The relationship between the use of derivatives and firm value under different economic cycles

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The relationship between the use of derivatives and firm value under different economic cycles

Abstract

This thesis explores the effect of derivative usage for hedging on firm value. By using a quarterly dataset of North American firms from 2000 to 2017, I examine whether the use of derivatives for hedging adds firm value. I focus on derivatives used for hedging rather than the generalized use of derivatives. Hedging can be an effective method of risk management and active risk management can lead to an increase in firm value. Firms are classified as ineffective speculators (IS firms) and effective hedgers (EH firms) based on their risk exposures before and after the use of derivatives. I add the economic cycles as another factor that might affect the effect of hedging on firm value. The results indicate that the use of derivatives for hedging adds firm value and the effect can last for longer than one year. For smaller firms, the value increase arising from hedging is more significant than that for larger firms. During economic expansions, hedging adds more value than that during economic recessions.

Keywords: derivatives, hedging, risk management, firm value

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1. Introduction

Firm value equals the value of equity plus the value of liabilities. According to Modigliani and Miller (1958), a firm's value is independent of the way that the firm is financed. This argument may be extended to imply that the use of risk management by the firm should not affect its value, as shareholders can manage risk by holding fully diversified portfolios of firms' stocks. However, in the presence of market imperfections, such as financial distress costs, information asymmetry and underinvestment, firms' risk management can decrease volatility in the firms' profits which in turn could lead to increases in firm value.

Firms face different kinds of business risks, such as strategic risk, compliance risk, reputational risk, operational risk, and financial risk. For example, other than specific risks that are related to firm-level activities, generally, firms are exposed to foreign exchange rate risk due to foreign sales, foreign income and foreign assets. Domestic firms are exposed to foreign exchange rate risk as well because they need to compete with international firms that are directly exposed to foreign exchange exposure, as stated in Aggarwal and Harper (2010). Firms are generally exposed to interest rate risk, and the more debt a company has, the higher is its interest rate risk. Besides, firms are exposed to commodity price risk. Geopolitical and climatological unpredictability have brought companies uncertainty about commodity outputs.

Scholars have investigated the relationship between risk management by using derivatives and firm value. However, they still hold different opinions about the effect of derivative use on firm value. Based on previous studies, in this thesis, I want to investigate the relationship between the use of derivatives and firm value, and to include the economic cycle as another variable that might affect the effect of derivatives use on firm value. The derivatives that should have positive effects on firm value will be the derivatives used for hedging rather than for speculating as hedging can

be an effective way of risk management. Scholars have discussed the effect of risk management on firm value. For example, McShane, Nair and Rustambecov (2011) find that increasing levels of firm risk management can increase firm value. Shin and Stulz (2000) also show that firm value decreases when firms are faced with higher total risk. Perez-Gonzalez and Yun (2013) find that active risk management policies lead to an increase in firm value. In this thesis, I will focus on the derivatives used for hedging. Following Guay (1999) and Zhang (2009), I divide firms that use derivatives into effective hedgers (EH firms) and ineffective hedgers/speculators (IS firms). A firm will be classified as an effective hedger (EH firm) if there is a decrease in its risk exposure after derivative use, otherwise, it will be classified as an ineffective hedger/speculator (IS firm). Guay (1999) focuses on new derivative users and employs a matched-pair control sample as a complement test. Zhang (2009) follows Guay's new-user method and estimates the determinants of firms' risk exposure before the use of derivatives and uses the determinants to calculate the expected risk exposure. After comparing real exposures after the adoption of derivatives with the estimated ones, firms are classified as EH firms (effective hedgers) and IS firms (ineffective speculators). The new-user approach focuses on firms that newly initiate the use of derivatives and examines the relationship between changes in derivative use and changes in firm risk. However, the new-user approach limits the number of firms in the sample and could lead to sample biases as it only focuses on firms that newly initiate the use of derivatives. It can be affected by period-specific conditions as well. For example, when macro-environment characteristics such as political conditions, the stock market and interest rates change, a firm's risk exposure will be influenced. To mitigate the influence of other factors other than the use of derivatives, I compare firms' risks cross-sectionally. Rather than using the new-user approach, I match each derivative user with a comparable non-user of derivatives following Barber and Lyon (1996) and Guay (1999), based on

industry, firm size, debt ratio, return on assets and growth rate, and compare their risk exposures. As stated before, firms are generally exposed to interest rate risk, and the higher a firm's use of debt, the higher its interest rate risk. I expect that firms with similar debt ratios face similar levels of interest rate risk. I expect that firms in the same industry of similar size operate similar businesses and have similar operational risks. I expect that firms with similar returns on assets and growth rates have similar financial performance and growth opportunities. By matching derivative users with non-derivative users based on their firm characteristics such as industry, firm size, debt ratio, return on assets and growth rate, I assume that paired firms are similar in other aspects than the use of derivatives. Matched non-derivative users can be used to replace the new-user method. The firm's stock return volatilities are used as the measure of the firm's total risk. After matching each derivative user with a comparable non-derivative user, I compare their stock return volatilities. If the stock return volatility of the derivative user exceeds that of its matched non-derivative user, I classify it as an EH firm (effective hedger), otherwise, it will be classified as an IS firm (ineffective speculator).

For derivative usage during different economic cycles, I expect that those firms that use derivatives during economic recessions would experience a higher increase in value than those that use derivatives during economic expansions. During economic recessions, there is more uncertainty in firms' operations such as the uncertainty in firms' cost of capital and the prices of products. They would experience higher cash flow volatilities and face higher risks. If firms use derivatives to manage such risks, the risk hedged during economic recessions would be higher than that during economic expansions, on average. The value increased by hedging would be higher during economic recessions than that during expansions.

2. Literature review

2.1 Risk management and firm value

Scholars have discussed the effect of risk management on firm value. McShane, Nair and Rustambecov (2011) find that increasing levels of firm risk management can increase firm value. They use a risk management rating[1] established by S&P (Standard and Poor's) as a measure of risk management and find that the risk management rating is positively related to firm value, for their sample of 82 insurance companies. Shin and Stulz (2000) also show that firm value decreases when firms are faced with higher total risk. They find a negative relationship between changes in total risk and changes in Tobin's q, which is a measure of firm value. Perez-Gonzalez and Yun (2013) also find that active risk management policies lead to an increase in firm value. By using financial data of 203 U.S. companies that used weather derivatives to hedge, Perez-Gonzalez and Yun (2013) find that firms that use weather derivatives to hedge have a 6% higher market-to-book ratio than those which do not. This leads to their conclusion that the use of derivatives leads to higher firm values. They also state that derivatives are powerful tools in both shifting and hedging risks.

2.2 Derivatives and firm value

Derivatives, as commonly used tools for risk management, have been widely addressed by scholars. Bodnar, Hayt, Marston and Smithson (1995) sent surveys to 2000 firms from over 40 industries and received a total of 530 usable responses. According to their results, 65% of large firms, defined as firms with a market value above $250 million, use derivatives while only about 13% of small firms, defined as firms with a market value below $50 million, use them. As for the use of derivatives among different industries, their survey shows that about 50 % of commodity-based

[1] An index that assesses the risk management culture, systems, processes and practice within the user.

industries, such as mining, agriculture, and refining, use derivatives. 40% of manufacturing firms report derivative usage. Among the transportation and utility industries, only 32% of firms declared derivative usage. For retail and wholesale trade firms, 29% of them report derivative usage. In the service industries, only 14% of the firms use derivatives. Among those firms which report the use of derivatives, 67% of them use derivatives as a way of risk management to minimize fluctuations in cash flow.

Smith and Stulz (1985) discuss the possible reasons why firms hedge. For example, a value-maximizing firm can hedge due to tax incentives, to reduce the costs of financial distress or as a consequence of managerial risk aversion. Bartram, Brown and Conrad (2011) find, by using a relatively large sample of nonfinancial firms from 47 countries, that firms hedge downside risk. They conclude that the use of derivatives is associated with significantly higher firm values during the economic downturn from 2001 to 2002. Allayannis and Weston (2001) examine 720 large U.S. nonfinancial firms and find evidence that the use of foreign currency derivatives causes an increase in firm value. They conclude that hedging can be a way to increase firm value. Pramborg (2004) adds to the findings of Allayannis and Weston (2001) by addressing different types of risk exposure, such as transaction exposure and translation exposure, and concludes that firm value is increased by hedging transaction exposure. By using a sample of 254 non-financial firms that are new derivative users, Guay (1999) finds a reduction in firm risk, which is measured by several different methods, after the firms have used derivatives. Also, Guay (1999) examines whether the types of derivatives are related to the firms' risk exposure and whether the adoption of such derivatives is relevant to the expected benefit from hedging. He concludes that his sample firms all used derivatives as an instrument of hedging, thus decreasing the risks that the firms are exposed to.

