We find that firms with a higher export ratio, more FC debt, a larger size, higher operating profitability, a higher debt ratio, and higher market risk are likely to use more transactions of currency derivatives. The transaction amounts of currency derivatives in the previous year are also positively related to those in the current year. On the contrary, firms with a higher import ratio, more intra-firm

transactions with foreign subsidiaries, and a higher market to book ratio are likely to engage in less transactions of currency derivatives. We also report some differences in the determinants between sell and buy transactions of currency derivatives. Among others, firms tend to take more short positions of currency derivatives when they have less intra-firm transactions with foreign subsidiaries but take more long positions when they have more FC debt.

Regarding the hedging-firm risk relation, 2SLS regression analyses show that more usage of currency derivatives by Korean firms does not lead to lower firm risk, regardless of accounting- or market-based volatility measures. In contrast, more sell transactions of currency derivatives contribute to the increase in firm risk. Our results also show that high EXE firms command lower firm risk through the usage of currency derivatives. The evidence on the insignificant hedging-firm risk relation is somewhat surprising but consistent with the evidence of no clear relationship between currency derivatives use and foreign exchange risk reported in existing studies. As Guay and Kothari (2003) note, the transaction amounts of currency derivatives by Korean firms (3.75% relative to total assets as shown in Table 2) may be economically too small to produce any economically meaningful benefits of risk reduction.

Lastly, more transactions, particularly sell transactions, of currency derivatives are associated with higher market-based performance of Tobin's q and industry-adjusted q, whereas they have little impact on accounting-based profitability measures. Hence, Korean firms' usage of currency derivatives fails to improve their profitability, but is perceived more favorably by the market. Our results further show that currency derivatives use by high EXE firms is associated with lower firm values. Combined with our earlier evidence of lower firm risk for high EXE firms which use currency derivatives more frequently and in larger amounts, these results indicate that the lower firm risk resulting from hedging with currency derivatives for high EXE firms is not materialized into higher firm value. This evidence seems to be attributable to the mismanagement of hedging strategies either due to the implementation of non-optimal hedges (e.g., under- or over-hedges) or due to the excessive costs associated with hedging. In fact, this evidence further suggests that when firms have relatively low and manageable EXE, currency derivatives

work as an effective tool in hedging foreign exchange risk and protecting firm value. Our robustness test confirms the positive, though weak, effect of currency derivatives use on market-based risk-adjusted performance.

The weak and somewhat conflicting evidence on the effects of hedging with currency derivatives on firm risk and performance reported in our paper should not be interpreted as undermining the benefits of currency derivatives for hedging. Rather, our results highlight the importance of a proper management of currency derivatives hedging strategies with the implementation of optimal hedges and thorough cost-benefit analysis of currency derivatives use.

References

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

Allayannis, G. and J. Ihrig, 2001, Exposure and markups, *Review of Financial Studies* 14, 805-835.

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

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

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

Bae, S.C., H.S. Kim and T.H. Kwon, 2016, Foreign currency debt financing, firm value, and risk: evidence from Korea surrounding the global financial crisis, *Asia-Pacific journal of Financial Studies* 45, 124-152.

Bali, T., S. Hume and T. Martell, 2007, A new look at hedging with derivatives: Will firms reduce market risk exposure?" *Journal of Futures Market* 27, 1053-1083.

Bartram, S. and G. Bodnar, 2007, The exchange rate puzzle, *Managerial Finance* 33, 642-666.

Bartram S., G.W. Brown and J. Conrad, 2011, The effects of derivatives on firm risk and value, *Journal of Financial and Quantitative Analysis* 46, 967-999.

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

Bartram, S., G.W. Brown and B. Minton, 2010, Resolving the exposure puzzle: The many facets of exchange rate exposure, *Journal of Financial Economics* 95, 148-173.

Bessembinder, H., 1991, Forward contracts and firm value: Investment incentive and contracting effects, *Journal of Financial and Quantitative Analysis* 26, 519-532.

Bodnar, G.M., B. Dumas, and R.C. Marston, 2002, Pass-through and exposure, *Journal of Finance* 57, 199-231.

Bodnar, G.M., and R.C. Marston, 2002, Exchange rate exposure: A simple model, in Choi, J., Power, M. (Ed.), Global Risk Management: Financial Operational and Insurance Strategies, *International Financial Review* 3, Elsevier Science, Amsterdam.

Brown, G.W., 2001, Managing foreign exchange risk with derivatives, *Journal of Financial Economics* 60, 401-448.

Brown, S., W. Goetzmann, B. Liang, and C. Schwarz, 2008. Mandatory disclosure and operational risk: evidence from hedge fund registration. *Journal of Finance* 63, 2785–2815.

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

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

Campa, J. and L. Goldberg, 1999, Investment, pass-through, and exchange rate: A cross-country comparison, *International Economic Review* 40, 287-314.

Chang, Y.C. and H.J. Lin, 2005, The use of foreign currency derivatives and foreign-denominated debts to reduce exposure to exchange rate fluctuations, *International Journal of Management* 22, 598-604.

Clark, E. and A. Judge, 2009, Foreign currency derivatives versus foreign currency debt and the hedging premium, *European Financial Management* 15, 606-642.

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

Copeland, T.E. and Y. Joshi, 1996, Why derivatives don't reduce FX risk, *McKinsey Quarterly* No.1, 66-79.

Döhring, B., 2008, Hedging and invoicing strategies to reduce exchange rate exposure: A euro-area perspective, *Economic Papers* 299, European Commission, Directorate-General for Economic and

Financial Affairs, Brussels, Belgium.

Dominguez, K.M.E. and L.L. Tesar, 2006, Exchange rate exposure. *Journal of International Economics* 68, 188-218.

Dumas, B. and B. Solnik, 1995, The world price of foreign exchange risk. *Journal of Finance* 50, 445-479.

Elliott, W., S. Huffman and S. Makar, 2003, Foreign denominated debt and foreign currency derivatives: complement or substitutes in hedging foreign currency risk? *Journal of Multinational Financial Management* 13, 123-139.

Froot, K.A., D.S. Scharfstein, and J.C. Stein, 1993, Risk management: coordinating corporate investment and financing policies, *Journal of Finance* 48, 1629-1658.

