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Determinants of Hedging and their Impact on Firm Value and Risk: After Controlling for Endogeneity Using a Two-stage Analysis*

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Abstract

Purpose – In this study, we investigate determinants of hedging with derivatives and its effect on firm value and firm risk for Korean firms.

Design/methodology – To avoid the endogeneity problem pointed out in previous studies, we use a two-stage analysis by using gains and losses from derivatives as instrument variable for hedging with derivatives.

Findings – Our analysis on the determinants of hedging shows that firms that are more leveraged and less profitable, and with more growth opportunities are likely to hedge through derivatives. Additionally, large firms, firms less diversified into industry, and firms more diversified geographically are likely to use derivatives. Our two-stage analysis shows that indicators of hedging with derivatives have an insignificant effect on firm value, and the indicator of futures/forwards use and of swaps use have significant negative effect on firm value. Whereas, the extent of hedging with derivatives has positive effect on firm value for all types of foreign currency derivatives, which suggests that moderately low hedgers use derivatives inefficiently, but extensive hedgers use derivatives properly. With regard to firm risk, hedging with derivatives increases market-based risk, but decreases accounting-based risk. Thus, we conclude that Korean firms use derivatives to manage operational volatility rather than to manage market risk, and accounting-based risk reduction through hedging is not directly translated into higher firm value.

Originality/value – This is not the first study to investigate hedging behavior of Korean firms, but the sample period that that this study analyzed is the longest and various method are used to control the endogeneity problem. We investigate not only total foreign currency derivatives but also by types of derivatives, including futures/forwards, options, and swaps.

Keywords: Corporate Finance, Derivatives, Hedging, Risk Management, Two-stage Analysis Model
JEL Classifications: C36, G14, G32

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1. Introduction

The derivatives market in Korea had been one of the biggest derivatives markets in the world. In 2011, the trading of derivatives in the Korea Exchange had been bigger than that of any other derivatives markets in the world and accounted for 17% of total trading. But since then, it has dramatically decreased and the trading in 2017 was 1/3 of the trading in 2011. Given the unprecedented change in the derivatives market in Korea, in this study, we aim to investigate the determinants of hedging with derivatives and its impact on firm value and firm risk in Korea. If hedging behavior of Korean firms does not increase firm value or reduce firm risk, then the downslide of the Korean derivatives market could be partially due to the inefficient use of derivatives by Korean firms.

According to classical financial theory, a firm's financial decisions do not alter the value of the firm because individual investors can hedge themselves using a homemade portfolio (Modigliani and Miller, 1958). However, there are some drawbacks of the Modigliani and Miller model in a real market, such as bankruptcy costs and underinvestment. Thus, many empirical studies show that there is a hedging premium that ranges from 1% to 10% of firm value (Adam and Fernando, 2006; Allayannis and Weston, 2001; Carter, Rogers and Simkins, 2006; Graham and Rogers, 2002; Nelson, Moffitt and Affleck-Graves, 2005). But recently, many researchers suggest that the hedging premium might disappear after controlling for endogeneity. For example, Bartram, Brown and Conrad (2011) use a propensity score matching technique to control the endogeneity problem, and they demonstrat that the effect of derivatives use on firm value is slightly positive but insignificant. Magee (2013) also use a dynamic panel estimator to control for unobservable firm specific factors, and found that foreign currency hedging no longer affects firm value.

In this study, we plan to use a two-stage analysis using the sum of the absolute value of gain and absolute value of loss as an instrument variable to control for the endogeneity problem between hedging and firm value. If firms use derivatives properly, then the gains and losses from derivatives is offset by gains and losses from underlying assets, and should not affect firm value and firm risk. Therefore, this variable is exogenous with firm value and firm risk. Moreover, the gains and losses from derivatives clearly explain the hedging behavior of firms. Therefore, we think that this variable is the proper instrument variable.

The two-stage analysis result shows that the indicator of hedging with derivatives has insignificant effect on value of firms or has significantly negative effect on the value for futures/forwards and swaps, which suggests that the decision to use derivatives is slightly detrimental to firm value. Whereas, extent of hedging with derivatives has significantly positive effect on firm value for all types of foreign currency derivatives. The opposite effects between indicator and extent suggest that moderately low hedgers use derivatives inappropriately while extensive hedgers use derivatives correctly to increase firm value. Our robustness test confirms this hypothesis. With respect to firm risk, hedging with derivatives has different effects for market-based risk and accounting-based risk. Both the indicator and the extent increase market risk of firms. Whereas, hedging with derivatives decreases accounting-based risk. Thus, we can conclude that Korean firms tend to use derivatives to manage operational volatility rather than to manage market risk, and accounting-based risk reduction through derivatives cannot be directly translated into higher firm value. We confirm these results by using two alternative tests; propensity score matching and test for new-hedgers and non-hedgers.

This is not the first study to investigate hedging behavior of Korean firms, but the sample period that that this study analyzed is the longest and various method are used to control the endogeneity problem. We investigate not only total foreign currency derivatives but also by

types of derivatives, including futures/forwards, options, and swaps.

The rest of the paper is organized as follows. In Section 2, we review the related literature on hedging and firm value or firm risk. Section 3 describes the variables and methodology used in this study and the empirical results are presented in Section 4. Section 5 concludes the paper.

2. Literature Review

In a perfect market, individual investors can make a homemade portfolio to diversify their risk, and, corporate decision of firms such as leveraging or hedging does not change firm value (Modigliani and Miller, 1958). However, real financial markets are imperfect and there are some frictions, such as financial distress costs, agency problems, or information asymmetry. Therefore, extant researches have suggested that firms should use derivatives for several reasons. For example, hedging could increase firm value by reducing the volatility of future cash flows, thereby reducing the probability of bankruptcy (Smith and Stulz, 1985). Hedging can also reduce financial distress costs by minimizing opportunistic behavior of shareholders towards bondholders (Mayers and Smith, 1987). Berkman and Bradbury (1996) investigate the factors affecting derivatives use and find that there is a strong positive relationship between leverage ratio and hedging. Many other studies also empirically support this finding in a variety of research contexts in different nations (Bartram, Brown and Fehle, 2009; Ertugrul, Sezer and Sirmans, 2008; Haushalter, 2000; Nguyen and Faff, 2002). The ratio of fixed assets to total assets is also related to bankruptcy cost. Firms with more fixed assets are more exposed to bankruptcy cost and thus, hedging becomes more valuable for these firms (Nance, Smith and Smithson, 1993).

Agency problem between shareholders and bondholders is another reason for firms to use derivatives. In the presence of agency problem, shareholders might forgo positive net present value projects if the gains accrue to bondholders primarily (Mayers and Smith, 1987; Myers, 1977), and thus, the firms would end up incurring a loss. This is called the problem of underinvestment. Hedging reduces the possibility of underinvestment by restricting the state to which the firm may default. Thus, firms with more growth opportunities are more likely to hedge with derivatives. Gay and Nam (1998), Guay (1999) and Nance, Smith and Smithson (1993) use a book-to-market ratio as a proxy for underinvestment problem and demonstrate that book-to-market ratio negatively affects hedge ratio. R&D expenditure is another proxy for growth opportunities and there is a positive relationship between R&D and hedging (Dolde, 1995; Gay and Nam; 1998; Geczy, Minton and Schrand, 1997; Nance, Smith and Smithson, 1993). The tax structure also affects hedging behavior. If a firm's tax function is convex, then expected tax would decrease by hedging. The more convex the tax function, the greater tax reduction there is. Hence, firms with convex tax function have more incentive to hedge with derivatives (Graham and Smith, 1999; Mayers and Smith, 1987; Mian, 1996; Nance, Smith and Smithson, 1993; Smith and Stulz, 1985). Dividend-paying firms have also an incentive to hedge, because investors want smooth dividends and thus, dividend-paying firms need to reduce future cash volatility to maintain the dividend payout ratio (Barton, 2001; Choi, Mao and Upadhyay, 2015).

Management incentive is another factor that affects the decision to hedge. If the cash compensation or stock holding of managers is high, then firms are more likely to use derivatives to stabilize their compensation because compensation is linked to firm value (Batram, Brown and Fehle, 2009; Berkman and Bradbury, 1996; Ertugrul, Sezer and Sirmans, 2008; Smith and Stulz; 1985, Stulz, 1984; Tufano, 1996). The availability of substitutes for

hedging also affects derivatives use. For instance, convertible debt reduces the sensitivity of equity value to firm value and preferred stock reduces the probability of default. Therefore, the existence of these substitutes decreases the incentive for hedging with derivatives (Geczy, Minton and Schrand, 1997; Nance, Smith and Smithson, 1993).

Despite the numerous studies about incentives for hedging with derivatives, empirical findings on whether derivatives use really can increase firm value or reduce firm risk are mixed. With respect to firm value, Allayannis and Weston (2001) find that the value of a hedging firm is 4.87% higher than a non-hedger. Graham and Rogers (2002) also claim that hedging increases debt capacity, and thus, a hedging firm's value is 1.1% higher than a non-hedger. Nelson, Moffitt and Affleck-Graves (2005) find that firms using derivatives have 4% more annual abnormal returns than derivatives non-users. Clark and Judge (2009) also suggest that the value generated from foreign currency swaps hedging is significantly higher than comparable foreign currency debt-based hedging strategies. There are other studies that analyze the effect of hedging by industry. Adam and Fernando (2006) analyze the gold mining industry and find that firms generate significant cash flow gains from their derivatives transactions and hedging has positive impact on shareholder value. Carter, Rogers and Simkins (2006) investigate hedging behavior in the airline industry and claim that hedging premium is as large as 10%.

With respect to firm risk, Guay (1999) shows that firm risk, including total risk, firm-specific risk, and market risk, declines with derivatives use. Allayannis and Ofek (2001) argue that firms use derivatives for hedging and firms significantly reduce exchange-rate exposure by using currency derivatives. Huffman and Makar (2004) also find that derivatives are a useful tool for managing risk, especially during short-term. Gay, Lin and Smith (2011) suggest that firms using derivatives have lower cost of equity by about 24-78 basis points than non-using firms. Recently, Batram, Brown and Conrad (2011) analyze firms across 47 countries and find strong evidence that using derivatives is associated with higher firm value, abnormal returns, and larger profits by reducing both total and systematic risk of firms, especially during economic downturn. Alam and Gupta (2018) demonstrate that the use of derivatives reduces volatility of firm's value, and thus, hedging can be value-enhancing during a financial crisis.

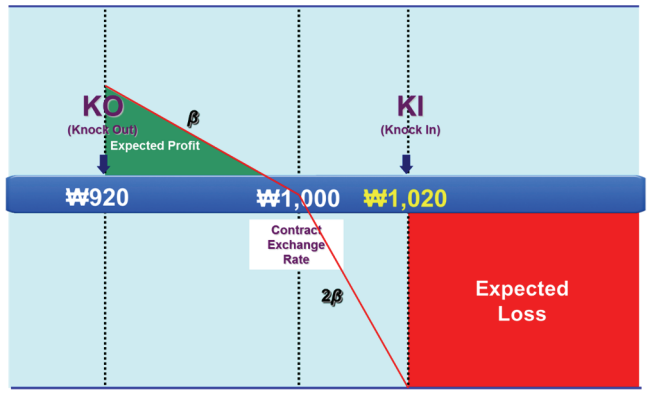
In contrast, Guay and Kothari (2003) are of the opinion that the potential gains from hedging are not very large and thus, are unlikely to generate large changes in firm value. They suggest that the increase in a hedging firm's value could have come from other risk management activities related to hedging activity. Lookman (2004) analyze oil exploration and production industry and find no significant relationship between hedging and firm value. Similarly, Jin and Jorion (2006) investigate oil and gas industry and find that hedging does not affect firm value, although it does reduce stock sensitivity of firms to oil and gas price. Clark, Judge and Mefteh (2006) argue that foreign currency derivatives use is neither a significant determinant of firms' exposure to foreign currency risk nor a significant determinant of firm value in French firms. Bhamra and Uppal (2009) demonstrate that the introduction of derivatives increases the volatility of stock returns. In Fauver and Naranjo (2010), firms with high agency and monitoring problems display a negative correlation between firm value and derivatives use. Hence, they claim that hedging has a negative impact on firm value in firms with high agency and monitoring problems. Belghitar, Clark and Mefteh (2013) and Carter, Pantzalis and Simkins (2003) find that foreign currency derivatives reduce overall currency risk exposure, but hedging has no significant effect on firm value. Magee (2013) argue that hedging and firm value are endogenously related and hedging premium disappears after controlling for endogeneity problem. Panaretou (2014) evaluates the effect of hedging on firm value using a sample from the UK firms, and find that only

foreign currency derivatives have significant effect on firm value, whereas interest rate hedging has insignificant effect.