However, Hentschel and Kothari (2001) find that within their sample of 425 large non-financial U.S. firms, firms that use derivatives do not show significant differences in the reduction of risk, compared to firms that do not use derivatives. Henschel and Kothari (2001) also conclude that the use of derivatives does not reduce or increase a firm's stock return volatility. They believe that firms use derivatives only to reduce risks associated with short-term contracts, which can barely influence total volatility and risk. Jin and Jorion (2006) note that in the oil and gas industry, there is no obvious evidence that hedging has any influence on firm value.

Guay and Kothari (2003) examine 234 large non-financial corporations and conclude that the magnitude of using derivatives is relatively small compared to the firm's overall risk. They believe the previous results on the increase in firm value caused by the use of derivatives are debatable.

2.3 Derivatives and the economic cycle

Bartram, Brown and Conrad (2011) note that their study on derivative use includes a period of recession and argue that during an economic recession, firms seem to use derivatives to reduce risk, and especially downside risks. They conclude that derivative use is more valuable during market downturns. When the stock market is going down, for example, in the bear market, firms face more risks as there is more uncertainty in their cost of capital and prices of products. To better understand whether it is the use of derivatives that led to the financial meltdown, Cyree, Huang and Lindley (2012) investigate the role of derivatives in the banking industry and their effects on banks' performance before and during the financial crisis. However, based on their sample of 335 commercial banks, the authors do not detect any significant effect on bank values either during economic expansions from 2003-2005 or during economic recessions from 2007 to 2009. They find that the consequences of banks' derivatives use do not vary considerably with economical fluctuations. Allayannis and Weston (2001) note that during the years in which the dollar

appreciates, the value increase from hedging is higher than that during the years that the dollar depreciates. They assume that firms with foreign sales have a net long position in foreign currency and the benefits of hedging will be higher during economic expansions.

2.4 Research objectives and hypotheses addressed

As described above, there have been articles discussing the relationship between the use of derivatives and firm value. However, scholars still hold different opinions on the use of derivatives and firm value. Some of them did not distinguish between the use of derivatives in general and the use of derivatives for hedging. Also, they do not state whether the effect of derivatives on firm value can last, that is, is the relationship between the use of derivatives and firm value stable in the long run? When other firms also adopt derivatives as a way to hedge risks, will the advantage of using derivatives for hedging disappear? Will derivative use for hedging have different effects on firm value during different economic periods?

In this thesis, I want to extend the previous studies on the use of derivatives and firm value, to examine whether the use of derivatives for hedging can increase firm value with the addition of the economic cycle as a possible variable that might affect the influence of hedging on firm value.

Firstly, in general, firms are exposed to foreign exchange risk, interest rate risk and commodity price risk. Such risks should be reflected in firm stock prices and stock return volatilities. Accordingly, risks will affect firm value. As the use of derivatives for hedging can decrease the relative risks that firms face, firm value would increase after the use of derivatives for hedging. Regarding the use of derivatives for hedging and firm value, I expect to see a positive relationship.

Hypothesis 1: The use of derivatives for hedging can increase firm value.

Henschel and Kothari (2001) and Stulz (1996) state that firms primarily use derivatives to reduce the risks associated with short-term contracts, therefore there is barely a change in overall firm volatility. They find no significant difference in risk exposure between firms that use derivatives and those that do not. In my thesis, I want to investigate whether the use of derivatives for hedging can only increase firm value over the short term. The short term is defined as a period of six months, as it is a standard benchmark for short-term and floating-rate instruments such as commercial paper and floating-rate bonds. If the use of derivatives to hedge can increase firm value, then other firms that do not use derivatives in the first place might imitate and adopt derivatives as a way to increase firm value. Accordingly, the advantage of the use of derivatives to hedge will disappear as all firms adopt derivatives as a way of reducing risk. Consequently, the increase in firm value caused by using derivatives to hedge may not last over the long term.

Hypothesis 2: The use of derivatives can increase firm value only for the short term

Guay and Kothari (2003) argue that derivative usage only accounts for a relatively small part of a firm's overall risk management of their sample of large firms. If firms' use of derivatives for risk management is small, then the increase in value caused by derivative use will be small when the firm's size is large. As larger firms may adopt various methods other than hedging to manage risk, the value increase by hedging for large firms will be smaller compared with that for small firms. Thus, I want to group my sample firms that use derivatives for hedging into two groups (large firms and small firms) by firm size, to see if the use of derivatives for hedging has different influences on the two groups. As stated above, I expect a more obvious change in firm value for small firms that use derivatives for hedging.

Hypothesis 3: The use of derivatives leads to higher increases in value for small firms than for large ones

Bartram, Brown and Conrad (2011) note that during an economic recession, firms use derivatives to reduce risks of downside markets. As the economy collapses, there is a risk that firms face uncertain costs of capital and product prices, and firms' cash flow volatilities would increase, in which case firm values can be negatively affected. Cyree, Huang and Lindley (2012) also investigate the effect of derivatives on banks' performance before and during the financial crisis. However, they do not find a significant difference in performance between the two periods. Their sample of firms consisted of financial firms rather than non-financial firms. Unlike non-financial firms, financial firms usually use derivatives for trading and speculating. Thus, I want to extend their study by using non-financial firms in my sample and add the economic cycle as a factor that might affect the impact of hedging on firm value. Choudhry et al. (2016) and Brandt and Kang (2004) find that stock market volatilities are higher during economic recessions than during expansions. Brandt and Kang (2004) also find that stock returns are negatively correlated with stock return volatilities. During economic recessions, firms face more uncertainty in operations such as the uncertainty in cost of capital and the prices of products. They would experience higher cash flow volatilities and face higher risks. If firms use derivatives to manage such risks, the risk hedged during economic recessions would be higher than that during economic expansions, on average. The value increased by hedging would be higher than that during expansions. If firms use derivatives to hedge downside risks, such as the risk that product prices would drop and the economy would decline, then the value increase during economic recessions would be higher than that during economic expansions as cash flow volatilities would be higher during economic recessions than during economic expansions. Therefore, the use of derivatives for hedging would add more value to a firm during economic recessions than during economic expansions.

Hypothesis 4: The use of derivatives adds more value to a firm during economic recessions

3. Methodology

3.1 Data

3.1.1 Data Description

Bodnar, Hayt, Marston and Smithson (1995) investigate 2000 firms from over 40 industries and find that about 50% of commodity-based and 40% of manufacturing industries report the use of derivatives. Based on their survey, I include commodity-based industries and manufacturing industries, as they are reported to be the most common derivative users. Capital market data for firms are obtained from the COMPUSTAT database, which has SIC codes with 1000-1499 (the mining industry), 0100-0700 (the agriculture industry) and 2000-3999 (the manufacturing industry) for the time period January 2000 to December 2017. I obtain quarterly data for total assets, liabilities, capital expenditures, sales, development expenses, shareholders' equity, stock returns, asset turnover, market value and book value. To calculate risk exposures of the firm for each quarter, I use daily stock prices from the CRSP database[2] to calculate daily stock returns and then transform daily stock return volatilities into quarterly stock return volatilities. Quarterly stock return volatilities are used as an estimation of firms' risk exposures.

Data on the use of derivatives is obtained from the COMPUSTAT database[3]. Data related to derivative use in the COMPUSTAT database include derivatives unrealized gains/losses, derivatives gains/losses, derivative assets-current, derivatives assets long-term, gains/losses on derivatives and hedging, gain/loss on ineffective hedges, derivative liabilities-current, and derivative liabilities long-term. If any of these accounts has a value, this means the firms use a

[2] https://wrds-web.wharton.upenn.edu/wrds/ds/crsp/stock_a/dsf.cfm?navId=128
[3] https://wrds-web.wharton.upenn.edu/wrds/ds/compd/funda/index.cfm?navId=83

derivative instrument during the relevant fiscal quarter. Variable names and descriptions from COMPUSTAT are shown in table 1.