Gagnon, J. and M. Knetter, 1995, Markup adjustment and exchange rate fluctuations: Evidence from panel data on automobile exports, *Journal of International Money and Finance* 14, 289-310.

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

Graham, J.R. and D. Rogers, 2002, Do firms hedge in response to tax incentive? *Journal of Finance* 57, 815-840.

Graham, J.R. and C.W. Smith, Jr., 1999, Tax incentives to hedge, *Journal of Finance* 54, 2241-2262/

Guay, W., 1999, The impact of derivatives on firm risk: An empirical examination of new derivatives users, *Journal of Accounting and Economics* 26, 319-351.

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

Hagelin, N., 2010, Why firms hedge with currency derivatives: an examination of transaction and translation exposure, *Applied Financial Economics* 20, 55-69.

Hagelin, N. and B. Pramborg, 2004, Hedging foreign exchange exposure: risk reduction from transaction and translation hedging, *Journal of International Financial Management & Accounting* 15, 1-20.

He, J. and L. Ng, 1998, The foreign exchange exposure of Japanese multinational corporations. *Journal of*

Finance 53, 733-753.

Hentschel, L. and S.P. Kothari, 2001, Are corporations reducing or taking risks with derivatives? *Journal of Financial and Quantitative Analysis* 36, 93-118.

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

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

Jorion, P., 1991, The pricing of exchange rate risk in the stock market, *Journal of Financial and Qualitative Analysis* 26, 353-376.

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

Hentschel, L. and S. Kothari, 2001, Are corporations reducing or taking risks with derivatives? *Journal of Financial and Quantitative Analysis* 36, 93-118.

Khil, J. and S. Suh, 2010, Risk management lessons from 'knock-in knock-out' option disaster, *Asia-Pacific Journal of Financial Studies* 39, 28-52.

Knetter, M., 1989, Price discrimination by U.S. and German exports, *American Economic Review* 79, 198-210.

Knetter, M., 1993, International comparisons of pricing-to-market behavior, *American Economic Review* 83, 473-486.

Knetter, M., 1994, Is export price adjustment asymmetric? Evaluating the market share and marketing bottleneck hypotheses, *Journal of International Money and Finance* 13, 55-70.

Kwon, T.H., S.C. Bae, and J.M. Chung, 2005, Do foreign investors price foreign exchange risk differently? *Journal of Financial Research* 28, 555-573.

Krugman, P., 1987, Pricing to markets when the exchange rates changes, in J. David Richardson and Seven Arndt (eds.). *Real-Financial Linkages among Open Economics*, MIT Press. Cambridge.

Lee, B.S., and M-Y.L. Li, 2012, Diversification and risk-adjusted performance: a quantile regression

approach, *Journal of Banking and Finance* 36, 2157-2173.

Leland, H.E., 1998, Agency costs, risk management, and capital structure, *Journal of Finance* 53, 1213-1243.

Manon, J., 1995, Exchange rate pass-through, *Journal of Economic Surveys* 9, 197-231.

Mayers, D. and C.W. Smith Jr., 1987, Corporate insurance and the underinvestment problem, J*ournal of Risk and Insurance* 54, 45-54.

Nydahl, S., 1999, Exchange rate exposure, foreign involvement and currency hedging of firms: some Swedish evidence, *European Financial Management* 5, 241-257.

Sharpe, W.F., 1966. Mutual fund performance. *Journal of Business* 39, 119–138.

Smith Jr., C.W. and R.M. Stulz, 1985, The determinants of firms' hedging policies, J*ournal of Financial and Quantitative Analysis* 20, 391-405.

Smith Jr., C.W. and R.L. Watts, R.L. (1992), 'The investment opportunity set and corporate financing, dividend, and compensation policies', *Journal of Financial Economics* 32, 263-292.

Tufano, P., 1996, Who manages risk? an empirical examination of risk management practices in the gold mining industry, *Journal of Finance* 51, 1097-1137.

Table 1. Definitions and measurements of regression variables

Variables	Definitions	Measurements
FCDEV	Transaction amount of currency derivatives	(forwards + futures + risk insurance + options & swaps) / total asset
FCDEV-Buy	Buy transactions (long position) of cur derivatives	(buy amount of cur forwards + cur futures + cur risk insurance) / total assets
FCDEV-Sell	Sell transactions (short position) of cur derivatives	(sell amount of cur forwards + cur futures + cur risk insurance) / total assets
OPTION	Currency option contracts	(currency call option + currency put option) / total assets
SWAP	Currency swap contracts	(currency swap + interest currency swap) / total assets
ROEVOL	Volatility of Return on equity	Ln(standard deviation of return on equity during t-1~t+1)
ROAVOL	Volatility of Return on assets	Ln(standard deviation of return on assets during t-1~t+1)
QVOL	Volatility of Tobin's q	Ln(standard deviation of Tobin's q during t-1~t+1)
IQVOL	Volatility of Industry-adjusted Tobin's q	Ln(standard deviation of Industry-adjusted Tobin's during t-1~t+1) q)
ROE	Return on equity	Net income / total equity
ROA	Return on asset	Net income / total assets
Q	Tobin's q	(MV of common stock + BV of preferred stock + BV of debt) / total assets
IQ	Industry-adjusted Tobin's q	Tobin's q – (mean of Tobin's q in t and industry)
EXPORT	Export ratio	Exporting amount / sales
IMPORT	Import ratio	Proxied by industry import ratio (cost of imported raw materials / sales)
NFCDEBT	Net FC debt ratio	(FC debt – FC assets) / total assets
FCDEBT	FC Financial debt ratio	FC long-term and short-term borrowing / total assets
INTTR	Related-party transactions with foreign subsidiaries	(Sales + purchases + profits + costs) / sales
DIVER	Product diversification	Caves' diversification index
FSIZE	Firm size	ln(sum of MVs of common and preferred stock + BV of debt in t)
EBITDA	Profitability	(EBIT+dep) / total assets
SG	Sales growth	(Sales in t – sales in t-1) / sales in t-1
LEV	Total debt ratio	Total debt / total assets
OCFVOL	Volatility of operating cash flow	Ln(standard deviation of operating cash flow in t~t-2)
BETA	Beta	Beta measured by the market model using daily stock and KOSPI returns
MB	Market to Book ratio	MV /BV of common stock
CR	Current ratio	Current assets / current liability
TAX	Tax ratio	Tax payment/pretax income
AGE	Firm age	ln(t - establishment t +1)
RND	R&D ratio	R&D expenses / total assets
OWN	Controlling shareholders ownership	Common shares held by largest shareholder / total common shares
FOR	Foreign investor ownership	Common shares held by foreign investors / total common shares
EXE	Expected exchange rate exposure	Estimated based on the Bodnar and Marston's (2002) *EXE* model