To sum up, as illustrated above, the question of whether derivatives use has any impact on firm risk and value remains inconclusive. Moreover, most of the aforementioned studies have focused on the US firms for whom foreign exchange risk is smaller than for firms from emerging markets. Prevost, Rose and Miller (2000) argue that small-economy countries that depend on imports and exports, like New Zealand, have different characteristics with respect to hedging. Hagelin (2003) investigate hedging by Swedish firms and find different pattern of derivatives use. Clark, Judge and Mefteh (2006) find that French firms use derivatives for different purposes than US firms, and Nguyen, Faff and Marshall (2007) also show that French firms use derivatives less intensively after the introduction of the Euro. Bae, Kim and Kwon (2018) demonstrate that use of currency derivatives does not lead to lower firm risk. In case of Malaysia, Ameer (2009) finds that the effect of hedging with derivatives on firms' value is very minimal compared to other countries. Thus, we find that when examining the effect of hedging with derivatives on firm value, it is necessary to take the local context into account.

Given the inconsistent empirical findings and the need to understand diverse contexts, we attempt, in this study, to analyze the motives for using derivatives and the effect of derivatives use on firm value and firm risk in Korean firms. The derivatives market in Korea had been one of the biggest derivatives markets in the world, but it has sharply decreased since 2011. One of the main reason for this downfall is the KIKO (knock-in and knock-out) incident in 2008. KIKO options are kind of currency derivatives which enable firms to sell dollars at a fixed rate if the exchange rate stays within the range set in the contract. If the exchange rate moves out of the range, however, firms may sustain huge losses with buying dollars on the foreign exchange market as expensive rate and selling them to the banks at low rate. Fig. 1 shows the structure of KIKO and how firms using KIKO suffer losses (Willett et al., 2011).

Fig. 1. Knock-In Knock-Out (KIKO)



Note: This diagram shows the structure of KIKO and how firms with using KIKO suffer losses in case of contracted exchange rate for won/dollar at ₩1,000 and double leverage KIKO. If the exchange rate stays within the range between ₩920 and ₩1,000, then firms gain a fixed profit. If the exchange rate drops to bellow ₩920, this contract will give loss to firms. More seriously, if the exchange rate is over ₩1,020, then firm must buy dollars at expensive rate (₩1,360 on 1/11/2009) from the foreign exchange market and sell them to the banks at contracted cheap price (₩1,000).

Source: Willett et al. (2011).

In 2008, won/dollar exchange rate were unexpectedly weekend with Global financial crisis, and it causes small firms using KIKO into crisis. Lots of the small firms declared "the black-ink balance bankruptcy" because of the KIKO contract, and after then, the size of Korean derivatives market has decreased. Therefore, investigating on Korean derivatives market give interesting insight about hedging behavior.

Recent studies emphasize the existence of endogeneity problem between firm value and hedging (Batram, Brown and Conard, 2011; Magee, 2013) in particular and thus, controlling endogeneity is very important for a study on hedging. Therefore, we intend to pay attention to the endogeneity between use of derivatives and firm value by using a two-stage analysis.

3. Variables and Methodology

Our sample consists of all manufacturing firms in Korea from 2005 to 2014. Next, we exclude firms that have experienced issues with administration at least once during the sample period because these firms do not meet the criteria for securities listing or disclosure standards. We collect derivatives use data from the footnotes of annual reports for each firm and each year. Data for overseas subsidiaries are also taken from annual reports. Other accounting data are sourced from FnGuide database. Our final sample consists of 337 firms and 3,047 firm-year data. The details of the variables are as follows.

3.1. Hedging Variable

To evaluate risk management policy of firms through derivatives, it is necessary to measure the extent to which firms hedge with derivatives. The best measure for this is the ratio of the derivatives position to the amount of risk exposure that the firm is trying to hedge (Tufano, 1996). However, in reality, it is very difficult to calculate the level of a firm's risk exposure because most firms do not disclose enough information to measure it and only disclose a notional amount of derivatives in the footnotes of annual reports. Notional amount of derivatives use has some limitations. It does not indicate the direction of the transaction, and thus, there is no information on whether firms are in short position or in long position for using derivatives. Moreover, if a firm has a two-way offset position using derivatives, it might have many derivatives in this notional amount, but in reality, the firm is not exposed to any risk. Hence, the notional amount of derivatives is usually much higher than its fair value. Nonetheless, it is a viable measure of hedging with derivatives because it represents the basis for calculating the amounts exchanged by the parties for the derivatives and the amount that is exposed to fluctuations in the underlying value. Therefore, many prior researches use the notional amount of derivatives as a measure of hedging (Allayannis and Ofek, 2001; Barton, 2001; Choi, Mao and Upadhyay, 2015; Ertugrul, Sezer and Sirmans, 2008; Haushalter, 2000; Panaretou, 2014). Similar to these studies, we collect notional amount of foreign currency derivatives of firms from the footnotes of annual reports from 2005 through 2014.[1] Additionally, we segregate foreign currency derivatives into forwards/futures, options, and swaps to examine whether the effects are different depending on the type of derivatives. In case of commodity derivatives, some firms report only contract quantity, not the notional value of the contract, and the user ratio of commodity derivatives is negligible (1% before year 2010 and 3% on average). Further, only few firms use interest rate derivatives (6% on average) and the extent of hedging with interest derivatives is 1/100 compared to the extent of hedging

[1] There was a change in accounting standards in 2010 and disclosure of derivatives usage for hedging purpose was made optional.

with foreign currency derivatives. Moreover, commodity or interest rate derivatives are used for a different purpose than foreign currency derivatives. Hence, we exclude commodity and interest rate derivatives from our analysis. To measure the extent of rigorous hedging, notional value of derivatives should be divided by foreign sales, but Barton (2001) demonstrate that notional value divided by total assets has significantly high correlation with foreign currency derivatives divided by foreign sales, and argue that notional value divided by total assets does, in fact, capture the basic attributes of hedging with derivatives. Therefore, we use notional value divided by total assets to measure the extent of hedging with derivatives.

Binary variable, which indicates whether a firm uses derivatives or not, is another simple measure of hedging activity. Despite the limitations on interpretation of analysis results, this dummy variable has the advantage of simplifying the measurement and overcoming the limitations of the data, and thus it is widely used for studies on hedging with derivatives (Batram, Brown and Fehle, 2009, Batram, Brown and Conrad, 2011; Nance, Smith and Smithson, 1993; Ngutyen and Faff, 2002; Panaretou, 2014). We also use a binary variable for derivatives use. The definitions of hedging variables are shown in equation (1) and equation (2).

$$\text{Hedging Indicator} = 1 \text{ if the firm uses derivatives, else } 0. \tag{1}$$

$$\text{Hedging Extent} = \frac{\text{Nominal value of derivatives at the end of year}}{\text{Total Assests}}. \tag{2}$$

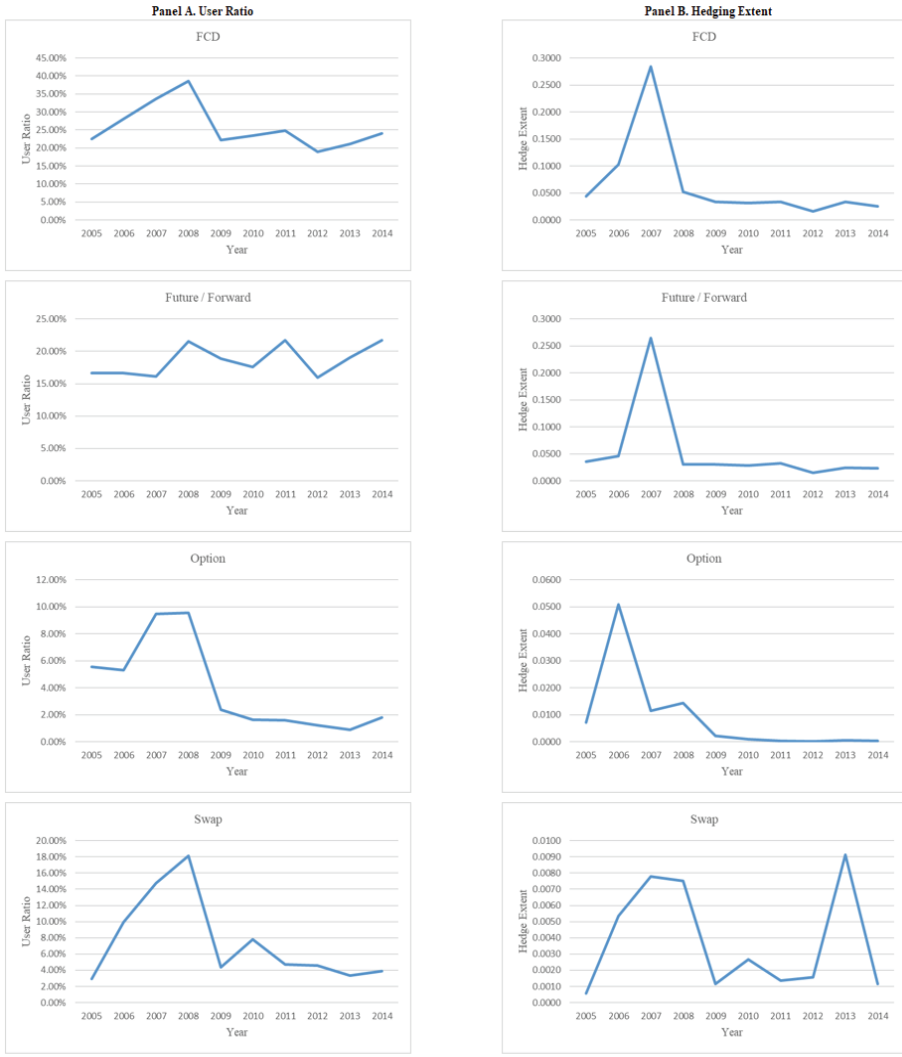
Among 337 firms, 184 firms use derivatives at least once during the sample period (136 firms for futures/forwards, 56 firms for options, and 80 firms for swaps). In each year, 25.57% of the sample firms hedge with foreign currency derivatives, and the average of hedging extent is 0.0632. In case of the US firms, user ratio of foreign currency derivatives is 35% (Allaynannis and Weston, 2001) and mean of hedging extent is 0.049 (Magee, 2013). In case of the UK firms, 71.79% of manufacturing firms use foreign currency derivatives and mean of hedging extent is 0.27 (Panaretou, 2014). It seems as though the hedging behavior of Korean firms is similar to those of the US firms. Detailed information about derivatives use is demonstrated in Table 1 and Fig. 2.