Table 1. Variables names and descriptions from COMPUSTAT

Variable name	Description in COMPUSTAT	More detailed description
AOCIDERGLQ	Accumulated Other Comprehensive Income-Derivatives Unrealized Gain/Loss[4]	The after-tax amount of unrealized gain/loss on derivative transactions or cash flow hedges
CIDERGLQ	Comprehensive income-Derivative Gains/Losses[5]	A component of the reconciliation between the company's net income and total comprehensive income
DERACQ	Derivative Assets-Current	-
DERALTQ	Derivative Assets Long-Term	-
DERHEDGLQ	Gain/Losses on Derivatives and Hedging	-
DERLCQ	Derivative Liabilities-Current	-

[4] This item is the after-tax amount of unrealized gain/loss on derivative transactions or cash flow hedges. This item includes: unrealized gains or losses on derivatives, unrealized gains or losses on cash flow hedges, a hedge of a foreign currency exposure to a forecasted transaction, reclassification adjustments pertaining to derivatives, cumulative effect of accounting change adjustments associated with the adoption of SFAS #133. This item excludes: unrealized gains or losses on marketable securities or available-for-sale securities, reclassification adjustments for non-derivatives, hedge of a foreign currency exposure of a net investment in a foreign operation. This item contains a combined figure data code if derivative or cash flow hedge is combined with another component of accumulated other comprehensive income. Annual data is available from 2001 forward and quarterly data is available from 1st quarter 2006 forward.

[5] This item represents derivative gains/losses reported after net income to arrive at total comprehensive income. It is a component of the reconciliation between the company's net income and total comprehensive income. This item includes: interest rate swap contracts, any adjustments reported in the derivative section, such as income taxes or discontinued operations, unrealized gain/loss on derivative contracts, hedging gain/loss, net investment hedges, reclassification adjustments that relate to derivatives, foreign currency forward contracts or any currency adjustments that relate to derivatives. This item excludes: any amounts that are already included in pre-tax income, tax adjustments when reported as a separate line item (i.e. not a component of derivatives), accumulated derivative gain/loss (i.e. balance sheet amount), pension liability adjustment, unrealized gain/loss on investment securities.

DERLLTQ	Derivative Liabilities Long Term	-
HEDGEGLQ	Gain/loss on ineffective Hedges[6]	The amount of gain or loss on a hedge transaction that exceeds the risk faced by the company

3.1.2 Classification of ineffective speculators (IS firms) and effective hedgers (EH firms)

If there is any value in the variables listed in Table 1, I classify the firm as a derivative user, otherwise, I classify the firm as a non-derivative user. Derivative users could use derivatives for both hedging and speculating purposes. The difference between the use of derivatives for hedging and speculation is the change in firms' risks. If a firm uses derivatives for hedging, its risk should decrease, if the hedge is effective. In the presence of market imperfection, risk management can decrease volatility in the firms' profits and in turn lead to an increase in firm value. The derivative use that increases the firm's value should be derivatives used for hedging rather than speculating.

To distinguish firms' use of derivatives for hedging and speculating, I follow Guay (1999) and Zhang (2009)'s method of classifying firms as either an effective hedger (EH firm) or an ineffective hedger/speculator (IS firm) by their risk exposures by the use of derivatives. A firm can offset part or all its business risk by holding derivatives (effective hedger), increase its risk by speculating in the derivatives market (speculator) or hold ineffective hedging instruments (ineffective hedger). Guay (1999) and Zhang (2009) focus on new derivative users that newly initiate the use of derivatives and examines the relationship between changes in derivative use and

[6] This item is the amount of gain or loss on a hedge transaction that exceeds the risk faced by the company. This item includes: fair value hedge ineffectiveness, cash flow hedge ineffectiveness, foreign currency hedge ineffectiveness. This item excludes ineffectiveness reported for non-hedge designated derivatives. Annual data is available from 2005 forward and quarterly data is available from first quarter 2006 forward.

changes in firm risk. However, the new-user approach limits the number of firms in the sample and causes sample biases as it only focuses on firms that newly initiate the use of derivatives. The new-user approach can be affected by period-specific conditions. For example, when macro-environment variables such as political conditions, state of the stock market and interest rates change, a firm's risk exposure will be influenced and affect the accuracy of the test.

To mitigate the influence caused by other factors rather than the use of derivatives, I compare firms' risks cross-sectionally. Rather than using the new derivative user method, I compare risk exposures of derivative users and comparable matched non-derivative users, matched based on firm characteristics. I divide the firms in my sample into two groups based on their use of derivatives as derivative users and non-derivative users. For each firm that reports derivative use, I find a paired firm without derivative use based on its industry, firm size, debt ratio, return on assets and growth rate, and compare average risk exposures of the paired firms. Firms face different kinds of risks such as interest rate risk, operational risk and financial risk. The more debt a firm has, the higher its interest rate risk. Firms with similar debt ratios are expected to face similar interest rate risks. Firms in the same industry of similar sizes, are expected to operate similar businesses and have similar operational risks. By matching derivative users with non-derivative users based on their firm characteristics such as industry, firm size, debt ratio, return on assets and growth rate, I assume that paired firms are similar in other aspects than the usage of derivatives. Matched non-derivative users can be used to replace the new-user method. If the risk exposure of the derivative user exceeds that of its comparable non-derivative user, I classify it as an ineffective hedger/speculator (IS firm) and if the risk exposure of the derivative users is lower than that of its comparable non-derivative user, I classify it as an effective hedger (EH firm).

Table 2. Comparing derivative data of ineffective speculators (IS firms) and effective hedgers (EH firms)

Firm name	Gain or loss on ineffective hedge/Total asset	Gain or loss on derivatives and hedging/Total asset	Derivatives unrealized gain or loss/Total asset
Effective hedgers (EH firms)	0.0000392	0.000967	-0.000659
Ineffective speculators (IS firms)	0.0000622	0.000513	-0.000668

After classifying the sample firms as IS firms (ineffective speculators) and EH firms (effective hedgers), I calculate the ratio of gain/loss on ineffective hedge, gain/loss on derivatives and hedging, and derivatives unrealized gain/loss on total asset separately. The averages of each ratio for IS and EH firms are shown in Table 2. By classification, EH firms use derivatives effectively to hedge and offset part or all their business risk and should have higher values in gain/loss on derivatives and hedging and derivatives unrealized gain/loss. IS firms use derivatives for speculating or hold ineffective hedging instruments and should have higher values in gain/loss on ineffective hedge. We can note that the ratio of gain/loss on ineffective hedge to total asset for EH firms is lower than that for IS firms. The ratio of gain/loss on derivatives and hedging to total asset of EH firms is lower than that of IS firms. The ratios of derivative unrealized gain/loss to total asset are both negative for IS and EH firms, while EH firms are slightly higher on average than IS firms.

3.1.3 Firm risks and firm values

I calculate quarterly stock return volatilities as a proxy for firms' risk exposures and merge quarterly volatilities from the CRSP database with derivative data from the COMPUSTAT database by CUSIP. Firms from the COMPUSTAT database and CRSP database use different identifications and have different data frequencies. Observations are dropped if they cannot be combined from two data sources, so that my actual data period for the whole analysis is from January 2006 to December 2017. Table 3 presents the summary statistics for EH firms (effective hedgers), IS firms (ineffective speculators) and non-derivative users.

Table 3. Average risk exposure, firm value and size for each group of firms

Firm name	Number of quarterly observations	Risk exposure (%)	Firm value	Size
EH firms (effective hedgers)	17,155	0.03	1.23	7.83
IS firms (ineffective speculators)	11,987	0.06	1.15	7.23
Derivative users	29,142	0.04	1.20	7.59
Non-derivative users	42,861	0.11	2.08	5.31
All firms	72,003	0.08	1.72	6.24

Note: Risk exposure is measured as stock return volatility, firm value is measured as Tobin's q ratio, size is measured as ln(assets), in million dollars.

The risk exposure of a firm is measured by the firm's quarterly stock return volatility, which is the firm's quarterly stock return standard deviation. The quarterly standard deviations are calculated from daily stock returns. Tobin's q is used as a proxy for the firm value, calculated as the market

value of outstanding securities divided by the total replacement cost of net assets, following Lewellen and Badrinath (1997). The COMPUSTAT variables for the calculation of Tobin's q are the market value of equity and total fair value of assets, separately. Size is the logarithm of total assets.