Table 2. Usages and profit/loss of currency derivatives by Korean firms

The usage of currency derivatives represents all transactions of currency derivatives except for buy and sell transactions for profit purposes by Korean firms during 2005-2010. All currency derivatives are measured as relative to total assets. Profit and Loss of derivatives are measured as relative to sales. *EXE* = expected exchange rate exposure. *FCDEV_D* = dummy variable for 1 for firms using currency derivatives and 0 otherwise. *FCDEV* = transaction amount of currency derivatives. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

	Full sample (N=3,582)		Firms with High EXE (N=1,792) (1)		Firms with Low EXE (N=1,790) (2)		Difference test (1-2)	
	Mean	Median	Mean	Median	Mean	Median	t-value	z-value
FCDEV_D	0.2473	0.0000	0.3103	0.0000	0.1844	0.0000	8.825***	8.731***
FCDEV	0.0375	0.0000	0.0537	0.0000	0.0213	0.0000	6.975***	8.873***
- Long currency forwards	0.0024	0.0000	0.0034	0.0000	0.0015	0.0000	3.746***	3.925***
- Short currency forwards	0.0123	0.0000	0.0206	0.0000	0.0039	0.0000	6.962***	10.408***
- Long currency futures	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-	-
- Short currency futures	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-	-
- Long currency risk insurance	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-	-
- Short currency risk insurance	0.0002	0.0000	0.0004	0.0000	0.0001	0.0000	3.504***	4.237***
- Total currency options	0.0055	0.0000	0.0084	0.0000	0.0025	0.0000	4.130***	5.638***
- Total currency swaps	0.0054	0.0000	0.0041	0.0000	0.0068	0.0000	-3.703***	-0.976
Profit and Loss of currency derivatives	-0.0008	0.0000	-0.0014	0.0000	-0.0001	0.0000	-3.058***	-0.390

Table 3. Summary statistics of variables

This table reports mean and median values of firm characteristics and other variables related to hedging activities for sample Korean firms during 2005-2010. *EXE* = expected exchange rate exposure. See Table 1 for definitions and measurements of other variables.

Variables	Full sample (N = 3,582)		High EXE firms (N = 1,792)		Low EXE firms (N = 1,790)		Difference test (High – Low)	
	Mean	Median	Mean	Median	Mean	Median	t-value	z-value
$ROEVOL_{t+1}$	-2.985	-3.083	-2.904	-2.951	-3.067	-3.250	3.653 ***	6.375 ***
$ROAVOL_{t+1}$	-3.653	-3.670	-3.604	-3.589	-3.703	-3.784	2.705 ***	4.063 ***
$QVOL_{t+1}$	-2.046	-2.051	-2.148	-2.143	-1.944	-1.954	-6.432 ***	-6.105 ***
$IQVOL_{t+1}$	-2.129	-2.128	-2.212	-2.182	-2.045	-2.052	-5.508 ***	-4.629 ***
ROE_{t+1}	-0.045	0.060	0.011	0.060	-0.101	0.060	5.147 ***	1.388
ROA_{t+1}	0.015	0.033	0.024	0.032	0.007	0.035	4.369 ***	-0.940
Q_{t+1}	1.037	0.899	0.973	0.877	1.100	0.923	-7.428 ***	-4.891 ***
IQ_{t+1}	-0.028	-0.096	-0.058	-0.103	0.002	-0.083	-3.955 ***	-0.926
$EXPORT_t$	0.268	0.111	0.425	0.448	0.110	0.018	35.656 ***	29.309 ***
$IMPORT_t$	0.179	0.163	0.237	0.204	0.120	0.084	24.958 ***	24.889 ***
$NFCDEBT_t$	0.021	0.000	0.027	0.003	0.016	0.000	4.014 ***	1.486
$FCFIN_t$	0.034	0.000	0.047	0.010	0.022	0.000	12.076 ***	14.381 ***
$INTTR_t$	0.079	0.000	0.119	0.018	0.039	0.000	14.155 ***	18.468 ***
$DIVER_t$	0.304	0.113	0.305	0.102	0.303	0.127	0.114	0.050
$FSIZE_t$	19.501	19.137	19.547	19.141	19.454	19.135	1.731 *	0.486
$EBITDA_t$	0.049	0.048	0.044	0.042	0.053	0.056	-3.872 ***	-7.549 ***
SG_t	0.101	0.068	0.116	0.078	0.086	0.061	2.621 ***	3.861 ***
LEV_t	0.436	0.446	0.458	0.471	0.413	0.416	6.904 ***	6.975 ***
$OCFVOL_t$	-3.198	-3.168	-3.152	-3.128	-3.244	-3.222	3.212 ***	2.955 ***
$BETA_t$	0.770	0.759	0.819	0.812	0.722	0.715	8.241 ***	7.980 ***
MB_t	1.202	0.829	1.061	0.757	1.344	0.917	-7.230 ***	-6.820 ***
CR_t	2.074	1.371	1.790	1.286	2.359	1.480	-6.359 ***	-6.591 ***
TAX_t	0.162	0.212	0.149	0.202	0.174	0.224	-2.343 **	-4.517 ***
AGE_t	3.458	3.611	3.474	3.611	3.442	3.638	1.468	-0.266
RND_t	0.013	0.004	0.012	0.004	0.014	0.004	-3.046 ***	2.001 ***
OWN_t	0.414	0.410	0.416	0.412	0.412	0.410	0.649	0.506
FOR_t	0.013	0.004	0.012	0.004	0.014	0.004	-5.326 ***	-4.097 ***
EXE_t	1.104	0.000	2.321	1.969	-0.114	-0.071	23.524 ***	22.010 ***