Table 1. Derivatives User Ratio and Extent of Hedging

Year	User Ratio				Hedging Extent			
	FCD	FOR	OPT	SWP	FCD	FOR	OPT	SWP
2005	22.51%	16.61%	5.54%	2.95%	0.0435	0.0359	0.0071	0.0006
2006	28.01%	16.67%	5.32%	9.93%	0.1022	0.0460	0.0509	0.0054
2007	33.68%	16.14%	9.47%	14.74%	0.2839	0.2646	0.0115	0.0078
2008	38.57%	21.50%	9.56%	18.09%	0.0525	0.0306	0.0144	0.0075
2009	22.22%	18.86%	2.36%	4.38%	0.0337	0.0303	0.0022	0.0012
2010	23.45%	17.59%	1.63%	7.82%	0.0321	0.0284	0.0009	0.0027
2011	24.84%	21.70%	1.57%	4.72%	0.0338	0.0321	0.0004	0.0014
2012	19.02%	15.95%	1.23%	4.60%	0.0166	0.0148	0.0002	0.0016
2013	21.15%	19.03%	0.91%	3.32%	0.0338	0.0241	0.0006	0.0091
2014	24.04%	21.66%	1.78%	3.86%	0.0252	0.0238	0.0003	0.0012
Total	25.57%	18.64%	3.77%	7.29%	0.0632	0.0511	0.0083	0.0038

Notes: 1. This table shows derivatives user ratio and average of hedging extent for each year. We collect the nominal amounts for foreign currency derivatives by type from the footnotes of annual reports. User ratio is calculated by number of firms which use derivatives divided by total number of firms and hedging extent is the nominal value of derivatives divided by total assets.
2. FCDs represents foreign currency derivatives, FOR represents futures/forwards, OPT represents options, and SWAP represent swaps.

Fig. 2. Derivatives User Ratio and Extent of Hedging



Notes: 1. This graph shows the user ratio and hedging extent. We collect the nominal amounts of foreign currency derivatives by type from the footnotes of annual reports. User ratio is calculated by number of firms that use derivatives divided by total number of firms and hedging extent is nominal value of derivatives divided by total assets.
2. Panel A shows derivatives user ratio and Panel B shows hedging extent.

Table 1 and Fig. 2 show that Korean firms mainly use futures/forwards as hedging tools. User ratio and hedging extent of options and swaps are significantly lower than those of futures/forwards. Another interesting observation is that both the user ratio and extent of hedging peaked in 2007, and subsequently both sharply decreased, especially in case of options and swaps. This is mainly due to the KIKO (knock-in and knock-out) incident in

2008. In 2007, lots of firms indiscriminately bought KIKO, which is a kind of exchange-rate option. In 2008, the Korean Won to Dollar exchange rate sharply increased due to the global financial crisis and most KIKO users incurred heavy losses, after which Korean firms reduced their use of derivatives and extent of hedging.

3.2. Firm Value and Firm Risk

Tobin's Q is a forward-looking, risk-adjusted, and slightly less susceptible to changes in accounting practices (Wernerfelt and Montgomery, 1988), and therefore, it is widely used to estimate firm value in the analysis of hedging with derivatives (Allayannis and Weston, 2001; Batram, Brown and Conrad, 2011; Clark and Judge, 2009; Clark, Judge and Mefteh, 2006; Fauver and Naranjo, 2010; Jin and Jorion, 2006; Magee; 2013; Panaretou, 2014). For this reason, we also chose to use Tobin's Q as a proxy for firm value, and we follow Chung and Pruitt's (1994) approximation of Tobin's Q because it can be easily calculated from a readily available dataset and there is a high degree of correlation between this simple measure and more rigorous approximations (Chung and Pruitt, 1994; Perfect and Wiles, 1994). Market value of a firm is calculated as the market value of common stock plus the market value of preferred stock and book value of total debt, and we define Tobin's Q as market value divided by total assets as denoted in equation (3).

$$\text{Tobin's Q} = \frac{\text{MV of Common Stock+ MV of Preferred Stock+BV of Debt}}{\text{Total Assets}}. \quad (3)$$

Hirsch and Seaks (1993) argue that the natural logarithm of Tobin's Q gives a better model specification than the raw Tobin's Q. Moreover, in our sample, the median of Tobin's Q is 0.793, which is smaller than the mean of Tobin's Q, which is 0.913, indicating that Tobin's Q is skewed. To control this, we use the natural logarithm of Tobin's Q in our test. Log-transformed Tobin's Q is commonly used in empirical studies (Allayannis and Weston; 2001, Chung and Jo, 1996; Carter, Rogers and Simkins, 2006; Panaretou, 2014). The industry to which a firm belongs has a crucial impact on the firm value as well (Wernerfelt and Montgomer, 1988). In order to isolate this effect, we also use industry-adjusted Tobin's Q calculated by taking the log difference between Tobin's Q of a firm and the median of Tobin's Q for the industry (the firm operates in) each year[2] as given in equation (4).

$$\text{Industry Adjusted Tobin's Q} = \text{Ln(Tobin's Q)} - \text{Ln(median of industry Tobin's Q)}. \quad (4)$$

We separate firm risk into market risk and accounting risk. We measure market risk as the firm's stock beta from CAPM. Specifically, we regress daily stock return of firm *i* in year *t* on daily stock market returns and define the coefficient as beta. For accounting risk, we calculate eight quarter earnings volatility of firm *i* from year *t* to year *t*+1[3].

[2] We divided manufacturing firms into seven industries: IT, material, medical, consumer discretionary goods, industrial material, energy, and essential consumer goods. We followed MKF classification provided by FnGuide. We also calculated adjusted Tobin's Q by taking the difference between firm's Tobin's Q and mean of Tobin's Q for the industry, but there is no significant difference.

[3] Instead, we also measured market risk as daily stock return volatility in year *t* (total risk) and standard deviation of residual from CAPM (firm specific risk). For accounting risk, we alternatively use FFO volatility instead of earnings volatility. The result is similar, so we only reported the result from using beta and earnings volatility. We can attach result from using total risk, firm specific risk, and FFO volatility, on request.

3.3. Control Variables

We use several control variables based on the previous literatures on the determinants of hedging decision and on the effect of hedging on firm value[4]. First, we control the firm's capital structure and financial distress cost because highly distressed firms would have lower value and more incentive to hedge (Batram, Brown and Fehle, 2009). We measure firm's capital structure through leverage ratio, given by total debt divided by shareholder's equity. Profitable firms are usually high-valued because they get better ratings in the market, and their incentive to hedge is low because the bankruptcy probability of profitable firms is low. Thus, we control profitability using profit margin, which is calculated by gross income divided by net sales. If a firm has limited access to financial markets, then firm value could be high since firms take only the high net present value projects, and firms have more incentive to use derivatives because underinvestment problem is high. We measure access to financial markets as dividend dummy, which is assigned the value 1 if the firm pays dividends, else 0. Myers (1977) and Smith and Watts (1992) argue that firm value is influenced by future investment opportunities. And firms with high investment opportunities are more likely to use derivatives because of underinvestment. Therefore, we control for investment opportunities by using capital expenditure divided by net sales. Market-to-book value ratio is another proxy for growth opportunity. Hence, we include market-to-book value ratio as another control variable. Although there is ambiguity in empirical evidence regarding the effect of firm size on Tobin's Q is ambiguous, large firms are more likely to use derivatives because of economies of scale. Thus, we control for size factor by calculating the natural log of market value of shareholder equity. Industrial and geographical diversification also affect firm value and hedging decisions. There is no consensus on effect of industrial diversification on firm value. Several theoretical arguments suggest that industrial diversification increases value (Williamson, 1970; Lewellen, 1971), but there is also substantial empirical evidence that suggests that industrial diversification is negatively related to firm value (Berger and Ofek, 1995; Lang and Stulz, 1994; Servaes, 1996). With regard to hedging behavior, industrial diversification could presumably affect only use of interest-rate derivatives since industrial diversification does not change foreign currency risk. To control for industrial diversification, we calculate Herfindahl index by using firm's sales in each industry sales. We use normalized Herfindahl index to adjust the range of the index from 0 to 1[5]. There is ambiguity regarding the impact of geographical diversification on firm value. Kim, Hwang and Burgers (1989) claim that geographical diversification increases growth rate and stability of ROA, but Geringer, Beamish and Dacosta (1989) demonstrate that the relationship between geographical diversification and firm value is inverse U-shaped. Denis, Denis and Yost (2002) and Kim and Mathur (2008) also demonstrate that geographical diversification reduces firm value because of inefficiency of capital allocation. However, as firms become more geographically diversified, they should use more foreign currency derivatives to manage increased currency risk (Seok et al., 2018). To control for this factor, we use diversification measure of Qian et al. (2010). This measure is defined by inter-regional diversification which

[4] We mainly followed Allaynnis and Weston (2001) and Panaretou (2014) and defined control variables following them.

[5] Detailed calculation of adjusted Herfindahl index is as follows. First, we calculate Herfindahl index as $H = \sum_{i=1}^{N} s_i^2$, where s_i is firm's sales contribution to industry sales i and N denotes number of industries that make up the firm's revenue. Then we adjust this index by $H^* = (H - 1/N)/(1 - 1/N)$ for $N > 1$ and 1 for $N = 1$.

is calculated by inter-continental subsidiary-based entropy indices[6].

There are several factors that influence hedging activity, but firm value directly. To investigate the determinants of hedging, we add some more control variables. First, firms with less cash or tangible assets have incentive to smooth out future cash flows using derivatives to avoid bankruptcy, hence, we use the quick ratio, calculated by the sum of cash and receivables divided by total current liabilities and tangible ratio, defined by total assets minus intangible assets divided by total assets. If the debt maturity of firms is longer, firms have an incentive to use derivatives to hedge long-term risk. We control for this factor by using debt maturity, calculated by long-term debt divided by total debt. Similar to Graham and Smith (1999), we use tax ratio as a control variable to investigate the determinants of hedging. Finally, we include industry and year dummies to control for industry and time effect. Table 2 gives a detailed explanation of the abovementioned control variables.

Table 2. Definitions of Variables

Variable		Definition
Q	Tobin's Q	(MV of common stock + MV of preferred stock + BV of debt) / (Total assets)
Adj. Q	Industry adjusted Q	Tobin's Q - (industry median of Tobin's Q at year t*)*
Beta	Market beta	Beta which is calculated by CAPM model using daily stock and KOSPI return
EVol	Earnings volatility	Standard deviation of EPS for 8 quarters (from year t to year t+1)
LEV	Leverage	(Total debt) / (Market value of shareholder equity)
PM	Profit Margin	(Gross income) / (Net sales)
DIV	Dividend Dummy	Dummy variable with value 1 if the firm pays dividend; else, then 0
CAPEX	Capital Expenditure	(Capital expenditures) / (Net sales)
MTB	MTB	(Stock price at the end of year) / (BPS)
SIZE	Size	Natural log of market value of shareholder equity
Ind. Div	Industrial Diversify	Adjusted Herfindahl index for firm's sales contribution in each industry
Geo. Div	Geographical Diversify	Measure of Qian, Khoury, Peng, and Qian (2010)
QR	Quick Ratio	(Cash + Receivables) / (Total current liabilities)
TR	Tangible Ratio	(Total assets - Intangible assets) / (Total assets)
DM	Debt Maturity	(Long-term debt) / (Total debt)
TAX	Tax ratio	(Corporation Tax) / (Taxable Income)

In Table 3, we present the summary statistics of each variable by non-hedgers and hedgers. Panel A shows the summary statistics of all variables for the total sample. As predicted, firms that use derivatives are more leveraged, less profitable and dividend-paying, have higher investment opportunities, longer debt maturity, and higher tax ratio. In Panel B, we present firm value and firm risk of hedgers and non-hedgers by type of derivatives. Prima facie, it appears that hedging with derivatives reduces firm value by 6.1% for Tobin's Q and 3.4% for adjusted Q. All the futures/forwards, options, and swaps reduce firm value. Further, all types of derivatives increase market risk and swaps increase accounting volatility. Therefore, without considering endogeneity problem, hedging with derivatives seems counterproductive for firm value and firm risk. We test the effect of each control variable on hedging behavior and firm value more elaborately in the next section.