We can see from Table 3 that on average, firms that use derivatives are larger than firms that do not use derivatives. Effective hedgers have the smallest risk exposure. Non-derivative users have the largest risk exposure. Although non-derivative users tend to have higher firm values than derivative users, EH firms (effective hedgers) have a higher firm value than IS firms (ineffective speculators) on average.

To see the changes in the firm value of each group of firms in each year, Table 4 lists the average firm value by year. Figure 1 and Figure 2 compare average firm values for each group of firms over each year. We can see from Table 4 and Figure 1 that on average, firms that do not use derivatives have a higher firm value than firms that report derivative use. Figure 2 suggests that for firms that use derivatives, EH firms (effective hedgers) have a higher firm value than IS firms (ineffective speculators), except for the year 2014.

Table 4. Average firm value for each group by year

Firm value (Tobin's q ratio)	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Derivative users	1.26	1.30	0.99	0.87	1.04	1.08	1.04	1.30	1.42	1.31	1.24	1.32
Non-derivative users	2.35	2.27	1.74	1.71	1.89	1.84	1.82	2.45	2.49	2.26	2.15	2.46
IS firms (ineffective speculators)	1.21	1.27	0.92	0.78	0.94	0.99	0.91	1.26	1.47	1.27	1.14	1.22
EH firms (effective hedgers)	1.29	1.32	1.04	0.92	1.10	1.12	1.11	1.33	1.39	1.35	1.32	1.40

Figure 1. Firm value of derivative users and non-users by year

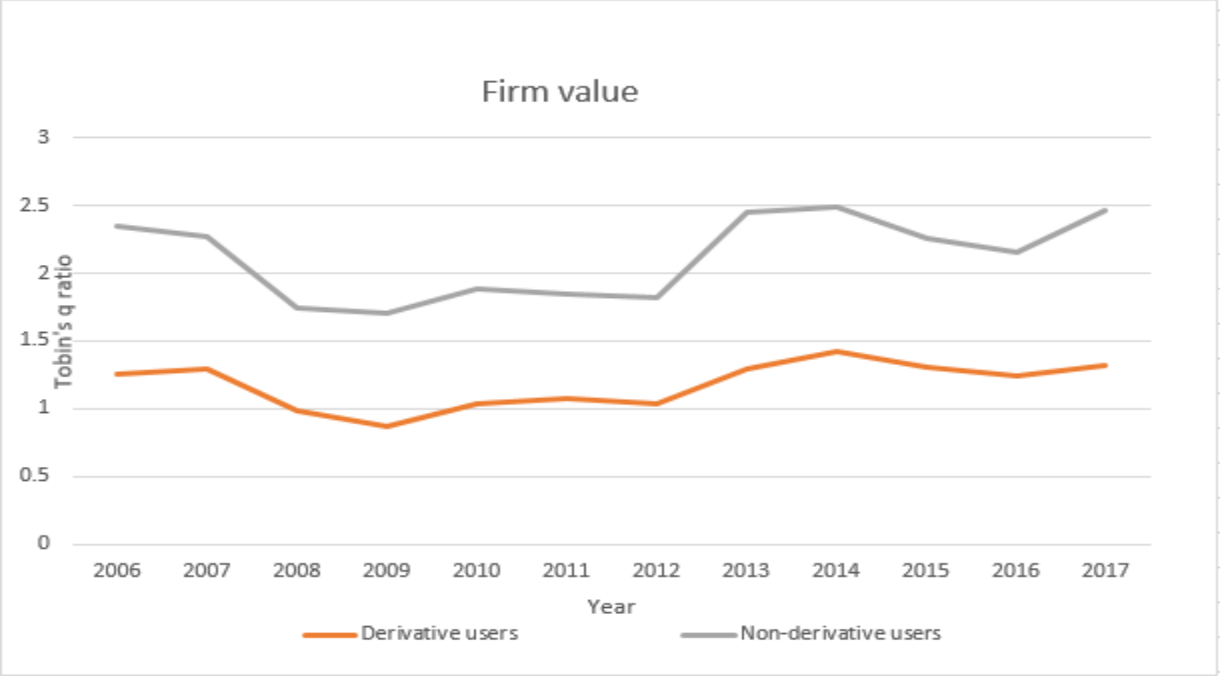
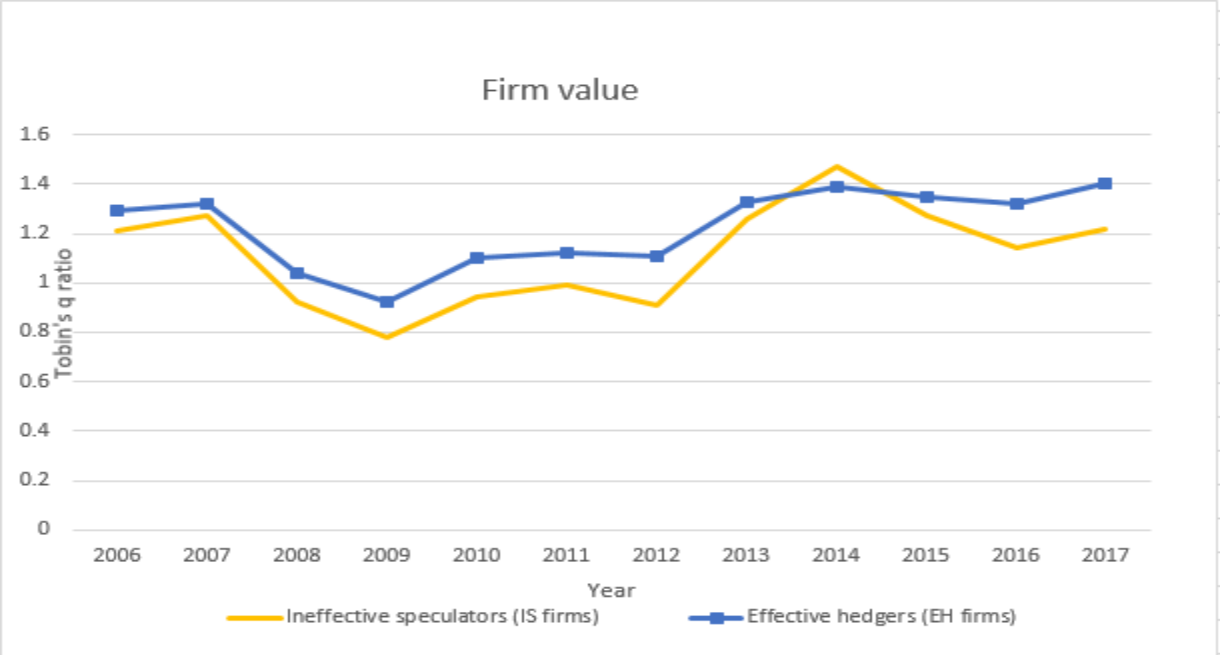


Figure 2. Firm value of ineffective speculators (IS firms) and effective hedgers (EH firms) by year



3.1.4 Summary statistics of derivative use by industry

Table 5 shows the detailed usage of derivatives for each industry. For the time period of 2006.01.01 to 2017.12.31, there are a total of 72,003 firm-quarter observations, of which 8,059 are in the mining industry, 206 are in the agriculture industry, and 63,738 are in the manufacturing industry. 29,142 of the observations are for derivative users (including IS firms and EH firms), and 17,155 are for effective hedgers (EH firms). Among the three industries, 28.23% of observations in the mining industry, 28.16% of observations in the agriculture industry, and 23.25% of the observations in the manufacturing industry are on EH firms.