Table 4. Tobit regression results on the determinants of currency derivatives

The dependent variable is *FCDEV*, *FCDEV-Sell*, and *FCDEV-Buy*, representing total-, sell-, and buy-transaction amount of currency derivatives, respectively. *EXE* = expected exchange rate exposure. See Table 1 for definitions and measurements of other variable. Standard errors are in parentheses. ***, ***, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Full sample

Variables	*FCDEV*		*FCDEV-Sell*		*FCDEV-Buy*	
	(1)	(2)	(3)	(4)	(5)	(6)
EXPORT	0.215***	0.210***	0.254***	0.261***	0.023*	0.022*
	(0.026)	(0.026)	(0.032)	(0.032)	(0.012)	(0.012)
IMPORT	-0.091*	-0.108**	-0.092	-0.119*	0.011	0.012
	(0.047)	(0.047)	(0.062)	(0.062)	(0.022)	(0.022)
NFCDEBT	-0.032		-0.465***		0.103***	
	(0.080)		(0.107)		(0.036)	
FCFDEBT		0.392***		-0.092		0.162***
		(0.104)		(0.146)		(0.046)
INTTR	-0.177***	-0.194***	-0.110**	-0.109**	-0.018	-0.026
	(0.043)	(0.043)	(0.047)	(0.048)	(0.020)	(0.020)
DIVER	0.022	0.023	0.056***	0.059***	0.025***	0.025***
	(0.016)	(0.016)	(0.019)	(0.019)	(0.007)	(0.007)
FSIZE	0.044***	0.043***	0.036***	0.032***	0.012***	0.013***
	(0.005)	(0.005)	(0.006)	(0.006)	(0.002)	(0.002)
MB	-0.027***	-0.025***	-0.022**	-0.019**	-0.006*	-0.006*
	(0.007)	(0.007)	(0.009)	(0.009)	(0.003)	(0.003)
EBITDA	0.473***	0.479***	0.261*	0.283**	0.054	0.055
	(0.110)	(0.110)	(0.136)	(0.138)	(0.053)	(0.053)
LEV	0.152***	0.106**	0.010	-0.024	0.004	-0.002
	(0.044)	(0.045)	(0.055)	(0.057)	(0.021)	(0.021)
OCFVOL	0.005	0.002	0.017*	0.016	-0.000	-0.000
	(0.008)	(0.008)	(0.010)	(0.011)	(0.004)	(0.004)
BETA	0.037*	0.042**	0.081***	0.084***	0.010	0.012
	(0.020)	(0.020)	(0.026)	(0.027)	(0.010)	(0.010)
TAX	0.032	0.034*	0.013	0.016	0.005	0.004
	(0.020)	(0.020)	(0.025)	(0.025)	(0.010)	(0.010)
AGE	-0.008	-0.008	-0.014	-0.016	-0.005	-0.004
	(0.010)	(0.010)	(0.013)	(0.013)	(0.004)	(0.004)
PastFCDEV	0.716***	0.716***	0.659***	0.720***	1.643***	1.664***
	(0.037)	(0.036)	(0.065)	(0.065)	(0.136)	(0.136)
FCDEV-Sell					0.096***	0.085***
					(0.025)	(0.024)
FCDEV-Buy			2.069***	1.950***		
			(0.314)	(0.318)		
OPTION			0.077	0.122	0.095*	0.082
			(0.158)	(0.160)	(0.054)	(0.054)
SWAP			0.017	-0.142	-0.142	-0.159
			(0.414)	(0.422)	(0.152)	(0.151)
Constant	-1.255***	-1.238***	-1.091***	-1.009***	-0.394***	-0.406***
	(0.101)	(0.100)	(0.126)	(0.125)	(0.050)	(0.050)
YEAR, IND dummy	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	3,472	3,472	3,472	3,472	3,472	3,472
LR Chi-squared	1042.54***	1094.91***	695.52***	677.38***	502.98***	505.73***

Panel B. High EXE firms

Variables	*FCDEV*		*FCDEV-Sell*		*FCDEV-Buy*	
	(1)	(2)	(3)	(4)	(5)	(6)
EXPORT	0.181***	0.194***	0.139***	0.158***	-0.000	0.000
	(0.036)	(0.036)	(0.041)	(0.041)	(0.015)	(0.015)
IMPORT	-0.210***	-0.235***	-0.227***	-0.262***	-0.018	-0.017
	(0.068)	(0.068)	(0.084)	(0.086)	(0.032)	(0.032)
NFCDEBT	-0.321***		-0.533***		0.048	
	(0.103)		(0.126)		(0.043)	
FCFDEBT		0.095		-0.035		0.113**
		(0.138)		(0.172)		(0.055)
INTTR	-0.190***	-0.199***	-0.125**	-0.129**	-0.024	-0.030
	(0.051)	(0.052)	(0.055)	(0.057)	(0.023)	(0.023)
DIVER	0.039*	0.045**	0.056**	0.064**	0.025***	0.026***
	(0.022)	(0.022)	(0.024)	(0.025)	(0.009)	(0.009)
FSIZE	0.045***	0.040***	0.038***	0.032***	0.015***	0.015***
	(0.006)	(0.006)	(0.007)	(0.007)	(0.003)	(0.003)
MB	-0.027**	-0.025**	-0.028**	-0.026**	-0.008	-0.007
	(0.011)	(0.011)	(0.013)	(0.013)	(0.005)	(0.005)
EBITDA	0.436***	0.432**	0.312	0.322	0.073	0.076
	(0.166)	(0.169)	(0.192)	(0.197)	(0.077)	(0.077)
LEV	0.135**	0.089	-0.029	-0.064	-0.020	-0.028
	(0.067)	(0.068)	(0.077)	(0.079)	(0.031)	(0.032)
OCFVOL	0.030***	0.028**	0.025*	0.024*	0.004	0.003
	(0.012)	(0.012)	(0.014)	(0.014)	(0.005)	(0.005)
BETA	0.014	0.022	0.078**	0.088***	-0.005	-0.003
	(0.028)	(0.029)	(0.033)	(0.034)	(0.012)	(0.012)
TAX	0.049*	0.053*	0.018	0.022	0.008	0.008
	(0.028)	(0.028)	(0.032)	(0.032)	(0.012)	(0.012)
AGE	-0.023	-0.023	-0.036**	-0.038**	-0.004	-0.004
	(0.014)	(0.014)	(0.016)	(0.016)	(0.006)	(0.006)
Past FCDEV	0.663***	0.691***	0.607***	0.676***	1.523***	1.533***
	(0.043)	(0.042)	(0.072)	(0.072)	(0.154)	(0.153)
FCDEV-Sell					0.095***	0.089***
					(0.026)	(0.026)
FCDEV-Buy			1.936***	1.820***		
			(0.363)	(0.370)		
OPTION			0.068	0.131	0.022	0.012
			(0.175)	(0.178)	(0.072)	(0.072)
SWAP			-0.083	-0.443	-0.181	-0.194
			(0.617)	(0.623)	(0.253)	(0.246)
Constant	-1.062***	-0.981***	-0.846***	-0.735***	-0.376***	-0.379***
	(0.136)	(0.135)	(0.153)	(0.152)	(0.065)	(0.064)
YEAR, IND dummy	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	1,741	1,741	1,741	1,741	1,741	1,741
LR Chi-squared	644.31***	655.51***	483.25***	466.58***	354.04***	356.53***