[6] We gathered subsidiary information of firms for each country from annual reports. Detailed calculation of measure of Qian et al. (2001) is as follows. First, we divide the subsidiaries continent-wise: Africa, Asia-, Europe, and America. We define inter-continent diversification *INTER* as $INTER = \sum_{a=1}^{m} P^a \ln(1/P^a)$. Here, P^a is number of subsidiaries in continent *a*.

Table 3. Summary Statistics for Variables

Panel A.

	All Firms			Non-Hedger			Hedger			Difference Test	
	N	mean	med	N	mean	med	N	mean	med	mean	med
Q	3047	-0.209	-0.232	2268	-0.194	-0.220	779	-0.255	-0.251	-3.00***	-1.94**
Adj. Q	3047	0.005	0.000	2268	0.013	0.002	779	-0.020	-0.009	-1.75*	-1.47*
Beta	3047	0.636	0.607	2268	0.587	0.560	779	0.778	0.757	12.07***	11.01***
EVol	3047	0.773	0.239	2268	0.735	0.215	779	0.886	0.293	1.89**	4.20***
LEV	3047	1.263	0.779	2268	1.211	0.697	779	1.416	1.050	3.62***	7.36***
PM	3047	0.200	0.163	2268	0.214	0.169	779	0.161	0.148	-9.82***	-5.51***
DIV	3047	0.780	1.000	2268	0.767	1.000	779	0.816	1.000	2.99***	2.86***
CAPEX	3047	0.077	0.040	2268	0.070	0.038	779	0.095	0.046	2.12**	2.88***
MTB	3047	1.062	0.778	2268	1.061	0.765	779	1.063	0.825	0.05	2.29**
SIZE	3047	11.884	11.476	2268	11.639	11.353	779	12.597	12.089	12.31***	8.02***
Ind. Div	3047	0.367	0.261	2268	0.378	0.279	779	0.334	0.225	-3.49***	-4.10***
Geo. Div	3047	0.138	0.000	2268	0.117	0.000	779	0.197	0.000	5.56***	4.99***
QR	3047	0.977	0.772	2268	1.048	0.812	779	0.768	0.649	-10.48***	-7.17***
TR	3047	0.493	0.496	2268	0.494	0.493	779	0.492	0.503	-0.38	1.05
DM	3047	0.075	0.026	2268	0.065	0.017	779	0.105	0.061	7.76***	9.60***
TAX	3047	0.242	0.218	2268	0.237	0.217	779	0.256	0.223	0.14***	1.55*

Panel B.

	Non-Hedger	Hedger	Difference	
Foreign Currency Derivatives				
Num	2268	779		
Q	-0.194	-0.255	-0.061***	(-3.00)
Adj. Q	0.013	-0.021	-0.034*	(-1.75)
Beta	0.587	0.778	0.192***	(12.07)
Evol	0.735	0.886	0.152*	(1.89)
Futures/Forwards				
Num	2479	568		
Q	-0.198	-0.260	-0.062***	(-2.59)
Adj. Q	0.012	-0.028	-0.041*	(-1.78)
Beta	0.597	0.806	0.209***	(11.98)
Evol	0.774	0.771	-0.003	(-0.03)
Options				
Num	2932	115		
Q	-0.205	-0.319	-0.114***	(-3.15)
Adj. Q	0.008	-0.082	-0.090**	(-2.44)
Beta	0.632	0.736	0.104***	(3.13)
Evol	0.779	0.623	-0.157	(-1.65)
Swaps				
Num	2825	222		
Q	-0.202	-0.308	-0.106***	(-3.15)
Adj. Q	0.009	-0.054	-0.063**	(-1.97)
Beta	0.625	0.774	0.149***	(5.75)
Evol	0.718	1.483	0.766***	(4.34)

Notes: 1. Panel A shows number of observations (N), mean of variables (mean), and median of variables (med). We show t-value for difference of mean and Wilcoxon's z-value for difference of median. We also present univariate difference test results by derivatives types in Panel B.

2. The superscripts *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

3.4. Methodology

Recent studies on hedging and firm value emphasize the existence of endogeneity problem. Bartram, Brown and Conrad (2011) argue that varied results in previous studies on hedging and firm value could mainly be explained by endogeneity, that is, a significant difference in the risk of firms who hedge or not could be due to omitted control variables that determine firm risk and hedging. To control for endogeneity, Bartram, Brown and Conrad (2011) use a propensity score matching technique. As a result, they discover that hedging premium disappears and the effect of derivatives use on firm value is slightly positive but marginal. They demonstrate that the effect of hedging on firm risk is more sensitive to endogeneity and omitted variables. Magee (2013) also find that foreign currency hedging depends on past data on firm value, and thus, is not strictly exogenous. Magee (2013) use dynamic panel estimator to control for unobservable firm-specific factors and find that foreign currency hedging do not affect firm value. Both these studies argue that the effect of hedging on firm value disappears after controlling for endogeneity.

In this study, we use a two-stage analysis to control for endogeneity. We use the sum of absolute value of gain and absolute value of loss from derivatives (*AGLD*) as an instrument variable. Gains and losses from derivatives are not related to firm value because derivatives are used for the purpose of hedging. That means, if a firm gains (losses) from derivatives for hedging, then the firm would lose (gain) from underlying assets also, and thus, hedging will not affect firm value. Moreover, *AGLD* has the highest and most significant regression coefficient in the regression model of explaining hedging with the *t*-value being greater than 3.0 in the first stage. Thus, we regress hedging indicator and hedging extent on control variables, which are known to affect both firm value and hedging, with *AGLD* as the instrument variable. In the first stage of regression, we get a predicted probability of derivatives use and predicted value of extent of hedging with derivatives. We regress firm value on these predicted values and control variables at the second stage. The model for the first stage is shown in equation (5), and the model for the second stage is shown in equation (6). Here, *Hedging* is one of the hedging indicators or the hedging extent defined in the equation (1) and equation (2). *Firm Value* is either Tobin's Q or adjusted Tobin's Q. *Firm Risk* is either beta or earnings volatility. *CONT* is control variables which affect both firm value and hedging, such as leverage, profit margin, dividend dummy, capital expenditure, size, book-to-market ratio, and industrial and geographical diversification. *AGLD* is the sum of absolute value of gains and absolute value of losses from derivatives which is used as the instrument variable. $\widehat{Hedging}$ is the predicted value of *Hedging* from the first stage regression.

$$Hedging_{i,t} = \alpha_1 + \beta_1 * AGLD_{i,t} + \beta_2 * CONT_{i,t} + v_{i,t}. \quad (5)$$

$$(Firm\ Value\ or\ Firm\ Risk)_{i,t} = \alpha_2 + \gamma_1 * \widehat{Hedging}_{i,t} + \beta_3 * CONT_{i,t} + \varepsilon_{i,t}. \quad (6)$$

As a robustness test, we do a propensity score matching test. Specifically, using hedging indicator, we estimate the propensity of firms to use derivatives based on the characteristics of firms, and match hedging firms with non-hedging firms based on this propensity score. Through this propensity score matching test, we directly compare firm value between hedging firms and non-hedging firms after controlling for likelihood of firms to use derivatives.

Table 4. Correlation between Variables

Panel A.	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**	**(15)**	**(16)**
Q	**1.00**															
Adj. Q	**0.94**	**1.00**														
Beta	**0.05**	**0.08**	**1.00**													
EVol	**-0.04**	**-0.03**	0.02	**1.00**												
LEV	**-0.23**	**-0.17**	0.01	**-0.05**	**1.00**											
PM	**0.29**	**0.19**	**-0.09**	**0.05**	**-0.25**	**1.00**										
DIV	**-0.07**	**-0.06**	**-0.04**	**0.10**	**-0.31**	**0.18**	**1.00**									
CAPEX	**0.04**	**0.04**	**0.05**	**0.03**	0.02	**0.08**	**-0.04**	**1.00**								
MTB	**0.70**	**0.65**	**0.09**	0.02	**-0.26**	**0.25**	**-0.05**	**0.08**	**1.00**							
SIZE	**0.33**	**0.30**	**0.22**	**0.29**	**-0.33**	**0.16**	**0.24**	**0.11**	**0.43**	**1.00**						
Ind. Div	**-0.06**	**-0.08**	**-0.04**	**-0.04**	**0.06**	-0.02	**-0.09**	0.03	-0.02	**-0.10**	**1.00**					
Geo. Div	-0.02	-0.02	**0.08**	**0.07**	-0.01	0.01	**0.06**	0.01	**0.05**	**0.34**	0.00	**1.00**				
QR	**0.10**	**0.05**	**-0.12**	**-0.07**	**-0.33**	**0.24**	**0.17**	**-0.04**	-0.01	**-0.05**	0.02	**-0.11**	**1.00**			
TR	**0.09**	**0.07**	-0.01	**-0.16**	**-0.15**	**0.09**	**0.10**	**-0.18**	**0.05**	**-0.12**	-0.03	**-0.04**	**0.32**	**1.00**		
DM	**-0.18**	**-0.18**	**0.11**	**0.11**	**0.14**	**-0.06**	**-0.08**	**0.09**	**0.07**	**0.21**	0.01	**0.11**	**-0.26**	**-0.21**	**1.00**	
TAX	**-0.03**	**-0.03**	-0.03	0.00	0.02	-0.01	0.00	0.01	-0.02	-0.01	**0.05**	-0.02	-0.02	-0.02	**0.07**	**1.00**
Panel B. FCDs																
Indicator	**-0.06**	**-0.03**	**0.19**	**0.03**	**0.06**	**-0.15**	**0.05**	**0.04**	0.00	**0.24**	**-0.06**	**0.11**	**-0.15**	-0.01	**0.15**	0.00
Extent	**0.04**	**0.04**	**0.05**	0.02	0.00	-0.01	0.01	0.01	**0.07**	**0.06**	-0.01	0.00	-0.02	-0.02	0.01	0.00
Panel C. Futures/Forwards																
Indicator	**-0.05**	**-0.04**	**0.18**	0.00	**0.04**	**-0.14**	**0.04**	0.03	0.03	**0.25**	**-0.05**	**0.16**	**-0.14**	0.00	**0.16**	0.02
Extent	**0.04**	**0.04**	**0.05**	0.02	-0.01	-0.01	0.01	0.01	**0.08**	**0.06**	-0.01	0.00	-0.02	-0.02	0.01	0.00
Panel D. Options																
Indicator	**-0.05**	**-0.04**	**0.04**	-0.01	0.03	**-0.06**	0.01	0.02	-0.04	0.01	-0.01	-0.02	**-0.04**	0.05	0.02	-0.02
Extent	0.00	0.01	0.01	0.00	0.03	-0.02	0.01	-0.01	-0.01	-0.02	0.02	-0.01	-0.01	**0.03**	-0.01	0.00
Panel E. Swaps																
Indicator	**-0.06**	**-0.04**	**0.09**	**0.09**	**0.05**	**-0.03**	**0.05**	**0.06**	-0.01	**0.17**	**-0.06**	-0.02	**-0.07**	**-0.10**	**0.15**	0.00
Extent	0.01	0.02	0.00	**0.07**	0.00	-0.01	0.02	0.01	0.00	**0.03**	-0.02	-0.01	0.00	**-0.03**	0.02	0.00

4. Empirical Results

4.1. Determinants of Hedging with Derivatives

Before proceeding to the empirical test, we present the Pearson correlation coefficients between each variable in Table 4. There are no specifically high correlations to doubt multi-collinearity between each variable except for Tobin's Q and adjusted Q. Interestingly, hedging indicator is negatively correlated with Tobin's Q and industry adjusted Tobin's Q, but hedging extent is positively correlated with Tobin's Q and industry adjusted Tobin's Q. These statistics suggest that although using derivatives is detrimental to firm value, if firms use more derivatives, then firm value increases. We will discuss more details about this later.