Table 5. Summary statistics by industry

Industry	Number of observations	Derivative users (Numbers)	EH firms (Numbers)	Derivatives users (%)	EH firms (%)
Mining	8,059	4,285	2,275	53.17	28.23
Agriculture	206	87	58	42.23	28.16
Manufacturing	63,738	24,770	14,822	38.86	23.25
Total	72,003	29,142	17,155	40.47	23.83

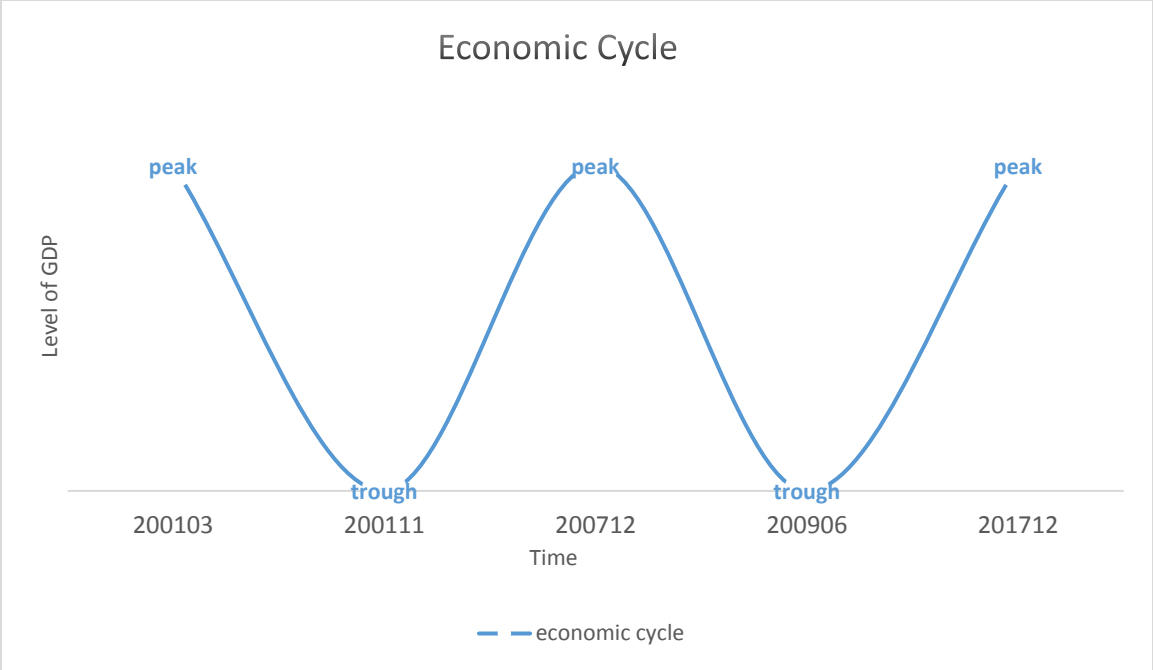
Note: Number of observations is firm-quarter, EH firms refer to effective hedgers.

3.1.5 Economic cycle division

Data from the NBER (National Bureau of Economic Research) are used to identify periods that are classified as expansionary versus recessionary. The NBER defines time periods as recessions or expansions according to economic indicators, such as real GDP, real income, employment, industrial production, and wholesale-retail sales. During a recession, a significant decline in economic activity spreads across the economy and can last from a few months to more than a year. Similarly, during an expansion, economic activity rises substantially, spreads across the economy,

and usually lasts for several years. NBER announces March 2001, and December 2007 as peaks and November 2001, and June 2009 as troughs of the business cycle. Recession periods start at the peak of a business cycle and end at the trough, expansion periods start at the trough and end at the peak. Accordingly, I classify the time periods from January 2000 to March 2001, from November 2001 to December 2007, and from June 2009 to December 2017 as expansion periods, and the time periods from March 2001 to November 2001, and from December 2007 to June 2009 as recession periods. Figure 3 shows the economic upturns and downturns over the complete period of the study.

Figure 3. Economic cycles during the sample period



3.1.6 Summary statistics of variables used in the analysis

Table 6 presents summary statistics of the variables used in the analysis. All variables are winsorized to avoid the impacts of extreme values. Negative shareholder's equity may be caused by large dividend payments, the amortization of intangible assets or borrowing money to cover

accumulated losses rather than issuing shares. Negative book value may be a result of a company's high liabilities and low assets. Asset turnover is the ratio of total sales to average assets. As total sales cannot be negative, the negative asset turnover ratio may be caused by current liabilities exceeding current assets.

Table 6. Summary statistics of variables used in the analysis

Variable name	Number of observations	Mean	Standard deviation	Minimum	Maximum
Total assets	72,003	4,504.12	17,558	0.18	375,319
Total liabilities	72,003	2,623.11	10,841.32	0	280,860
Net sales	72,003	708.26	1,889.56	0	13,241
Shareholders' equity	52,739	2,165.90	8,807.41	-17,311	194,500
R&D expenses	42,984	46.45	145.91	0.01	1,078.3
Capital expenditure	71,332	114.9	367.89	0	2,726.4
Market value	72,003	5,354.73	22,569.71	0	790,050.1
Book value	72,003	1,553.22	4,234.45	-175.08	30,133
Asset turnover (ratio)	72,003	0.22	0.17	-0.22	24.32
Size (ln(assets))	72,003	6.24	2.11	1.91	11.22
Tobin's q (ratio)	72,003	1.50	1.22	0.24	4.88

Note: Mean, Standard deviation, Minimum, and Maximum are measured in million dollars.

3.2 Methodology of empirical tests

Following Guay (1999) and Zhang (2009), I divide derivative users into effective hedgers (EH firms) and ineffective hedgers/speculators (IS firms) according to their risk exposures before and after the use of derivative uses. Firms are classified as derivative users if there is any value in one or more variables listed in Table 1, otherwise, firms are classified as non-derivative users. Guay

(1999) and Zhang (2009) classified derivative users as IS firms and EH firms based on their risk exposures before and after the use of derivatives. My actual sample period is from January 2006, and if I follow the new-users method, I will lose observations as many of the firms initiated the use of derivatives before 2006. Instead of finding new derivative users, I compare the risk exposure of my sample of derivative users with comparable non-users by matching firms' industry, size, debt ratio, return on assets and growth rate. Barber and Lyon (1997) detect abnormal operating performance by comparing sample firms and control firms based on their size, return on assets and market-to-book ratio. I match derivative users and non-derivative user control firms on firm size (Barber and Lyon (1997)), debt ratio, return on assets (Barber and Lyon (1997)) and growth rate. I expect that firms with similar debt ratios face similar levels of interest rate risk. I expect that firms in the same industry of similar size operate similar businesses and have similar operational risks. I expect that firms with similar returns on assets and growth rates have similar financial performance and growth opportunities.

Firstly, firms that use derivatives will be matched to all other firms that do not use derivatives from the same industry. And I calculate the differences in their size, return on assets, debt ratio and growth rate respectively. The matched non-user is chosen as the firm with the least differences in all these aspects.

After finding each derivative user a matched non-user firm, I compare their risk exposures. I classify my sample firm as an ineffective hedger/speculator (IS firm) if its risk exposure exceeds that of its comparable non-derivative user firm, and as an effective hedger (EH firm) if its risk exposure is lower than that of its comparable non-derivative user firm.

3.2.1 Capturing the effect of derivative use on firm value

As discussed by many scholars, e.g. Nance, Smith and Smithson (1993), hedging decisions are correlated with firm-specific factors such as size, investment opportunities and leverage. An OLS (ordinary least squares) regression is unable to capture the effect of derivative use on firm value, as it is difficult to interpret the beta of the OLS model as an effect of derivatives alone. Following Perez-Gonzales and Yun (2013) and Hentschel and Kothari (2001), I use instrumental variables (IVs) on the use of derivatives. Hentschel and Kothari (2001) state that firms are primarily exposed to foreign exchange and interest rate risk, and they measure exposures by regressing monthly firm equity returns on percentage changes in a stock market index, an exchange rate index, and an interest rate. However, the exposures to foreign exchange, interest rate and commodity price risk can only capture part of the total risks related to currency, interest rate and commodity price fluctuations, which cannot be a measure of firms' total risk. In this thesis, I use firm stock return volatilities to measure firms' total risk exposure. Firms' stock return volatilities are used as my instrumental variable as I expect that firms that face more risk use more derivatives for hedging.

Firstly, the first stage of FE-2SLS-IV (Fixed Effect-Two Stage Least Squares-Instrumental variable) uses the following specification:

$$\text{Derivative use}_{i,t}=\alpha_1 * \text{Risk exposure}_{i,t} + \beta_1 * \text{control variables}_{i,t} + \varepsilon_{i,t} \quad (1)$$

Derivative $use_{i,t}$ is an indicator variable that takes on the value one if firm i uses derivatives to hedge (EH firms) over quarter t and zero otherwise. Risk $exposure_{i,t}$ is the stock return volatility for firm i over quarter t. To calculate the volatility of stock returns for each quarter, I use daily data to calculate the stock return for each trading day and therefrom, the standard deviation of stock returns for each quarter. The quarterly standard deviations are used as a proxy for the quarterly volatility.

$$\sigma_{i,t}=\sqrt{\frac{\sum(R_i-\overline{R})^2}{63-1}} \quad (2)$$

$\sigma_{i,t}$ is the quarterly standard deviation of firm i's stock return over time period t, $R_{i,t}$ is firm i's daily stock return at time t, and $\overline{R}$ is the average daily stock return over the relevant quarter. The number of trading days in each quarter is 63, assuming 252 trading days in a year.