Panel C. Low EXE firms

Variables	*FCDEV*		*FCDEV-Sell*		*FCDEV-Buy*	
	(1)	(2)	(3)	(4)	(5)	(6)
EXPORT	0.232***	0.186***	0.290***	0.315***	0.039	0.033
	(0.052)	(0.052)	(0.071)	(0.074)	(0.028)	(0.028)
IMPORT	0.196**	0.193**	0.130	0.125	0.093**	0.095**
	(0.080)	(0.079)	(0.115)	(0.116)	(0.040)	(0.040)
NFCDEBT	0.579***		-0.602**		0.208***	

	(0.136)		(0.243)		(0.076)	
FCFDEBT		1.031***		-0.559		0.223**
		(0.169)		(0.349)		(0.095)
INTTR	-0.146*	-0.159*	-0.062	-0.051	-0.023	-0.026
	(0.085)	(0.084)	(0.100)	(0.101)	(0.041)	(0.041)
DIVER	-0.027	-0.032	0.024	0.029	0.010	0.008
	(0.025)	(0.024)	(0.033)	(0.033)	(0.012)	(0.012)
FSIZE	0.046***	0.048***	0.041***	0.037***	0.009**	0.010***
	(0.007)	(0.007)	(0.011)	(0.011)	(0.004)	(0.004)
MB	-0.026***	-0.026***	-0.008	-0.007	-0.003	-0.003
	(0.009)	(0.009)	(0.012)	(0.012)	(0.005)	(0.005)
EBITDA	0.347**	0.321**	0.105	0.143	0.035	0.033
	(0.156)	(0.155)	(0.220)	(0.222)	(0.084)	(0.085)
LEV	0.129**	0.100	0.017	0.005	-0.012	-0.009
	(0.063)	(0.062)	(0.091)	(0.092)	(0.034)	(0.034)
OCFVOL	-0.019*	-0.020*	0.008	0.008	-0.005	-0.006
	(0.011)	(0.011)	(0.017)	(0.017)	(0.006)	(0.006)
BETA	0.063**	0.064**	0.084*	0.079*	0.033**	0.035**
	(0.030)	(0.029)	(0.047)	(0.047)	(0.017)	(0.017)
TA	-0.000	0.000	0.005	0.005	0.000	0.001
	(0.004)	(0.004)	(0.004)	(0.004)	(0.002)	(0.002)
TAX	0.000	-0.002	-0.015	-0.016	0.005	0.004
	(0.028)	(0.028)	(0.041)	(0.042)	(0.018)	(0.017)
AGE	0.001	0.002	0.004	0.002	-0.001	-0.000
	(0.014)	(0.014)	(0.022)	(0.022)	(0.007)	(0.007)
Past FCDEV	0.816***	0.770***	1.265***	1.279***	1.638***	1.675***
	(0.076)	(0.075)	(0.191)	(0.194)	(0.274)	(0.276)
FCDEV-Sell					0.110*	0.095
					(0.066)	(0.067)
FCDEV-Buy			2.459***	2.321***		
			(0.667)	(0.670)		
OPTION			-0.216	-0.155	0.269***	0.263**
			(0.472)	(0.453)	(0.103)	(0.104)
SWAP			0.255	0.255	-0.036	-0.041
			(0.561)	(0.573)	(0.204)	(0.206)
Constant	-1.436***	-1.473***	-1.345***	-1.270***	-0.381***	-0.401***
	(0.161)	(0.160)	(0.251)	(0.248)	(0.085)	(0.086)
YEAR, IND dummy	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	1,731	1,731	1,731	1,731	1,731	1,731
LR Chi-squared	373.94***	392.17***	169.98***	166.74***	185.23***	182.49***

Table 5. 2SLS regression results on the effects of currency derivatives on firm risk

The table reports 2nd stage regression results of accounting-based risk measures of *ROEVOL* and *ROAVOL* in Panel A and market-based risk measures of *QVOL* and *IQVOL* in Panel B as dependent variables. In the 1st stage, $FCDEV_{t+1}$ is estimated using $FCDEV_t$ as instrument variable and other variables as control variables. *EXED* is an indicator variable with a value of 1 for firms whose expected exchange rate exposure (EXE) is greater than its median value and 0 otherwise. See Table 1 for definitions and measurements of other variables. Firm-clustered standard errors are in parentheses. ***, ***, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Accounting-based volatility