Before investigating the effect of hedging with derivatives on firm value and firm risk, we analyze the determinants of hedging decision to explore which firms use derivatives. Specifically, we run regression model of equation (7).

$$\begin{aligned} Hedging_{i,t} = {} & \alpha_1 + \beta_1 * LEV_{i,t} + \beta_2 * PM_{i,t} + \beta_3 * DIV_{i,t} + \beta_4 * CAPEX_{i,t} \\ & + \beta_5 * MTB_{i,t} + \beta_6 * SIZE_{i,t} + \beta_7 * Ind.Div_{i,t} + \beta_8 * Geo.Div_{i,t} \\ & + \beta_9 * QR_{i,t} + \beta_{10} * TR_{i,t} + \beta_{11} * DM_{i,t} + \beta_{12} * TAX_{i,t} \\ & + \sum_{j=1}^{J} \gamma_j * YEAR_j + \sum_{k=1}^{K} \delta_k * INDUSTRY_{i,k} + \upsilon_{i,t}. \end{aligned} \quad (7)$$

Table 2 gives definitions of all control variables in the equation (7).YEAR is year dummy variable and INDUSTRY is industry dummy variable. Hedging is either hedging indicator or hedging extent. We run logistic regression for hedging indicator and Tobit regression for hedging extent. Table 5 displays the results of equation (7).

Table 5. Hedging Determinant

	FCD		Future / Forward	
	Indicator	**Extent**	**Indicator**	**Extent**
LEV	0.100***	0.171***	0.080**	0.175***
	(8.71)	(3.34)	(4.84)	(2.71)
PM	-2.150***	-2.628***	-2.268***	-3.055***
	(22.90)	(-4.15)	(20.31)	(-3.79)
DIV	0.233*	0.390**	0.248*	0.391
	(2.99)	(2.03)	(2.72)	(1.61)
CAPEX	0.339*	0.297	0.333*	0.303
	(3.32)	(1.16)	(2.73)	(0.92)
MTB	-0.297***	-0.040	-0.149**	0.087
	(16.95)	(-0.47)	(4.34)	(0.87)
SIZE	0.437***	0.449***	0.372***	0.484***
	(136.39)	(9.04)	(96.54)	(7.86)
Ind. Div	-0.256*	-0.292	-0.258	-0.405
	(2.77)	(-1.33)	(2.23)	(-1.46)
Geo. Div	0.226	0.175	0.392**	0.362
	(1.88)	(0.76)	(5.13)	(1.30)

Table 5. (Continued)

	FCD		Future / Forward	
	Indicator	**Extent**	**Indicator**	**Extent**
QR	-0.547***	-0.498***	-0.594***	-0.556***
	(27.77)	(-3.81)	(23.40)	(-3.34)
TR	2.017***	1.520***	2.073***	1.798***
	(29.37)	(2.89)	(25.04)	(2.70)
DM	1.152***	0.711	1.352***	1.188*
	(7.41)	(1.22)	(9.31)	(1.67)
TAX	0.003	0.003	0.015	0.012
	(0.03)	(0.11)	(0.65)	(0.41)
Intercept	-6.444***	-7.912***	-6.392***	-9.503***
	(142.30)	(-10.56)	(123.74)	(-10.08)
Year	Yes	Yes	Yes	Yes
Sector	Yes	Yes	Yes	Yes
Pseudo R	0.2398		0.2235	
Log Likelihood		-2501		-2025
	Option		**Swap**	
	Indicator	**Extent**	**Indicator**	**Extent**
LEV	0.038	0.045	0.133***	0.018***
	(0.27)	(0.92)	(8.42)	(2.96)
PM	-1.632	-1.150*	-0.857	-0.143*
	(2.57)	(-1.67)	(1.47)	(-1.72)
DIV	0.213	0.205	0.499*	0.061**
	(0.51)	(1.01)	(3.79)	(2.12)
CAPEX	0.453	0.322	0.262	0.026
	(1.82)	(1.22)	(1.26)	(0.96)
MTB	-0.578***	-0.365***	-0.499***	-0.050***
	(7.87)	(-2.61)	(15.06)	(-3.30)
SIZE	0.246***	0.168***	0.471***	0.050***
	(11.47)	(3.15)	(79.30)	(7.33)
Ind. Div	-0.012	0.085	-0.542**	-0.064**
	(0.00)	(0.38)	(4.03)	(-2.05)
Geo. Div	0.121	0.052	-0.753**	-0.082**
	(0.09)	(0.20)	(6.50)	(-2.42)
QR	-0.637***	-0.469***	-0.145	-0.004
	(7.39)	(-2.86)	(0.88)	(-0.25)
TR	4.020***	2.896***	-1.173*	-0.135*
	(25.35)	(4.88)	(3.74)	(-1.89)
DM	0.126	-0.103	2.391***	0.265***
	(0.02)	(-0.16)	(19.16)	(3.76)

Table 5. (Continued)

	Option		Swap	
	Indicator	**Extent**	**Indicator**	**Extent**
TAX	-0.133**	-0.069	-0.009	-0.001
	(4.65)	(-1.43)	(0.05)	(-0.15)
Intercept	-5.860***	-4.719***	-8.835***	-1.038***
	(29.66)	(-5.72)	(100.71)	(-8.88)
Year	Yes	Yes	Yes	Yes
Sector	Yes	Yes	Yes	Yes
Pseudo R	0.1796		0.2277	
Log Likelihood		-446		-359

Notes: 1. This table shows the result of equation (5). Left columns of each derivatives are results of using hedging indicator as dependent variable and right columns are results of hedging extent. We run logistic regression for derivatives indicator and thus Wald chi-squares are in brackets and Pseudo R-square values are at the bottom. In case of hedging extent, we run Tobit regression and t-statistics are in brackets and log likelihood values are at the bottom.

2. The superscripts *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Most control variables explain decision of firms to use derivatives with an expected sign. Leverage (LEV) is significantly positive for both indicator and extent, except for options, which suggests that more leveraged firms are likely to use more derivatives to reduce bankruptcy cost. Similarly, less profitable firms have a higher bankruptcy probability, and hence, they need to use derivatives to reduce bankruptcy cost. As a result, profit margin (PM) has negative coefficient. In case of dividend dummy variable (DIV), it has significant positive value, and hence, we conclude that dividend-paying firms are more likely to use derivatives, especially swaps, to maintain dividend payout ratio by smoothing out earnings. Capital expenditure (CAPEX) and market-to-book ratio (MTB) are measures of growth opportunity. Firms with high CAPEX and low MTB have more growth opportunity and suffer more from underinvestment. Hence, these firms have more incentive to use derivatives. Our results show positive effect of CAPEX and negative effect of MTB, which support the hypothesis and result of Batram, Brown and Fehle (2009). The effect of firm size on decision of derivatives use is considered a little controversial. In general, small size firms have higher financial distress costs, and hence, they have more incentive to use derivatives for managing earning volatility. On the other hand, there are also economies of scale for hedging. For example, because of the existence of large fixed start-up costs of hedging, small firms may be reluctant to use derivatives. Several empirical studies show the later effect to be more prominent (Allayannis and Weston, 2001; Barton, 2001; Batram, Brown and Fehle, 2009; Magee, 2013; Panaretou; 2014). Similar to these international studies, our results show that large firms are more likely to use more derivatives in Korea. Industrial diversification (Ind. Div.) shows a negative value although it is significant only for swaps. Industrially diversified firms are able to hedge through operational strategy, and hence, they have a low incentive to use derivatives to smooth out earnings. Whereas, geographical diversification (Geo. Div.) has a positive effect on futures/forwards use, but negative effect on swaps use. Seok et al. (2018) shows that geographically diversified firms, especially through inter-continental operations, have more

incentive to use derivatives to hedge cash flows in multiple currencies. Our results partially support Seok et al. (2018) by showing a positive effect of geographical diversification on futures/forwards.

Quick ratio (QR) has a significant negative coefficient as expected. Firms with high quick ratio have less financial distress cost, and hence, a low incentive to use derivatives. However, tangible ratio (TR), which is another measure of asset liquidity of a firm, has opposite sign with the hypothesis. In general, when firms have more tangible assets, then their financial distress cost decreases and hence, there no incentive to use derivatives (Batram, Brown and Conrad, 2011). But, in our results, except for swaps, TR has significantly positive value, which suggests that firms with more tangible assets are more likely to use futures/forwards and options. The debt structure of firms measured by debt maturity (DM) also affects the decision of using derivatives. Theoretically, as debt maturity increases, firms need to hedge risk from longer debt, and hence, debt maturity has a positive effect on decision of hedging. Finally, the structure of tax (TAX) does not affect hedging behavior of Korean firms, contrary to the existing evidence from international research and the hypothesis (Geczy, Minton and Schrand, 1997; Nance, Smith and Smithson, 1993; Tufano, 1996). However, Graham and Rogers (2002) argue that firms do not hedge in response to tax because the incentive is smaller than for other hedging incentives, such as increasing debt capacity and interest deductions. Thus, our results suggest that Korean firms do not hedge by using derivatives because of tax benefits.

In short, results in Table 5 show that determinants of hedging with derivatives for Korean firms are similar with hypothesis and evidence from international studies. Firms that are highly leveraged, less profitable, and smaller quick ratio are more likely to use derivatives to reduce bankruptcy cost. Further, firms with high capital expenditure and low market-to-book ratio use more derivatives to avoid underinvestment. Scale of economy for using derivatives is an important issue for Korean firms, and hence, small firms are less likely to hedge with derivatives. These results suggest that Korean firms use derivatives at least for the same purpose as international firms do. Now, we investigate whether using derivatives of Korean firms increases firm value and decreases risk as thought.

4.2. Effect of Hedging on Firm Value and Risk

Before analyzing the effect of hedging with derivatives on firm value, we first check the existence of endogeneity between hedging and firm value by using Hausman specification test to verify the validity of the two-stage model. We regress equation (5) and calculate the residual of regression. Then we insert this residual in equation (6) with true hedging variable. Thereafter, the significance of the residual coefficient is used to judge whether there is endogeneity or not. Results of the Hausman test show that the coefficients of the residual are all significant at 5% level7 and thus we conclude that two-stage analysis is the better approach to use than the simple OLS regression for testing the effect of hedging on firm value. Specifically, we run regression model of equation (8).

$$\begin{aligned} Value_{i,t} = {} & \alpha_1 + \beta_1 * HedgingIV_{i,t} + \beta_2 * LEV_{i,t} + \beta_3 * PM_{i,t} + \beta_4 * DIV_{i,t} \\ & + \beta_5 * CAPEX_{i,t} + \beta_6 * MTB_{i,t} + \beta_7 * Size_{i,t} + \beta_8 * Ind.Div_{i,t} \\ & + \beta_9 * Geo.Div_{i,t} + \sum_{j=1}^{J} \gamma_j * YEAR_j + \sum_{k=1}^{K} \delta_k * INDUSTRY_{i,k} + \upsilon_{i,t}, \end{aligned} \quad (8)$$

[7] t-statistic of residual in Tobin's Q (adjusted Q) is -2.45 (-2.36) for total foreign currency derivative, -2.46 (-2.37) for future /forward, -2.35 (-2.25) for option and -2.39 (-2.30) for swap. Hedging also has significant endogeneity problem with market beta (with 1% significant coefficient of residual) and earning volatility (with 10% significant coefficient of residual).

where, *Value* is one of the Tobin's Q or industry adjusted Tobin's Q, and *HedgingIV* is a predicted hedging indicator or predicted hedging extent obtained from the equation (5). Other variables are defined in Table 2.

Table 6 presents the second stage result of equation (8). We run a logistic regression for hedging indicator and use the predicted value for columns (1) and (3). In case of hedging extent, we run Tobit regression and use the predicted value for columns (2) and (4). Results for Tobin's Q are reported in columns (1) and (2) and results for industry adjusted Tobin's Q are presented in columns (3) and (4). We report the effect of derivatives on firm value separately by type of derivatives. Panel A shows effect of all foreign currency derivatives, Panel B shows effect of futures/forwards, Panel C shows effect of options, and Panel D shows effect of swaps.