Control variables are variables that might affect a firm's use of derivatives for hedging. Following Bartram (2019), firms with higher leverage and lower size are more likely to use derivatives. I use size, measured by the logarithm of total assets, and leverage, the ratio of the book value of debt to the market value of shareholders' equity as control variables.

$\varepsilon_{i,t}$ is the error term of the regression.

The following second stage specification is used to test the effect of derivative use on firm value, where firm value is measured by the firm's Tobin's Q:

$$\text{Firm value}_{i,t}= \alpha_2*\widehat{derivative\ use}_{i,t}+\beta_2*X_{i,t}+\varepsilon_{i,t} \quad (3)$$

$\widehat{Derivative\ use}_{i,t}$ is the estimated derivative use calculated using equation (1). $X_{i,t}$ stands for variables other than derivative use that might affect firm value. Following previous studies concerning derivative use and firm value, control variables are factors that might affect firm value such as investment opportunities, the ratio of capital expenditures to sales and the ratio of research and development expenses to sales (e.g., Allayannis, Lel and Miller (2012), McShane, Nair, Rustambecov (2011), Ayturk, Gurbuz and Yanik (2016)), sales growth rate, an indicator of firms' potential growth opportunities (McShane, Nair, Rustambecov (2011)), size, measured as the log of total assets, and asset turnover ratio, an indicator used to measure the efficiency of a company's use of assets. $\varepsilon_{i,t}$ is the error term of the regression.

3.2.2 Capturing time-effect of derivatives use for hedging on firm value

To investigate the time effect of derivative use on firm value, I regress leading firm values as dependent variables to see if the influence of hedging lasts over the long term. If derivative use for hedging can only increase firm value for a relatively short period, for example, six months, then after six months, it should have no more impact on firm value. The multiple regression equation is written as follows:

$$\text{Firm value}_{i,t+4}=\alpha_3*\widehat{derivative\ use}_{i,t}+\beta_3*\text{Control variables}_{i,t}+\varepsilon_{i,t} \quad (4)$$

$\text{Firm value}_{i,t+4}$ is firm i's value in quarter t+4, which is the year after it uses derivatives. If the use of derivatives for hedging can only affect short-term risks, I expect to find that α_3 (the coefficient of derivative use at time t) is statistically insignificant as I regress the next year's firm value at t+4 on estimated derivative use at t, and should find no impact. The estimated derivative use is calculated using equation (1). $\varepsilon_{i,t}$ is the error term of the regression.

3.2.3 Whether derivative use has different effects on firms of different sizes

As previous studies note that derivative use has little effect on firm value for large firms, I classify the sample of firms that use derivatives for hedging into two groups, large groups and small groups, based on their size, to see whether there is any difference between the two groups. Firms are ranked according to their size, and the top 50% of them are classified as large firms, others are classified as small firms. I use the two-stage instrumental variable approach as described before for the two groups classified by size. After estimating derivative use for hedging, the estimated derivative use is regressed on firm value separately for the two different size groups.

As large firms may have a more complete risk management system and could adopt other methods other than using derivatives to hedge, I expect that the value increase by hedging using derivatives

to be smaller for large firms compared to that for small firms. I expect that α_2, the coefficient of estimated derivative use in equation (3) will be greater for small firms than for large ones.

3.2.4 Whether derivatives have different effects on firm values in different periods

Bartram, Brown and Conrad (2011) consider that firms use derivatives to reduce downside risks. It is of great importance for firms to use derivatives to reduce risks during economic recessions, and especially against the risks of price uncertainties. During economic recessions, there is more uncertainty in firms' operations such as the uncertainty in firms' cost of capital and the prices of products. They would experience higher cash flow volatilities and face higher risks. Firms could hedge against such risk by using derivatives. I follow Bartram, Brown and Conrad (2011)'s study by classifying the time period of the study into economic upturns and downturns, to examine if the economic cycle influences the impact of hedging on firm value.

I use the following regression equation to examine the effect of hedging using derivatives upon firm value during different economic cycles.

$$\text{Firm value}_{i,t} = \alpha_4 * \widehat{derivative\ use}_{i,t} + \gamma * \text{Recession}_t * \widehat{derivative\ use}_{i,t} + \beta_4 * \text{Control variables}_{i,t} + \varepsilon_{i,t} \quad (5)$$

Recession_t is a dummy variable that equals 1 when the quarter t is classified as recessionary, and 0 otherwise. $\text{Recession}_t * \widehat{derivative\ use}_{i,t}$ is an interaction variable, which equals estimated derivative usage when firm i uses derivatives for hedging during quarter t, and 0 otherwise. Bartram, Brown and Conrad (2011) argue that firms hedge against downside risk especially during economic recessions. During economic expansions, there is less uncertainty in firms' operations such as the uncertainty in firms' cost of capital and the prices of products. They would experience lower cash flow volatilities and face lower risks. When firms use derivatives to hedge against firm

risks, firm value increase will be higher than that during economic expansions. I expect γ, the coefficient of $\text{Recession}_t * \widehat{derivative\ use}_{i,t}$, will be positive. $\varepsilon_{i,t}$ is the error term of the regression.

4. Results

4.1 The effect of derivatives on firm value

To investigate the relationship between the use of derivatives for hedging and firm value, I run a linear regression using firm value and the estimated derivative use as in equation (3). Table 7 shows the results.

Table 7. Results of the regressions of derivative use on firm value

Variable name	coefficient
Intercept	9.851***
	(11.59)
$\widehat{\text{Derivative}}$ use	24.207***
	(8.13)
Capital expenditure to sales	-0.002***
	(-8.70)
R&D expenses to sales	0.0003***
	(3.93)
Asset turnover rate	-1.138***
	(-20.73)
Sales growth rate	0.269***
	(13.50)

Size	-2.254***
	(-8.79)

Notes: t statistics are reported within parentheses. * denotes significance at the 0.10 level. ** denotes significance at the 0.05 level. ***denotes significance at the 0.01 level.

Number of observations: 72,003, Adjusted R-square:0.1225.

The results in Table 7 indicate that the use of derivatives for hedging can increase firm value. The coefficient of estimated derivative use is 24.207 and the p-value is less than 0.0001, which implies that the use of derivatives for hedging has a positive effect on firm value and the result is statistically significant. This result is consistent with Hypothesis 1 that hedging increases firm value. When a firm uses 1 unit of derivatives for hedging, its value will increase by 24.207.

The coefficients of capital expenditures to sales and R&D expenses to sales are -0.002 and 0.0003 respectively, which implies that these two factors have little impact on firm value. Inconsistent with the hypothesis that investment opportunities should have positive effects on firm value, the coefficient of capital expenditures to sales is negative. The asset turnover rate has a negative effect on firm value, and the coefficient is statistically significant, which suggests a higher asset turnover rate is correlated with a lower firm value. This is inconsistent with the hypothesis that a company's efficiency of use of assets has positive effects on firm value. The coefficient of sales growth rate is positive and statistically significant. This is consistent with the hypothesis that higher growth opportunities can lead to higher firm value. The coefficient of size is -2.254 and is statistically significant.

4.2 The time-effect of derivatives used for hedging on firm value

Table 8 indicates the results of the estimation of equation (4), which investigates the impact of the use of derivatives for hedging upon firm values in the long term.

Table 8. Results of the regressions of derivative use on next year's firm value

Variable name	coefficient
Intercept	8.226***
	(9.57)
$\widehat{\text{Derivative}}$ use	18.181***
	(6.04)
Capital expenditure to sales	-0.002***
	(-8.42)
R&D expenses to sales	0.0001*
	(2.15)
Asset turnover rate	-1.207***
	(-20.42)
Sales growth rate	0.284***
	(13.03)
Size	-1.743***
	(-6.72)

Notes: t statistics are reported within parentheses. * denotes significance at the 0.10 level. ** denotes significance at the 0.05 level. ***denotes significance at the 0.01 level.

Number of observations:72,003, Adjusted R-square:0.1348.