Variables	$ROEVOL_{t+1}$				$ROAVOL_{t+1}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$FCDEV_{t+1}$	0.771	4.928**			0.346	3.126**		
	(0.568)	(2.183)			(0.448)	(1.571)		
$FCDEV_{t+1}$ x $EXED_t$		-4.792**				-3.224**		
		(2.129)				(1.517)		
$FCDEV\text{-}Sell_{t+1}$			-0.464	2.607**			-0.899	2.171*
			(0.708)	(1.171)			(0.630)	(1.220)
$FCDEV\text{-}Sell_{t+1}$ x $EXED_t$				-4.031***				-4.100***
				(1.521)				(1.487)
$FCDEV\text{-}Buy_{t+1}$			-2.353	3.849			0.006	5.107
			(4.972)	(10.572)			(4.361)	(8.602)
$FCDEV\text{-}Buy_{t+1}$ x $EXED_t$				-6.669				-5.261
				(11.204)				(9.366)
$EXED_t$		0.450***		0.270**		0.393***		0.311***
		(0.163)		(0.123)		(0.138)		(0.112)
$FSIZE_t$	-0.088**	-0.083**	-0.059*	-0.054*	-0.071**	-0.067**	-0.049*	-0.045
	(0.035)	(0.033)	(0.030)	(0.029)	(0.031)	(0.029)	(0.029)	(0.028)
MB_t	0.156**	0.174**	0.207***	0.231***	0.133**	0.149***	0.174***	0.200***
	(0.068)	(0.068)	(0.067)	(0.068)	(0.053)	(0.052)	(0.053)	(0.055)
$EBITDA_t$	-1.610*	-1.488*	-1.976**	-1.852**	-1.147	-1.038	-1.479*	-1.327*
	(0.842)	(0.884)	(0.793)	(0.791)	(0.819)	(0.834)	(0.765)	(0.759)
$DIVER_t$	-0.159	-0.199*	-0.128	-0.140	-0.153	-0.188*	-0.126	-0.143
	(0.113)	(0.111)	(0.111)	(0.109)	(0.104)	(0.100)	(0.100)	(0.097)
LEV_t	1.655***	1.581***	1.686***	1.666***	-0.301	-0.369	-0.332	-0.364
	(0.328)	(0.339)	(0.315)	(0.314)	(0.291)	(0.296)	(0.283)	(0.281)
$BETA_t$	0.217*	0.209	0.278**	0.291**	0.253**	0.239**	0.318***	0.331***
	(0.131)	(0.131)	(0.129)	(0.128)	(0.122)	(0.120)	(0.122)	(0.121)
$OPTION_t$			2.858***	2.833***			2.256***	2.228***
			(0.598)	(0.597)			(0.495)	(0.493)
$SWAP_t$			-1.299	-0.559			-0.875	-0.027
			(1.257)	(1.271)			(1.093)	(1.079)
constant	-2.272***	-2.647***	-3.023***	-3.340***	-2.406***	-2.694***	-2.953***	-3.277***
	(0.678)	(0.659)	(0.589)	(0.579)	(0.604)	(0.592)	(0.573)	(0.569)
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	886	886	886	886	886	886	886	886
Adjusted R-squared	0.130	0.069	0.199	0.199	0.057	0.029	0.098	0.095
F-value (in 1st. stage)	9.20***	9.49***	6.44***	6.03***	9.20***	9.49***	6.44***	6.03***
Wald chi-squared	1565.52***	1758.67***	2105.44***	2196.60***	815.90***	873.90***	1056.05***	1070.97***

Panel B. Market-based volatility

Variables	$QVOL_{t+1}$				$IQVOL_{t+1}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$FCDEV_{t+1}$	0.239	0.638			0.305	0.686		
	(0.218)	(0.749)			(0.256)	(0.805)		
$FCDEV_{t+1}$ x $EXED_t$		-0.460				-0.489		
		(0.735)				(0.821)		
$FCDEV\text{-}Sell_{t+1}$			1.047**	1.556**			0.696*	1.229***
			(0.504)	(0.704)			(0.376)	(0.423)
$FCDEV\text{-}Sell_{t+1}$ x $EXED_t$				-0.758				-0.880
				(0.857)				(0.594)
$FCDEV\text{-}Buy_{t+1}$			1.239	-1.611			0.129	-2.610
			(2.761)	(5.753)			(3.038)	(6.096)
$FCDEV\text{-}Buy_{t+1}$ x $EXED_t$				3.794				3.667
				(6.055)				(6.956)
$EXED_t$		0.040		-0.006		0.159*		0.101
		(0.080)		(0.069)		(0.094)		(0.080)
$FSIZE_t$	0.013	0.013	0.011	0.010	-0.061***	-0.059***	-0.053**	-0.053**
	(0.017)	(0.017)	(0.017)	(0.017)	(0.022)	(0.022)	(0.023)	(0.022)
MB_t	0.431***	0.433***	0.411***	0.412***	0.362***	0.371***	0.354***	0.362***
	(0.031)	(0.030)	(0.034)	(0.034)	(0.033)	(0.033)	(0.037)	(0.036)
$EBITDA_t$	0.528	0.538	0.633	0.694	0.222	0.261	0.261	0.325
	(0.444)	(0.449)	(0.463)	(0.471)	(0.576)	(0.565)	(0.587)	(0.576)
$DIVER_t$	0.092	0.089	0.090	0.086	0.097	0.082	0.104	0.088
	(0.070)	(0.072)	(0.076)	(0.076)	(0.081)	(0.082)	(0.082)	(0.083)
LEV_t	-1.140***	-1.147***	-1.164***	-1.164***	-0.975***	-1.005***	-0.964***	-0.988***
	(0.162)	(0.162)	(0.163)	(0.162)	(0.184)	(0.185)	(0.184)	(0.185)
$BETA_t$	0.446***	0.445***	0.391***	0.400***	0.250***	0.225**	0.189**	0.188**
	(0.087)	(0.088)	(0.089)	(0.090)	(0.095)	(0.093)	(0.093)	(0.092)
$OPTION_t$			0.143	0.141			0.623**	0.592**
			(0.339)	(0.337)			(0.284)	(0.278)
$SWAP_t$			0.275	0.227			-1.014	-0.746
			(0.617)	(0.613)			(0.779)	(0.803)
Constant	-3.015***	-3.050***	-2.885***	-2.880***	-1.343***	-1.458***	-1.436***	-1.509***
	(0.354)	(0.356)	(0.365)	(0.369)	(0.439)	(0.441)	(0.458)	(0.450)
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	886	886	886	886	877	877	877	877
Adjusted R-squared	0.409	0.407	0.391	0.389	0.200	0.205	0.196	0.202
F-value (in 1st. stage)	9.20***	9.49***	6.44***	6.03***	18.27***	17.41***	10.01***	8.28***
Wald chi-squared	710.97***	723.23***	639.84***	686.17***	217.32***	236.27***	219.58***	253.45***