Table 6. Hedging Effect on Firm Value

	Q		Adj. Q	
	(1)	**(2)**	**(3)**	**(4)**
Panel A. FCDs				
Indicator_IV	-0.038		-0.029	
	(-0.72)		(-0.55)	
Extent_IV		0.214**		0.208**
		(2.42)		(2.33)
LEV	-0.003	-0.010*	-0.004	-0.010**
	(-0.64)	(-1.94)	(-0.87)	(-2.07)
PM	0.297***	0.346***	0.295***	0.340***
	(5.38)	(6.48)	(5.31)	(6.32)
DIV	-0.076***	-0.085***	-0.074***	-0.083***
	(-4.61)	(-5.09)	(-4.48)	(-4.93)
CAPEX	-0.046*	-0.045*	-0.044*	-0.043*
	(-1.87)	(-1.83)	(-1.77)	(-1.72)
MTB	0.295***	0.278***	0.291***	0.274***
	(40.67)	(26.77)	(39.82)	(26.21)
SIZE	0.021***	0.009*	0.018***	0.008
	(3.38)	(1.68)	(2.90)	(1.33)
Ind. Div	-0.077***	-0.079***	-0.076***	-0.078***
	(-4.03)	(-4.13)	(-3.95)	(-4.06)
Geo. Div	-0.136***	-0.126***	-0.127***	-0.117***
	(-6.11)	(-5.58)	(-5.66)	(-5.13)
Intercept	-0.688***	-0.538***	-0.558***	-0.418***
	(-10.31)	(-6.92)	(-8.32)	(-5.35)
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	No	No
Adj_R	0.5326	0.5334	0.4644	0.4653
Panel B. Futures/Forwards				
Indicator_IV	-0.125*		-0.118	
	(-1.68)		(-1.58)	
Extent_IV		0.270**		0.262**
		(2.42)		(2.33)
LEV	-0.001	-0.010*	-0.002	-0.011**
	(-0.29)	(-1.96)	(-0.50)	(-2.08)

Table 6. (Continued)

Panel B. Futures/Forwards				
PM	0.272***	0.346***	0.268***	0.340***
	(4.80)	(6.47)	(4.72)	(6.32)
DIV	-0.075***	-0.084***	-0.073***	-0.082***
	(-4.56)	(-5.04)	(-4.42)	(-4.88)
CAPEX	-0.046*	-0.046*	-0.043*	-0.043*
	(-1.85)	(-1.87)	(-1.75)	(-1.76)
MTB	0.295***	0.273***	0.290***	0.269***
	(41.26)	(22.83)	(40.37)	(22.36)
SIZE	0.026***	0.008	0.023***	0.006
	(3.95)	(1.26)	(3.53)	(6.00)
Ind. Div	-0.079***	-0.075***	-0.078***	-0.074***
	(-4.15)	(-3.93)	(-4.07)	(-3.87)
Geo. Div	-0.127***	-0.124***	-0.118***	-0.114***
	(-5.52)	(-5.40)	(-5.10)	(-4.97)
Intercept	-0.732***	-0.511***	-0.605***	-0.392***
	(-10.36)	(-5.97)	(-8.51)	(-4.56)
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	No	No
Adj_R	0.5329	0.5334	0.4648	0.4653
Panel C. Options				
Indicator_IV	0.086		0.121	
	(0.59)		(0.83)	
Extent_IV		1.129**		1.095**
		(2.42)		(2.33)
LEV	-0.004	-0.009*	-0.005	-0.010**
	(-0.99)	(-1.90)	(-1.20)	(-2.02)
PM	0.316***	0.338***	0.312***	0.332***
	(6.06)	(6.42)	(5.96)	(6.27)
DIV	-0.078***	-0.090***	-0.076***	-0.088***
	(-4.71)	(-5.22)	(-4.59)	(-5.05)
CAPEX	-0.048*	-0.039	-0.045*	-0.037
	(-1.94)	(-1.59)	(-1.83)	(-1.49)
MTB	0.297***	0.296***	0.293***	0.291***
	(41.43)	(41.84)	(40.58)	(40.93)
SIZE	0.017***	0.018***	0.015***	0.016***
	(3.77)	(4.02)	(3.23)	(3.51)
Ind. Div	-0.076***	-0.098***	-0.075***	-0.097***
	(-3.99)	(-4.64)	(-3.93)	(-4.54)
Geo. Div	-0.138***	-0.140***	-0.129***	-0.131***
	(-6.28)	(-6.37)	(-5.80)	(-5.89)
Intercept	-0.666***	-0.659***	-0.543***	-0.536***
	(-11.50)	(-11.41)	(-9.33)	(-9.22)
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	No	No
Adj_R	0.5325	0.5334	0.4645	0.4653

Table 6. (Continued)

Panel D. Swaps				
Indicator_IV	-0.830***		-0.859***	
	(-6.55)		(-6.74)	
Extent_IV		1.289**		1.251**
		(2.42)		(2.33)
LEV	0.010**	-0.008*	0.009*	-0.009*
	(1.97)	(-1.69)	(1.89)	(-1.83)
PM	0.261***	0.452***	0.254***	0.443***
	(5.05)	(5.81)	(4.88)	(5.65)
DIV	-0.070***	-0.101***	-0.068***	-0.099***
	(-4.30)	(-5.26)	(-4.14)	(-5.09)
CAPEX	-0.024	-0.069***	-0.021	-0.066**
	(-0.99)	(-2.63)	(-0.85)	(-2.49)
MTB	0.277***	0.312***	0.272***	0.307***
	(36.48)	(32.82)	(35.57)	(32.08)
SIZE	0.053***	-0.002	0.053***	-0.004
	(7.61)	(-0.23)	(7.44)	(-0.39)
Ind. Div	-0.097***	-0.039	-0.097***	-0.039
	(-5.06)	(-1.58)	(-5.03)	(-1.59)
Geo. Div	-0.186***	-0.081**	-0.178***	-0.073**
	(-8.06)	(-2.52)	(-7.67)	(-2.26)
Intercept	-1.044***	-0.441***	-0.933***	-0.324***
	(-12.79)	(-4.06)	(-11.38)	(-2.97)
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	No	No
Adj_R	0.5390	0.5334	0.4723	0.4653

Notes: 1. This table shows the result of equation (4) with firm value as dependent variable, that is, regression firm value on predicted hedging variable from first stage regression with several control variables. Dependent variable of left columns (1) and (2), is natural logarithm of Tobin's Q and dependent variable of right columns (3) and (4), is industry adjusted Tobin's Q. Predicted hedging indicator, *Indicator_IV*, is used as independent variable for (1) and (3), and predicted hedging extent *Extent_IV*, is used as independent variable for (2) and (4). We include industry dummies only for (1) and (2), since industry effect is already adjusted for (3) and (4).

2. Panel A is analysis for foreign currency derivatives, Panel B is for futures/forwards, Panel C is for options, and Panel D is for swaps. We denote t-statistics in brackets and R-square values at the bottom.
3. The superscripts *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

The results show that decision of firms to use derivatives slightly reduces firm value, especially for futures/forwards and swaps. However, if we use industry adjusted Tobin's Q, then only swaps reduce firm value significantly. This result suggests that Korean firms could be using derivatives inefficiently, at least partially for swaps. Allayannis and Weston (2001) show that a hedging premium of about 4.63 % ~ 5.26% exists for the U.S. firms, but in Korea, there hedging premium for options and for futures/forwards is marginal, and swaps instead reduce firm value. Clark, Judge and Mefteh (2006) analyze French non-financial firms, and find that derivatives use is not a significant factor of firm value, and conclude that speculation

and inefficiency plays a prominent role in use of derivatives by French firms. Similarly, Korean firms also seem to use derivatives indiscriminately without a deep understanding of hedging. One example of this is the KIKO (knock-in and knock-out option), which is a type of foreign currency derivative. From late 2006 to early 2008, Korean banks promoted KIKO as a safe product with low probability of loss, and as a result, many firms bought KIKO, but their main purpose was not hedging. The firms only wanted stable revenue from KIKO and ended up being over-hedged without the underlying assets. When the exchange rate increased sharply with the 2008 global crisis, most of the firms that had bought KIKO incurred enormous losses. If hedging was correctly understood, firms would not have incurred the big losses because losses from derivatives are offset by gains from underlying assets. Inefficient derivatives use by Korean firms also appears in the result of Kwon, Chang and Jung (2010) and Kwon, Park and Chang (2011) which show that the negative impact of using derivatives on Korean firm value.

Unlike the hedging indicator, the hedging extent significantly increases firm value for all of futures/forwards, options, and swaps. The average hedging extent for derivatives use is 0.247 for total foreign currency derivatives, 0.274 for futures/forwards, 0.103 for options, and 0.052 for swaps. Combined with the result from Table 6, it suggests that hedging premium is 5.29% for total foreign currency derivatives, 7.40% for futures/forwards, 11.63% for options, and 6.74% for swaps. These values are reasonable compared to the results obtained from international studies[8]. Combined with the result of hedging indicator, we conclude that decision to use hedging is detrimental for firm value in Korea, but extensive users are more likely to efficiently use derivatives than moderate users. We investigate more about this later.

Other control variables explain firm value well with the expected results. Profitability, measured by profit margin (*PM*) has positive impact on firm value, and more profitable firms are better valued in the market. If firms have limited access to financial markets, then they would only take positive net present value projects, and firm value would increase. In Table 6, dividend dummy (*DIV*), which measures access to financial markets, has negative coefficient as hypothesis. Growth opportunity, measured by *CAPEX* and *MTB*, has negative relation to firm value, which suggests that firms with more growth opportunity suffer higher underinvestment problem, and hence, they are undervalued in the market. There is no consistent evidence in international research that might explain relationship between firm size and value. However, according to the positive coefficient of size in Table 6, large firms seems to be better valued in the market in Korea. This result may come from the existence of big conglomerates, called chaebol, in Korea. Both industrial and geographical diversification decrease firm value. Diversification affects firm value in two ways. Firms diversify their risk through diversification, and as a result, they smooth out earnings. Whereas, inefficiency of capital allocation to multi-industries and multi-regions reduces firm value. The negative coefficients of industrial diversification (*Ind. Div,*) and geographical diversification (*Geo. Div.*) suggest that the second effect is more prominent in Korea.

We divided the effect of hedging on firm risk into two categories; market-based risk and accounting-based risk. Market-based risk refers to the risk that investors face in the stock market. We measure market-based risk by stock beta, that is, the regression coefficient of CAPM. Alternatively, we measure market-based risk by return volatility and standard deviation of residual from CAPM, but the results are not significantly different, and hence, we report the result using stock beta only. Accounting-based risk is the operational risk for a

[8] Allaynnis and Westorn (2001) demonstrated hedging premium is 4.63% ~ 5.26% for U.S. firms. Batram, Brown, and Conrad (2011) suggested 7% ~ 14% hedging premium for 47 countries. Belghitar, Clar, and Mefteh showed insignificant 9.7% hedging premium.

firm. We measure accounting-based risk by earnings volatility in eight quarters. Table 7 shows the result when we insert stock beta and earnings volatility in the equation (8) instead of firm value. Results for market-based risk are reported in columns (1) and (2), and results for accounting-based risk are presented in columns (3) and (4). Columns (1) and (3) present the results of using hedging indicator as independent variable, and columns (2) and (4) present the results of using hedging extent as independent variable. We report the effect of derivatives on firm risk separately by type of derivatives. Panel A shows effect for all foreign currency derivatives, Panel B shows effect for futures/forwards, Panel C shows effect for options, and Panel D shows effect for swaps.