As we can see in table 8, the coefficient of estimated derivative use is 18.181, and the p-value is less than 0.0001, which shows that the use of derivatives for hedging has a positive effect on firm value in the next year, and it is statistically significant. This is not consistent with Henschel and

Kothari (2001) and Stulz (1996), who conclude that firms primarily use derivatives to reduce the risks associated with short-term contracts. The positive effect on firm value can last for a relatively long time, in this case, the effect still exists after one year. The coefficients of capital expenditures to sales and R&D expenses to sales are -0.002 and 0.0003 respectively. The coefficient of capital expenses to sales is negative and it is inconsistent with the hypothesis that investment opportunities have positive impacts on firm value. The coefficient of the sales growth rate is 0.284 and is statistically significant. This suggests that higher growth opportunities have positive effects on next year's firm value. The coefficient of asset turnover rate is -1.207 and it is statistically significant, which indicates that the asset turnover rate has a negative effect on next year's firm value. The coefficient of size is -1.743 and is statistically significant.

4.3 The effect of derivative use on firms of different sizes

The effect of derivative use on firms of different sizes is investigated by estimating equation (3), separately for large firms and small firms. Table 9 shows the results. Panel A shows the results of derivative use for hedging for small firms, panel B shows that for the group of large firms.

Table 9. Results of the regressions of derivative use on firm value for small and large firms

Panel A. Results for small firms	
Variable name	coefficient
Intercept	10.308***
	(36.62)
$\widehat{\text{Derivative use}}$	84.588***
	(25.37)
Capital expenditure to sales	0.0005
	(0.55)
R&D expenses to sales	0.00012
	(1.28)
Asset turnover rate	-1.144***
	(-15.62)
Sales growth rate	0.232***
	(9.45)
Size	-3.398***
	(-27.24)

Panel B. Results for large firms

Variable name	coefficient
Intercept	5.627***
	(22.18)
$\widehat{\text{Derivative}}$ use	9.237***
	(9.24)
Capital expenditure to sales	-0.002***
	(-9.65)
R&D expenses to sales	0.002***
	(6.47)
Asset turnover rate	-0.682***
	(-8.10)
Sales growth rate	0.307***
	(7.86)
Size	-0.999***
	(-11.96)

Notes: t statistics are reported within parentheses. * denotes significance at the 0.10 level. ** denotes significance at the 0.05 level. ***denotes significance at the 0.01 level.

Number of observations:36,002, Adjusted R-square:0.1268.

We can note from Table 9, Panel A, that for small firms, the coefficient of derivative use for hedging on firm value is 84.588 and it is statistically significant. It means that when small firms

adopt 1 unit of derivative for hedging, their firm value will increase on average by 84.588. Table 10, Panel B, indicates that for large firms, the coefficient of derivatives for hedging on firm value is 9.237 and it is statistically significant. It means that when large firms use 1 unit of derivatives for hedging, their firm value will increase on average by 9.237. The coefficient of derivative use for small firms is greater than that for large firms. This is consistent with hypothesis 3. Derivative use for hedging is positively related to firm value and the value increase obtained by hedging using derivatives is smaller for large firms than for small firms. This is consistent with the explanation that large firms have a more complete risk management system and might have other ways to reduce risk rather than by using derivatives. For small firms, the coefficient of capital expenditure to sales and R&D expenses to sales are both very small and statistically insignificant. The coefficient of asset turnover rate is -1.144 and it is statistically significant. This is inconsistent with the hypothesis that the efficiency of a firm's use of assets is positively related to firm value. The coefficient of the sales growth rate is 0.232 and it is statistically significant, which is consistent with the hypothesis that growth opportunities are positively related to firm value. The coefficient of size is -3.398 and is statistically significant. For large firms, the coefficient of capital expenditure to sales is -0.002 and the coefficient of R&D expenses to sales is 0.002. This reflects that the impact of these two factors is still very small though they are statistically significant. The direction of the coefficient of capital expenditure to sales is still inconsistent with the hypothesis that investment opportunities have positive effects on firm value. The coefficient of asset turnover rate is -0.682, which means that for large firms, a higher asset turnover rate is associated with a lower firm value. This is inconsistent with the hypothesis that the efficiency of a company's use of assets improves firm value. The coefficient of the sales growth rate is 0.307 and is statistically

significant. This is consistent with the hypothesis that firms with higher growth opportunities have higher values. The coefficient of size is -0.999 and is significant.

4.4 The effects of derivative use on firm values in different periods

To investigate whether the use of derivatives for hedging has similar effects on firm value during different economic periods, a dummy variable is added to control for the economic cycle. Table 10 shows the results of the estimation of equation (5), which addresses the effect of derivative use upon firm value in periods of economic expansion and recession, separately.

Table 10. Results of the regression of the impact of the economic cycle on firm value

Variable name	Coefficient
Intercept	9.826***
	(11.59)
$\widehat{\text{Derivative}}$ use	24.168***
	(8.14)
Recession*$\widehat{derivative\ use}$	-1.198***
	(-12.00)
Capital expenditure to sales	-0.002***
	(-9.26)
R&D expenses to sales	0.0003***
	(4.07)
Asset turnover rate	-1.152***
	(-21.04)

Sales growth rate	0.261***
	(13.11)
Size	-2.245***
	(-8.78)

Notes: t statistics are reported within parentheses. * denotes significance at the 0.10 level. ** denotes significance at the 0.05 level. ***denotes significance at the 0.01 level.

Number of observations:72,003, Adjusted R-square:0.1269.

We can see in table 10 that the coefficient of the Recession*$\widehat{derivative\ use}$ variable is -1.198, and the coefficient of $\widehat{derivative\ use}$ is 24.168. Both coefficients are statistically significant. During economic recessions, the coefficient of derivative use for hedging is 22.97 (-1.198+ 24.168), which means that firm value will increase by around 22.97 units when the firm adopts 1 unit of derivative in economic downturns. During economic expansions, the recession dummy equals 0, so the coefficient of derivative use is 24.168, which means that when a firm uses 1 unit of derivative, its firm value will increase by 24.168. This result is inconsistent with hypothesis 4 and shows that during economic recessions, the value increase by using derivatives for hedging is less than that during economic expansions. The results in table 11 are consistent with Bartram, Brown and Conrad (2011) that firms' use of derivatives can decrease risk and in turn, increase firm value. The negative coefficient of the interaction variable that is inconsistent with the previous conclusions may be caused by sample bias. The possible explanation may be that the consequence of derivative use on firm value do not have considerable differences as the economy fluctuates, which is consistent with Cyree, Huang and Lindley (2012). Also, Allayannis and Weston (2001) assume that firms use foreign currency derivatives and according to their results, the hedging premium is larger during those years in which the dollar has appreciated, that is during expansions.

The coefficient of capital expenditure to sales and R&D expenses to sales are both very small though they are statistically significant, which means their effect on firm value is very weak. The direction of the coefficient of capital expenditures to sales is inconsistent with the hypothesis that investment opportunities have positive impacts on firm value. The coefficient of asset turnover rate is -1.152 and is statistically significant, which suggests that a higher asset turnover rate is associated with a lower firm value. This is inconsistent with the hypothesis that the efficiency of a firm's use of assets is positively associated with firm value. The coefficient of sales growth rate is positive and statistically significant. The coefficient of size is -2.245 and is statistically significant.

5. Robustness check

To see if there exist any estimation issues, I apply tests for homoscedasticity, autocorrelation, multicollinearity, and normality of residuals respectively.

5.1 Test for homoscedasticity

I use white test to test for homoscedasticity. The results are shown in Table 11.

Table 11. Results of Test of first and second moment specification

Test of first and second moment specification		
DF	Chi-Square	Pr > ChiSq
9	2291.22	<.0001

We can note from Table 11 that the Chi-square is 2291.22 and the probability is less than 0.0001, which implies that there exists heteroscedasticity in the model.

5.2 Tests for autocorrelation

Table 12. Results of Durbin Watson test

Durbin-Watson D	Number of observations	1st order autocorrelation
1.952	52732	0.024

Durbin Watson test is used for test of correlation here. We can see from Table 12 that the Durbin-Watson D is 1.952, which is near 2. The first order autocorrelation is 0.024. The result suggest that in this model, there is no autocorrelation.