Table 6. 2SLS regression results on the effects of currency derivatives on firm performance

The table reports 2nd stage regression results of accounting-based performance measures of *ROE* and *ROA* in Panel A and market-based performance measures of *Q* and *IQ* in Panel B as dependent variables. In the 1st stage, $FCDEV_{t+1}$ is estimated using $FCDEV_t$ as instrument variable and other variables as control variables. *EXED* is an indicator variable with a value of 1 for firms whose expected exchange rate exposure (EXE) is greater than its median value and 0 otherwise. See Table 1 for definitions and measurements of other variables. Firm-clustered standard errors are in parentheses. ***, ***, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Accounting-based performance

Variables	ROE_{t+1}				ROA_{t+1}			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$FCDEV_{t+1}$	-0.080	-1.736			-0.012	-0.119		
	(0.171)	(1.571)			(0.023)	(0.086)		
$FCDEV_{t+1}$ x $EXED_t$		1.886				0.122		
		(1.621)				(0.090)		
$FCDEV\text{-}Sell_{t+1}$			0.215	0.078			0.024	0.030
			(0.153)	(0.165)			(0.039)	(0.057)
$FCDEV\text{-}Sell_{t+1}$ x $EXED_t$				0.165				-0.005
				(0.199)				(0.068)
$FCDEV\text{-}Buy_{t+1}$			1.778**	2.642			0.311	0.555
			(0.787)	(2.844)			(0.224)	(0.682)
$FCDEV\text{-}Buy_{t+1}$ x $EXED_t$				-1.099				-0.300
				(3.019)				(0.668)
$EXED_t$		-0.075		0.051		-0.001		0.006
		(0.072)		(0.051)		(0.006)		(0.006)
$FSIZE_t$	0.016**	0.013*	-0.003	-0.004	0.003	0.003	0.000	0.000
	(0.008)	(0.007)	(0.006)	(0.007)	(0.002)	(0.002)	(0.002)	(0.002)
$EBITDA_t$	0.777***	0.772**	0.823***	0.838***	0.360***	0.362***	0.365***	0.366***
	(0.253)	(0.301)	(0.261)	(0.270)	(0.065)	(0.067)	(0.065)	(0.068)
SG_t	-0.016	-0.035	-0.017	-0.024	-0.008	-0.010	-0.009	-0.010
	(0.045)	(0.061)	(0.044)	(0.049)	(0.008)	(0.008)	(0.008)	(0.008)
RND_t	0.541	0.810	0.902	0.901	0.205	0.226	0.272*	0.279*
	(0.550)	(0.775)	(0.678)	(0.696)	(0.155)	(0.155)	(0.145)	(0.144)
LEV_t	-0.218**	-0.217*	-0.228**	-0.235**	-0.059***	-0.059***	-0.060***	-0.060***
	(0.110)	(0.117)	(0.109)	(0.111)	(0.015)	(0.016)	(0.015)	(0.015)
AGE_t	0.017	0.019	0.020	0.019	0.002	0.002	0.002	0.002
	(0.029)	(0.029)	(0.028)	(0.028)	(0.003)	(0.003)	(0.003)	(0.003)
FOR_t	-0.005	-0.026	0.067	0.079	0.033	0.032	0.044**	0.046**
	(0.094)	(0.108)	(0.089)	(0.100)	(0.021)	(0.021)	(0.020)	(0.020)
OWN_t	0.038	-0.015	0.012	0.003	0.025*	0.022	0.022*	0.021
	(0.075)	(0.115)	(0.077)	(0.082)	(0.014)	(0.015)	(0.013)	(0.014)
$OPTION_t$			-0.867*	-0.870*			-0.117**	-0.118**
			(0.486)	(0.485)			(0.046)	(0.046)
$SWAP_t$			0.236	0.391			-0.032	-0.012
			(0.212)	(0.283)			(0.065)	(0.066)
Constant	-0.316**	-0.176	0.074	0.070	-0.047	-0.039	0.008	0.006
	(0.140)	(0.204)	(0.209)	(0.194)	(0.040)	(0.042)	(0.038)	(0.037)
YEAR, IND dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	886	886	886	886	886	886	886	886
Adjusted R-squared	0.022	0.027	0.065	0.066	0.208	0.204	0.224	0.226
F-value (in 1st. stage)	8.65***	8.86***	6.49***	6.00***	8.65***	8.86***	6.49***	6.00***

Wald chi-squared	216.73***	182.25***	527.58***	704.21***	1772.50***	1640.22***	2879.78***	3929.94***