Table 7. Hedging Effect on Firm Risk

	Beta		**EVol**	
	(1)	**(2)**	**(3)**	**(4)**
Panel A. FCDs				
Indicator_IV	0.289***		-0.504	
	(4.61)		(-1.52)	
Extent_IV		0.312***		-0.983*
		(2.91)		(-1.74)
LEV	0.006	0.007	0.057*	0.067**
	(1.09)	(1.10)	(1.89)	(2.11)
PM	-0.107	-0.166**	0.582*	0.612*
	(-1.62)	(-2.57)	(1.66)	(1.79)
DIV	-0.103***	-0.109***	0.005	0.033
	(-5.21)	(-5.38)	(0.05)	(0.31)
CAPEX	0.000	0.010	0.051	0.029
	(-0.02)	(0.33)	(0.32)	(0.18)
MTB	0.019**	-0.017	-0.332***	-0.231***
	(2.15)	(-1.38)	(-7.17)	(-3.49)
SIZE	0.049***	0.061***	0.535***	0.532***
	(6.59)	(8.88)	(13.60)	(14.79)
Ind. Div	0.004	-0.011	0.022	0.053
	(0.16)	(-0.48)	(0.18)	(0.44)
Geo. Div	0.077***	0.114***	-0.290**	-0.380***
	(2.87)	(4.16)	(-2.05)	(-2.64)
Intercept	0.231***	0.228**	-5.609***	-5.862***
	(2.87)	(2.43)	(-13.19)	(-11.83)
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
Adj_R	0.2085	0.2052	0.1242	0.1244
Panel B. Futures/Forwards				
Indicator_IV	0.464***		-0.837*	
	(5.20)		(-1.77)	
Extent_IV		0.393***		-1.238*
		(2.91)		(-1.74)

Table 7. (Continued)

Panel B. Futures/Forwards				
LEV	-0.002	0.006	0.060**	0.068**
	(-0.50)	(1.07)	(1.99)	(2.12)
PM	0.268***	-0.167***	0.510	0.613*
	(4.72)	(-2.58)	(1.41)	(1.80)
DIV	-0.073***	-0.107***	0.006	0.026
	(-4.42)	(-5.31)	(0.06)	(0.25)
CAPEX	-0.043*	0.009	0.048	0.033
	(-1.75)	(0.29)	(0.31)	(0.21)
MTB	0.290***	-0.024*	-0.328***	-0.209***
	(40.37)	(-1.69)	(-7.19)	(-2.73)
SIZE	0.023***	0.058***	0.548***	0.540***
	(3.53)	(7.83)	(13.12)	(13.84)
Ind. Div	-0.078***	-0.005	0.016	0.036
	(-4.07)	(-0.24)	(0.13)	(0.30)
Geo. Div	-0.118***	0.117***	-0.247*	-0.392***
	(-5.10)	(4.25)	(-1.68)	(-2.69)
Intercept	-0.605***	0.267***	-5.745***	-5.985***
	(-8.51)	(2.58)	(-12.75)	(-10.97)
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
Adj_R	0.2100	0.2052	0.1244	0.1244
Panel C. Options				
Indicator_IV	0.043		-0.560	
	(0.24)		(-0.60)	
Extent_IV		1.643***		-5.181*
		(2.91)		(-1.74)
LEV	0.015***	0.007	0.043	0.065**
	(2.72)	(1.21)	(1.53)	(2.09)
PM	-0.215***	-0.178***	0.743**	0.648*
	(-3.42)	(-2.79)	(2.24)	(1.93)
DIV	-0.097***	-0.116***	-0.001	0.056
	(-4.87)	(-5.55)	(-0.01)	(0.51)
CAPEX	0.006	0.018	0.042	0.003
	(0.22)	(0.60)	(0.27)	(0.02)
MTB	0.010	0.008	-0.320***	-0.312***
	(1.14)	(0.99)	(-7.01)	(-6.93)
SIZE	0.072***	0.073***	0.498***	0.493***
	(13.09)	(13.50)	(17.07)	(17.32)
Ind. Div	-0.007	-0.040	0.041	0.143
	(-0.30)	(-1.55)	(0.34)	(1.06)

Table 7. (Continued)

Panel C. Options				
Geo. Div	0.096***	0.093***	-0.324**	-0.314**
	(3.59)	(3.49)	(-2.31)	(-2.24)
Intercept	0.044	0.052	-5.272***	-5.307***
	(0.63)	(0.74)	(-14.30)	(-14.42)
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
Adj_R	0.2029	0.2052	0.1236	0.1244
Panel D. Swaps				
Indicator_IV	0.149		2.007**	
	(0.96)		(2.47)	
Extent_IV		1.877***		-5.916*
		(2.91)		(-1.74)
LEV	0.012**	0.009	0.008	0.059**
	(2.08)	(1.62)	(0.27)	(1.97)
PM	-0.209***	-0.012	0.895***	0.126
	(-3.31)	(-0.13)	(2.70)	(0.25)
DIV	-0.098***	-0.132***	-0.023	0.106
	(-4.92)	(-5.67)	(-0.22)	(0.86)
CAPEX	0.003	-0.025	-0.017	0.138
	(0.09)	(-0.78)	(-0.11)	(0.83)
MTB	0.013	0.032***	-0.269***	-0.386***
	(1.40)	(2.78)	(-5.52)	(-6.37)
SIZE	0.066***	0.044***	0.408***	0.586***
	(7.75)	(3.84)	(9.06)	(9.78)
Ind. Div	-0.003	0.047	0.092	-0.130
	(-0.14)	(1.59)	(0.75)	(-0.83)
Geo. Div	0.104***	0.179***	-0.209	-0.585***
	(3.71)	(4.58)	(-1.41)	(-2.84)
Intercept	0.113	0.369***	-4.366***	-6.306***
	(1.14)	(2.81)	(-8.35)	(-9.11)
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
Adj_R	0.2032	0.2052	0.1253	0.1244

Notes: 1. This table shows the result of equation (4) with firm risk as dependent variable, that is, regression firm risk on predicted hedging variable from first stage regression with several control variables. Dependent variable of left columns (1) and (2), is market-based risk, measured by stock beta, and dependent variable of right columns (3) and (4), is accounting-based risk, measured by earnings volatility. Predicted hedging indicator, *Indicator_IV*, is used as independent variable for (1) and (3), and predicted hedging extent *Extent_IV*, is used as independent variable for (2) and (4).

2. Panel A is analysis for foreign currency derivatives, Panel B is for futures/forwards, Panel C is for options, and Panel D is for swaps.

3. We denote t-statistics in brackets and R-square values at the bottom. The superscripts *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

The results show that hedging affects market-based risk and accounting-based risk differently. All foreign currency derivatives, including futures/forwards, options, and swaps, increase market-based risk. Especially, stock beta increases as hedging extent increases. Batram, Brown and Conrad (2011) use propensity score matching method and show that firms with hedging have 6% lower stock beta than non-hedgers. Guay (1999) also show that new users of derivatives experience significant reductions in return volatility by about 5% relative to non-users. Whereas, Bae, Kim and Kwon (2018) show that short position of derivatives increases volatility of Tobin's Q in Korea. Therefore, our results suggest that Korean firms use foreign currency derivatives in non-optimal ways, at least with regard to managing market risk. On the contrary, hedging significantly reduces earnings volatility. Hedging indicator of futures/forwards and hedging extent for all types of foreign currency derivatives have significant negative value. Batram, Brown and Conrad (2011) also show lower cash flow volatility and earnings volatility for derivatives users. Thus, result of accounting-based risk for Korean firms follows the evidence presented by international studies, unlike studies for market-based risk. Therefore, we conclude that Korean firms use derivatives to reduce volatility associated with operation rather than reducing market-based risk and reduction in earnings volatility through derivatives is not directly linked to reducing market risk.

4.4. Robustness Test

Result of Table 6 shows that hedging indicator and hedging extent have different effects on firm value, which suggest that moderate hedgers use derivatives inefficiently and extensive hedgers use derivatives more appropriately. To investigate this hypothesis more, we define extensive hedgers as firms which use derivatives above median value of hedging extent for each year, and define *High* dummy variable, which is assigned the value of 1 for extensive hedgers and 0 for moderate hedgers. We insert interaction term between *High* and hedging indicator in the equation (8). If extensive hedgers use derivatives more appropriately as per our hypothesis, the interaction term of hedging indicator with *High*, which indicate effect of hedging for high users, should have a positive coefficient. Table 8 presents the results.

Table 8. Effect of Moderately Low Hedging and Extensive Hedging on Firm Value and Risk

	Q	**Adj. Q**	**Beta**	**Evol**
Indicator_IV	-0.150**	-0.136**	0.238***	-0.773*
	(-2.27)	(-2.05)	(2.98)	(-1.83)
Indicator_IV*High	0.119***	0.114***	0.055	-0.285
	(2.75)	(2.62)	(1.05)	(-1.03)
LEV	-0.001	-0.002	0.007	0.062**
	(-0.18)	(-0.43)	(1.25)	(2.04)
PM	0.273***	0.272***	-0.118*	0.524
	(4.89)	(4.84)	(-1.76)	(1.47)
DIV	-0.074***	-0.072***	-0.102***	0.011
	(-4.47)	(-4.35)	(-5.15)	(0.10)
CAPEX	-0.043*	-0.041	0.001	0.059
	(-1.73)	(-1.63)	(0.04)	(0.38)
MTB	0.292***	0.288***	0.017*	-0.340***
	(39.72)	(38.89)	(1.95)	(-7.24)

Table 8. (Continued)

	Q	Adj. Q	Beta	Evol
SIZE	0.027***	0.024***	0.052***	0.550***
	(4.12)	(3.61)	(6.56)	(13.15)
Ind. Div	-0.083***	-0.082***	0.001	0.007
	(-4.33)	(-4.23)	(0.04)	(0.06)
Geo. Div	-0.133***	-0.124***	0.079***	-0.282**
	(-5.95)	(-5.51)	(2.92)	(-1.98)
Intercept	-0.728***	-0.597***	0.212**	-5.706***
	(-10.67)	(-8.70)	(2.57)	(-13.10)
Year	Yes	Yes	Yes	Yes
Industry	Yes	No	Yes	Yes
Adj_R	0.5336	0.4654	0.2085	0.1242

Notes: 1. This table shows the effect of moderately low hedging and extensive hedging on firm value. We classify extensive hedgers as firms that use derivatives above median value of hedging extent in each year and define *High* as one for extensive hedgers. We insert interaction term of *High* with hedging indicator at equation (4) and re-estimate it. Thus, indicator shows the effect of moderately low hedging and the interaction term shows the effect of extensive hedging. Predicted hedging indicator, *Indicator_IV*, from equation (3) is used.

2. The superscripts *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Result of Table 8 shows significant negative value of hedging indicator and significant positive value of interaction term for firm value as expected. This means that moderate hedgers use derivatives inefficiently, and as a result, derivatives reduces value of these firms. However, positive coefficient of interaction term suggest that extensive hedgers use derivatives more effectively, and thus, derivatives increase their value. The opposing effects of high and low use of derivatives is counterbalanced and thus the effect of using derivatives on firm value lose its significance in Table 6. On the contrary, the interaction term of hedging indicator with High is insignificant for firm risk, which suggests that both high and low use of derivatives increases stock beta and decreases earnings volatility. Table 7 shows the same effect of hedging indicator and hedging extent for stock beta and earnings volatility on firm value. Therefore, we conclude that moderately low hedgers use derivatives inefficiently, and thus, low use of derivatives is detrimental at least with regard to firm value; but low-level hedging reduces earnings volatility just as high-level hedging does.