5.3 Tests for multicollinearity

Table 13. Results of variable inflation

Variable name	VIF (Variable inflation)
Capital expenditure to sales	1.412
R&D expenses to sales	1.071
Asset turnover rate	1.010
Sales growth rate	1.010
Year	1.011
Industry	1.038
Size	6301.500
$\widehat{Derivative\ use}$	6297.974

We can see from Table 13 that the VIFs for capital expenditure to sales, R&D expenses to sales, asset turnover rate, sales growth rate, year, and SIC are less than 10, which indicating there is no multicollinearity for these variables. For the variables of size and $\widehat{Derivative\ use}$, the VIFs are way larger than 10, which indicate that there is multicollinearity for

these two variables. However, the estimated derivative use is my instrumental variable from the 2 stage least squares regression, the multicollinearity is not unexpected.

5.4 Tests for normality of residuals

Table 14. Results of Normality of residuals

Test	Statistic		P-value	
Kolmogorov-Smirnov	D	0.127	Pr > D	<0.0100
Cramer-von Mises	W-Sq	152.920	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	912.525	Pr > A-Sq	<0.0050

The results in Table 14 indicate that the residuals are not normally distributed.

5.5 Adjustments

I make some adjustments regarding to heteroscedasticity and normality of residuals. I use cluster robust standard errors to account for within-cluster correlation or heteroscedasticity which may be present. Also, I add the lagged dependent variable to account for the fact that the present level of the firm value may be sticky. I cluster SIC and year.

The results of all the adjusted regressions are shown in Table 15.

Table 15. Results of adjusted regressions

Variable name	Firm value$_t$	Firm value$_{t+4}$	Firm value (small firms)	Firm value (large firms)	Firm value$_t$
Intercept	9.818**	1.242*	10.151***	5.593***	9.755**
	(2.08)	(1.78)	(7.36)	(22.18)	(2.07)
$\widehat{\text{Derivative}}$ use	24.213	1.855	84.515***	9.243***	24.106
	(1.47)	(0.80)	(5.15)	(9.24)	(1.46)
Lagtobinq	0.02**	0.778***	0.047***	0.016	0.035***
	(2.34)	(52.61)	(6.80)	(1.19)	(4.77)
Recession*$\widehat{derivative\ use}$	-	-	-	-	-1.167***
					(-5.85)
Capital expenditure to sales	-0.002***	-0.0006***	0.0005	-0.002***	-0.002***
	(-5.85)	(-3.49)	(0.54)	(-9.65)	(-6.52)
R&D expenses to sales	0.0003*	0.00005	0.0001	0.002**	0.0003*
	(1.83)	(-1.60)	(1.36)	(6.47)	(1.82)
Asset turnover rate	-1.130***	-0.076	-1.154***	-0.682***	-1.140***
	(-6.07)	(-0.57)	(-5.23)	(-8.10)	(-6.16)
Sales growth rate	0.26***	-0.006	0.233***	0.307***	0.250***
	(9.91)	(-0.33)	(8.15)	(7.86)	(9.97)
Size	-2.254	-0.205	-3.380***	-0.998***	-2.239
	(-1.59)	(-1.01)	(-5.48)	(-11.96)	(-1.58)

Notes: t statistics are reported within parentheses. * denotes significance at the 0.10 level. ** denotes significance at the 0.05 level. ***denotes significance at the 0.01 level.

We can not that from Table 15, the directions of coefficient of estimated derivative use remain the same, but the significances have changed. The coefficients are only significant when the regressions are done by small and large firms separately.

6. Conclusion

This thesis investigates the relationship between the use of derivatives for hedging and firm value. Using quarterly data, the results show that by using derivatives to hedge, firm value can be significantly increased. Consistent with the hypothesis that the use of derivatives for hedging can decrease relative risks that firms face, such as foreign exchange risk, interest risk and commodity price risk, and firm value increases when firms are faced with lower total risk, this result implies that the use of derivatives can increase firm value. Inconsistent with the hypothesis that using derivatives can only increase firm value for a short period, the result indicates that the effect of derivatives for hedging can last for longer than one year. For smaller firms, the use of derivatives for hedging can be more effective at increasing value than for larger firms. The result is consistent with the hypothesis that larger firms have more complete risk management systems and may adopt other ways than hedging to decrease total risk. While firms using derivatives for hedging can increase firm value in both recessionary and expansionary periods, the value increase of hedging is not as significant during recessions as that during expansions. This is inconsistent with the hypothesis that during recessionary periods, the use of derivatives for hedging can add more value.

This thesis contributes to the literature with an updated data sample and adds the economic cycle as another variable that might affect the effect of derivatives use on firm value. I focus on derivatives for hedging rather than the general use of derivatives. Also, I classify IS firms and EH firms using comparable matching firms rather than the new-users method.

This thesis, however, is subject to several limitations. For example, the result of the time effect and the effect of economic cycles are inconsistent with previous studies. The magnitude of sample size can impact the accuracy of the generalization of the conclusion. There may be some sample bias caused by sample selection. We can also notice that the adjusted R-squareds for the regressions are around 0.10 to 0.15, which suggests that there are still omitted variables that have impacts on firm value. The results might be affected by adding control variables. Future research can be improved by using a more complete dataset.

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Appendix

A.1. Derivative data from Ford Motor Company

I download the 10Q form in quarter 2, 2017 from Ford Motor Company to check whether the variables for derivative are the same as those from the COMPUSTAT database. Table A1 shows the numbers and descriptions from both COMPUSTAT and Ford Motor's quarterly report.

Table A1. Derivative data for Ford Motor Company in 2017Q2

Variable name in COMPUSTAT	Description in COMPUSTAT	Value in COMPUSTAT (million dollars)	Value in Ford 10Q (million dollars)	Variable name and description in Ford 10Q
AOCIDERGLQ	Accumulated Other Comprehensive Income-Derivatives Unrealized Gain/Loss	253	253	Derivative instruments-ending balance
CIDERGLQ	Comprehensive income-Derivative Gains/Losses	137	137	Net income-derivative instruments
DERACQ	Derivative Assets-Current	870	870	Fair value of derivative assets-current portion

DERALTQ	Derivative Assets Long-Term	803	803	Fair value of derivative assets-non-current portion
DERHEDGLQ	Gain/Losses on Derivatives and Hedging	-61	-	-
DERLCQ	Derivative Liabilities-Current	473	473	Fair value of derivative liabilities-current portion
DERLLTQ	Derivative Liabilities Long Term	201	201	Fair value of derivative liabilities-non-current portion
HEDGEGLQ	Gain/loss on ineffective Hedges	4	4	Fair value hedges-ineffectiveness

Table A1 shows the numbers and descriptions for each variable from the COMPUSTAT database and the Ford Motor Company's quarterly report respectively. The numbers from the two sources are the same. For the "gain/losses on derivatives and hedging" variable, I did not find a comparable variable in the Ford Motor Company's quarterly report. For the "gain/loss on ineffective hedges" variable, Ford Motor Company puts it in "Income effect of derivative financial instrument", and it is classified as "ineffectiveness in fair value hedges". The variable "derivative gains/losses" is put in Ford Motor Company's "Consolidated statement of comprehensive income" and is classified as "net income-derivative instruments". Ford Motor Company puts the variables of derivative assets

and liabilities in “Balance sheet effect of derivative financial instruments” and records them at fair value. Ford Motor Company puts the “derivatives unrealized gain/loss” variable in “Accumulated other comprehensive income/loss” and classifies it as “derivative instruments-ending balance”.

A.2. Results of the coefficients of the first stage of FE-2SLS-IV

I follow Perez-Gonzales and Yun (2013) and Hentschel and Kothari (2001) and use instrumental variables (IVs) on the use of derivatives. For the first stage of FE-2SLS-IV (Fixed Effect-Two Stage Least Squares-Instrumental variable), the dummy variable, derivative use, is regressed on risk exposure and other control variables. After that, estimated derivative use is calculated using the estimated coefficients. Table A2 shows the results of the coefficients of variables. Table A3 shows the results of estimated derivative use.

Table A2. Results of the coefficients of variables of regression (1)

Variable name	Coefficient
Intercept	-0.284***
	（-46.61）
Volatility	-0.00374
	（-0.42）
Size	0.086***
	（98.88）
Leverage	-0.00004
	（-1.28）

Notes: t statistics are reported within parentheses. * denotes significance at the 0.10 level. ** denotes significance at the 0.05 level. ***denotes significance at the 0.01 level.

Number of observations:72,003, Adjusted R-square:0.1734.

Table A3. The value of estimated derivative use

Variable name	100% max	95%	90%	75%	50%	25%	10%	5%	0% min
Estimated derivative use	0.800	0.577	0.507	0.399	0.264	0.128	0.017	-0.116	-0.136