Panel B. Market-based performance

Variables	Q_{t+1}				IQ_{t+1}			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$FCDEV_{t+1}$	0.358***	1.038**			0.139*	0.938**		
	(0.118)	(0.459)			(0.130)	(0.453)		
$FCDEV_{t+1}$ x $EXED_t$		-0.771*				-0.907*		
		(0.490)				(0.468)		
$FCDEV\text{-}Sell_{t+1}$			0.548**	0.664*			0.132	0.604
			(0.263)	(0.361)			(0.316)	(0.395)
$FCDEV\text{-}Sell_{t+1}$ x $EXED_t$				-0.182				-0.643
				(0.431)				(0.463)
$FCDEV\text{-}Buy_{t+1}$			1.509	-0.732			1.006	-1.046
			(1.619)	(3.000)			(1.939)	(3.279)
$FCDEV\text{-}Buy_{t+1}$ x $EXED_t$				2.825				2.722
				(2.991)				(3.378)
$EXED_t$		0.017		-0.053		0.009		-0.048
		(0.052)		(0.045)		(0.049)		(0.042)
$FSIZE_t$	0.058***	0.060***	0.053***	0.054***	0.056***	0.058***	0.055***	0.057***
	(0.013)	(0.014)	(0.013)	(0.013)	(0.014)	(0.014)	(0.014)	(0.013)
$EBITDA_t$	1.827***	1.820***	1.852***	1.859***	1.493***	1.477***	1.491***	1.514***
	(0.357)	(0.362)	(0.357)	(0.361)	(0.314)	(0.327)	(0.317)	(0.323)
SG_t	0.030	0.040	0.026	0.032	-0.014	-0.001	-0.013	-0.006
	(0.049)	(0.049)	(0.048)	(0.048)	(0.039)	(0.038)	(0.038)	(0.039)
RND_t	5.389**	5.267**	5.480***	5.446***	6.253***	6.101***	6.169***	6.184***
	(2.105)	(2.119)	(2.122)	(2.071)	(1.833)	(1.825)	(1.836)	(1.801)
LEV_t	0.347***	0.348***	0.345**	0.348***	0.330***	0.333***	0.311***	0.319***
	(0.128)	(0.128)	(0.134)	(0.131)	(0.115)	(0.115)	(0.120)	(0.116)
AGE_t	-0.021	-0.021	-0.017	-0.017	-0.006	-0.006	-0.007	-0.008
	(0.025)	(0.026)	(0.025)	(0.024)	(0.026)	(0.026)	(0.027)	(0.026)
FOR_t	0.211	0.217	0.247	0.227	0.102	0.108	0.107	0.085
	(0.154)	(0.156)	(0.151)	(0.152)	(0.152)	(0.152)	(0.149)	(0.150)
OWN_t	-0.148	-0.126	-0.154	-0.143	0.026	0.053	0.017	0.030
	(0.135)	(0.137)	(0.136)	(0.135)	(0.125)	(0.126)	(0.128)	(0.127)
$OPTION_t$			0.156	0.161			0.200	0.204*
			(0.115)	(0.115)			(0.122)	(0.120)
$SWAP_t$			0.102	-0.067			0.444	0.282
			(0.514)	(0.526)			(0.470)	(0.483)
constant	-0.328	-0.383	-0.227	-0.216	-1.413***	-1.477***	-1.392***	-1.407***
	(0.290)	(0.295)	(0.291)	(0.287)	(0.300)	(0.303)	(0.299)	(0.294)
YEAR, IND dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	886	886	886	886	886	886	886	886
Adjusted R-squared	0.362	0.355	0.351	0.350	0.253	0.245	0.252	0.252
F-value (in 1st. stage)	8.65***	8.86***	6.49***	6.00***	8.65***	8.86***	6.49***	6.00***
Wald chi-squared	1669.26***	2599.58***	2840.39***	1703.13***	1853.90***	3434.30***	4702.70***	4638.72***

Table 7. Robustness test for the effect of currency derivatives use on risk-adjusted performance

The table reports 2nd stage regression results of accounting-based risk-adjusted performance measures of *ROE/ROEVOL* and *ROA/ROAVOL* in Panel A and market-based risk-adjusted performance measures of *Q/QVOL* and *IQ/IQVOL* in Panel B. In the 1st stage, $FCDEV_{t+1}$, $FCDEV\text{-}Sell_{t+1}$, and $FCDEV\text{-}Buy_{t+1}$ are estimated using $FCDEV_t$, $FCDEV\text{-}Sell_t$, and $FCDEV\text{-}Buy_t$, respectively, as instrument variable and other variables as control variables. *EXED* is an indicator variable with a value of 1 for firms whose expected exchange rate exposure (EXE) is greater than its median value and 0 otherwise. See Table 1 for definitions and measurements of other variables. Firm-clustered standard errors are in parentheses. ***, ***, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Accounting-based risk-adjusted performance

Variables	*(ROE / ROEVOL)* $_{t+1}$				*(ROA / ROAVOL)* $_{t+1}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$FCDEV_{t+1}$	-0.090	-1.426			0.007	0.059		
	(0.201)	(1.044)			(0.012)	(0.044)		
$FCDEV_{t+1}$ x $EXED_t$		1.526				-0.059		
		(1.098)				(0.045)		
$FCDEV\text{-}Sell_{t+1}$			-0.080	0.018			-0.008	-0.021
			(0.193)	(0.155)			(0.017)	(0.024)
$FCDEV\text{-}Sell_{t+1}$ x $EXED_t$				-0.153				0.017
				(0.279)				(0.026)
$FCDEV\text{-}Buy_{t+1}$			-0.585	0.416			-0.077	-0.157
			(1.581)	(3.161)			(0.097)	(0.310)
$FCDEV\text{-}Buy_{t+1}$ x $EXED_t$				-1.191				0.094
				(2.670)				(0.308)
Other control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
YEAR, IND dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	886	886	886	886	886	886	886	886
Adjusted R-squared	0.010	0.021	0.012	0.013	0.094	0.087	0.107	0.110
F-value (in 1st. stage)	8.05***	8.32***	5.46***	5.19***	8.05***	8.32***	5.46***	5.19***
Wald chi-squared	40.36***	34.94***	39.52***	47.79***	705.72***	625.86***	1102.93***	1570.84***

Panel B. Market-based risk-adjusted performance

Variables	*(Q / QVOL)* $_{t+1}$				*(IQ / IQVOL)* $_{t+1}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$FCDEV_{t+1}$	0.092	1.918			0.310**	1.341		
	(0.718)	(2.136)			(0.172)	(0.931)		
$FCDEV_{t+1}$ x $EXED_t$		-2.285				-1.189		
		(2.065)				(0.980)		
$FCDEV\text{-}Sell_{t+1}$			-1.125	-1.983			0.017	-0.282
			(1.712)	(1.521)			(0.331)	(0.337)
$FCDEV\text{-}Sell_{t+1}$ x $EXED_t$				2.342				0.584
				(1.975)				(0.484)
$FCDEV\text{-}Buy_{t+1}$			4.917	40.470			1.201	9.123
			(10.249)	(35.052)			(2.311)	(5.932)
$FCDEV\text{-}Buy_{t+1}$ x $EXED_t$				-45.226				-10.058
				(36.383)				(6.590)
Other control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
YEAR, IND dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	886	886	886	886	877	877	877	877
Adjusted R-squared	0.074	0.069	0.069	0.056	0.159	0.146	0.160	0.157
F-value (in 1st. stage)	8.05***	8.32***	5.46***	5.19***	8.09***	8.33***	5.46***	5.18***
Wald chi-squared	184.13***	203.77***	101.58***	91.46***	201.07***	185.09***	179.31***	179.10***