We conducted two alternative tests to control for endogeneity; propensity score matching and univariate test for new hedgers and non-hedgers. Batram, Brown and Conrad (2011) conduct a propensity score matching test to control for endogeneity between hedging and firm risk. First, they estimate the logistic model for hedging indicator on firm characteristics that are expected to influence the choice of hedging decision. From this estimation, they calculate a propensity score of using derivatives, and match derivatives users with non-users who have similar propensity scores. Through this methodology, selection bias and endogeneity are eliminated. Alternatively, Guay (1999) investigate firm risk of new-hedgers and non-hedgers as another method of controlling for endogeneity. They argue that if firms use derivatives to hedge risks, then firm risk will be reduced when firms begin using derivatives. Following these two methods, we conduct propensity score matching test and investigate firm value and risk for new-hedgers and non-hedgers. First, we run logistic regression of the equation (7) and estimate propensity score for using derivatives, and then, we match hedgers and non-hedgers based on this score. Through this method, we investigate

difference in firm value and risk between hedgers and non-hedgers after controlling for endogeneity. The result is presented in Table 9A. We also investigated firm value and firm risk according to new-hedgers and non-hedgers in the similar fashion as Guay (1999) and show the results in Table 9B. Here, we only report the results of using total foreign currency derivatives.

Table 9. Propensity Score Matching Test and Test for New-Hedgers and Non-Hedgers

	Panel A. Propensity Score Matching			
	Non-Hedger	**Hedger**	**Difference**	
FCDs				
Num	227	227		
Q	-0.252	-0.248	0.005	(0.11)
Adj. Q	-0.001	-0.028	-0.027	(-0.67)
Beta	0.635	0.695	0.060**	(2.11)
Evol	1.084	0.766	-0.318*	(-1.78)
Futures/Forwards				
Num	176	176		
Q	-0.204	-0.175	0.028	(0.60)
Adj. Q	0.021	0.050	0.030	(0.65)
Beta	0.616	0.757	0.141**	(2.60)
Evol	0.821	0.694	-0.127*	(-1.76)
Options				
Num	62	62		
Q	-0.273	-0.251	0.022	(0.31)
Adj. Q	-0.036	-0.016	0.020	(0.31)
Beta	0.760	0.715	-0.045	(-0.74)
Evol	0.678	0.667	-0.011	(-0.06)
Swaps				
Num	108	108		
Q	-0.255	-0.246	0.009	(0.12)
Adj. Q	-0.026	-0.019	0.008	(0.11)
Beta	0.759	0.743	-0.016	(-0.36)
Evol	1.469	1.218	-0.251	(-0.47)
Panel B. Non-Hedgers and New-Hedgers				
	Non-Hedger	**New-Hedger**	**Difference**	
FCDs				
Num	2010	192		
Q	-0.203	-0.191	0.012	(0.37)
Adj. Q	0.007	0.031	0.024	(0.82)
Beta	0.570	0.687	0.117***	(4.62)
Evol	0.849	0.675	-0.174*	(-1.71)
Futures/Forwards				
Num	2202	136		
Q	-0.206	-0.197	0.009	(0.26)
Adj. Q	0.007	0.033	0.026	(0.77)
Beta	0.582	0.706	0.125***	(4.07)
Evol	0.795	0.613	-0.182*	(-1.95)
Options				
Num	2612	49		
Q	-0.214	-0.311	-0.097*	(-1.72)
Adj. Q	0.002	-0.059	-0.061	(-1.05)
Beta	0.617	0.695	0.078	(1.60)
Evol	0.800	0.698	-0.102	(-0.68)

Table 9. (Continued)

Swaps				
Num	2499	97		
Q	-0.211	-0.256	-0.045	(-0.96)
Adj. Q	0.003	-0.019	-0.022	(-0.50)
Beta	0.609	0.753	0.144***	(4.13)
Evol	0.733	1.313	0.580**	(2.61)

Notes: 1. This table shows the test results for new-hedgers and non-hedgers. Panel A shows the result of propensity score matching. We estimate propensity score of using derivatives from equation (5) and match hedgers with non-hedgers with similar propensity scores. In Panel B, we present mean of firm value and risk grouped by non-hedgers and new-hedgers, and their difference. New-hedger is hedger that starts to use derivatives.

2. We denote t-statistics in brackets. The superscripts *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 9 supports the results from Table 6 and Table 7. Compared with simple univariate test results of Table 3, which shows negative effect of hedging on firm value and accounting-based risk, this result shows that hedging decision marginally increases firm value and significantly reduces accounting based volatility after controlling for endogeneity.

Finally we analyze whether the effect of hedging by derivatives has changed after the financial crisis. After the financial crisis and the KIKO incident in 2008, the use of derivatives by Korean firms has been shrinking due to various institutional constraints and psychological reasons. This might have reduced effective hedging through derivatives by Korean firms. We investigate this by analyzing only the data from 2008. Table 10 shows the results.

Table 10. Hedging Effect on Firm Value and Risk after the Financial Crisis

Panel A. Firm Value				
	Tobin's Q		**Adjusted Q**	
IV_Indicator	-0.146**		-0.143**	
	(-2.06)		(-1.99)	
IV_Extent		-0.085		-0.083
		(-1.15)		(-1.11)
LEV	0.001	-0.002	0.002	-0.001
	(0.25)	(-0.32)	(0.36)	(-0.17)
PM	0.171**	0.237***	0.195***	0.259***
	(2.39)	(3.75)	(2.69)	(4.05)
DIV	-0.062***	-0.064***	-0.060***	-0.062***
	(-3.26)	(-3.40)	(-3.11)	(-3.25)
CAPEX	-0.050	-0.055*	-0.062*	-0.067**
	(-1.56)	(-1.71)	(-1.91)	(-2.05)
MTB	0.329***	0.335***	0.324***	0.330***
	(35.71)	(38.10)	(34.82)	(37.14)
SIZE	0.031***	0.020***	0.030***	0.019***
	(3.85)	(3.58)	(3.69)	(3.42)
Ind. Div	-0.063***	-0.059***	-0.062***	-0.057**
	(-2.87)	(-2.65)	(-2.78)	(-2.57)
Geo. Div	-0.146***	-0.158***	-0.144***	-0.156***
	(-6.00)	(-6.68)	(-5.84)	(-6.50)

Table 10. (Continued)

Panel A. Firm Value				
	Tobin's Q		**Adjusted Q**	
Intercept	-0.753***	-0.665***	-0.674***	-0.588***
	(-8.79)	(-9.38)	(-7.78)	(-8.20)
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	No	No
Adj_R	0.5817	0.5810	0.5372	0.5365
Panel B. Firm Risk				
	Market Beta		**Earning Volatility**	
IV_Indicator	0.2893***		-0.5041	
	(4.61)		(-1.52)	
IV_Extent		0.3117***		-0.1794
		(2.91)		(-1.06)
LEV	0.0062	0.0067	0.0565*	0.0458
	(1.09)	(1.10)	(1.89)	(1.61)
PM	-0.1075	-0.1662**	0.5817*	0.7591**
	(-1.62)	(-2.57)	(1.66)	(2.31)
DIV	-0.1032***	-0.1091***	0.0053	-0.0042
	(-5.21)	(-5.38)	(0.05)	(-0.04)
CAPEX	-0.0005	0.0098	0.0509	0.0366
	(-0.02)	(0.33)	(0.32)	(0.23)
MTB	0.0188**	-0.0173	-0.3319***	-0.3148***
	(2.15)	(-1.38)	(-7.17)	(-6.99)
SIZE	0.0490***	0.0606***	0.5352***	0.4994***
	(6.59)	(8.88)	(13.60)	(17.25)
Ind. Div	0.0037	-0.0111	0.0219	0.0463
	(0.16)	(-0.48)	(0.18)	(0.38)
Geo. Div	0.0770***	0.1137***	-0.2904**	-0.3325**
	(2.87)	(4.16)	(-2.05)	(-2.36)
Intercept	0.2306***	0.2280**	-5.6085***	-5.3560***
	(2.87)	(2.43)	(-13.19)	(-14.32)
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
Adj_R	0.2085	0.2052	0.1242	0.1239

Notes: 1. This table shows the result of equation (4). Panel A uses firm value as dependent variable, that is, regression firm value on predicted hedging variable from first stage regression with several control variables, and Panel B uses firm risk as dependent variable, that is, regression firm risk on predicted hedging variable from first stage regression with several control variables. Dependent variable of left columns (1) and (2) of Panel A is natural logarithm of Tobin's Q and dependent variable of right columns (3) and (4) of Panel A is industry adjusted Tobin's Q. Dependent variable of left columns (1) and (2) of Panel B is market-based risk, measured by stock beta, and dependent variable of right columns (3) and (4) of Panel B is accounting-based risk, measured by earnings volatility. Predicted hedging indicator, *Indicator_IV*, is used as independent variable for (1) and (3) and predicted hedging extent *Extent_IV*, is used as independent variable for (2) and (4). We include industry dummies only for (1) and (2) in Panel A, since industry effect is already adjusted for (3) and (4) in Panel A.

2. The superscripts *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A shows the effect of hedging on firm value after the financial crisis and the KIKO incident. Now, hedging significantly reduces firm value. Additionally, hedging extent no longer positively affects to firm value on contrast with the result of using total sample period. It suggests that hedging effectiveness decreases significantly after 2008. Panel B shows the effect on hedging on firm risk. Effect of hedging on firm's accounting volatility loses significance. Combined with the results from Panel A, we conclude that institutional constraints on the use of derivatives hinder the efficiency of derivatives, and thus, hedging reduce firm value after 2008.

5. Conclusion

In this paper, we investigate the determinants of hedging with derivatives and the effect of hedging on firm value and firm risk. In particular, we carry out analyses by paying close attention to the endogeneity problem between hedging and firm value. Prior studies suggest the existence of endogeneity between hedging and firm value or firm risk (Bartram, Brown and Conrad, 2011; Guay, 1999; Magee, 2013). That means, firms with high risk or low value are expected to have stronger incentives to hedge with derivatives, and thus, positive, negative, or insignificant relation between hedging and firm value or firm risk may be observed, even when firms use derivatives to increase firm value and reduce firm risk. Therefore, we use a two-stage analysis to control for endogeneity. In the first stage, we regress hedging variables on several control variables using absolute value of gains and losses from derivatives as an instrument variable, and find the predicted values of hedging. We plug these predicted values into the second stage model and analyze the effect of hedging on firm value and risk after controlling for endogeneity.

We also investigate determinants of hedging with derivatives. Most variables show same effects with hypothesis or in line evidence from international studies. For example, more leveraged and less profitable firms are likely to use derivatives to reduce financial distress costs. The effect of underinvestment measured by capital expenditure, and market-to-book value, has positive impact on derivatives use, which suggests that firms with more growth opportunities hedge using derivatives to reduce underinvestment. Because of economies of scale, large firms are more likely to use derivatives. Industrial diversification reduces incentive for hedging since cash flow is diversified through multiple industries. Whereas, geographical diversification increases incentive of using futures/forwards but decreases incentive for using swaps. A firm's capital structure, measured by quick ratio and debt maturity, also affects the decision of using derivatives. Firms with less quick ratio and longer debt maturity have incentive to use derivatives to reduce bankruptcy cost. However, tax structure of firms do not affect decision of hedging on the contrast with hypothesis.

The second stage analysis shows that the decision to hedge with derivatives has a slightly negative effect on firm value, but hedging extent increases firms value for all types of foreign currency derivatives. This result is because moderate hedgers use derivatives inefficiently, and thus, their use of derivatives reduces firm value. We confirm this by investigating the effect of high level of hedging on firm value, and find that, low use of derivatives decreases firm value, but high usage of derivatives increases firm value. Hedging with derivatives affects market-based risk and accounting-based risk differently. We measure market-based risk as stock beta, and hedging significantly increases stock beta for all types of derivatives. Whereas, hedging reduces accounting-based risk, which is measured by earnings volatility. Therefore, we conclude that Korean firms use derivatives for the purpose of managing operational volatility rather than for managing stock market risk. We confirm this through two alternative tests: propensity score matching and test for new-hedgers and non-hedgers. Finally, after the

financial crisis and KIKO incident in 2008, effectiveness of hedging with derivatives reduces because of institutional constraints on the derivative use.

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