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Derivatives Use, Internal Control and Firm Risk Hedging Effect

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Abstract

Based on the sample of Chinese A-share listed companies during 2010-2020, this paper analyses the effect of derivatives use on corporate risk, as well as the moderating effect of internal control. The study finds that firm derivatives reduce corporate risk, and the internal control quality intensifies the risk hedging effect. The instrumental variable method, the treatment effect model, lagging the explanatory variables by one period, adding control variables and replacing the explained variables show that the above conclusions are robust. The risk hedging effect is only significant in non-state-owned firms, small firms and firms with high information transparency, indicating that corporate governance plays a crucial role in the risk hedging of derivatives. The findings provide some theoretical references for the regulation of derivatives market, disclosure of derivatives information and firm risk management.

Keywords

Derivatives Use, Internal Control, Risk Hedging

1. Introduction

With the intensification of fluctuations in the global economy, the acceleration of the internationalization of the RMB and the deepening of interest rate and exchange rate market-oriented reforms, the fluctuations in commodity prices, exchange rates and interest rates have had an increasing impact on the operating performance of Chinese firms, and how to cope with the risks of the complex and volatile external environment is an urgent problem. With the continuous development of the capital market, derivatives have become an important tool for risk management. The motivation of creating derivatives is to hedge risk. Derivatives are characterized by high complexity, high leverage, and high risk, which have the function of speculation. Reasonable use of derivatives can effectively reduce the

adverse effects of fluctuations in interest rates and exchange rates on corporate cash flows, but when management adopts derivatives for speculative arbitrage purposes, it may increase corporate risks. Therefore, the research on the effect of the use of derivatives has become the focus of urgent attention and solution in both academic and practical circles.

At present, academics have not reached consistent conclusions on the effect of the use of derivatives. Some scholars indicate that derivatives use can reduce the risk of firms (Guay, 1999; Bartram et al., 2011; Allayannis & Ofek, 2001), and others believe that derivatives use does not achieve the effect of risk hedging (Copeland & Joshi, 1996; Hentschel & Kothari, 2001; Jin & Jorion, 2006). Domestic research on derivatives and firm value is relatively extensive, while research on derivatives and firm risk is relatively scarce. Moreover, the research on the influence of the quality of corporate internal control on the use of derivatives and corporate risk is rarely involved. Whether the use of derivatives can achieve the effect of risk management, what is the effect of the quality of internal control on the relationship between the use of derivatives and firm risk, and whether the effect of using derivatives for risk management is different for firms with different characteristics? The above issues deserve further discussion.

In 2020, the "Notice on Matters Related to Effectively Strengthening the Management of Financial derivatives Business" issued by SASAC increased the requirements for the management of financial derivatives business, which was officially implemented from 2021. In order to avoid the impact of this document on the hedging effect of derivatives on corporate risks, we take a sample of Chinese A-share listed companies in 2010-2020 to analyse the effect of the use of derivatives on corporate risk, as well as the moderating effect of internal control. We find that derivatives use can reduce corporate risk, and the quality of internal control intensifies the risk hedging effects; In order to test the robustness of the results, we adopt Instrumental variable method, the treatment effect model, lagging the explanatory variables by one period, adding control variables and replacing the explained variables, and the results show that the above conclusions are still robust. In further analysis, we find that the effect of derivatives on reducing corporate risk is only significant in non-state-owned firms, small firms and firms with higher information transparency.

The contributions of this paper mainly lie in the following: firstly, we expand the research related to the economic consequences of derivatives. Second, we investigate the moderating role of internal control quality in the relationship between the use of derivatives and corporate risk, expanding the horizon of research related to derivatives and corporate risk. Thirdly, the findings of this paper suggest that there are differences in the risk hedging effects of derivative use among firms with different characteristics.

2. Literature Review and Research Hypotheses

2.1. Derivatives and Firm Risk

Firm risk is closely related to the survival and development of firms, and firm risk

is a central topic for investors to make investment decisions and for management to formulate strategies. Firm risk can lead to bankruptcy or financial difficulties, and it can affect the development of a business. The higher the firm risk, the greater the pressure on the firm's operations, the firm needs to invest more resources to cope with a variety of unpredictable situations, which will increase the firm's operating costs. Survival and development of firms need to obtain external resources, but the party providing resources will put forward higher requirements for enterprises with high risk, which will also increase the cost of doing business. For firms, dealing with unknown risks is an extremely resource-consuming firm activity. The need for risk management in business has increased dramatically.

With the continuous development of the capital market, derivatives have become an important tool for risk management. Derivatives are mainly represented by futures and options. The original intention of derivatives is to help investors reduce risks and realize the purpose of risk hedging. At present, for the risk hedging effect of derivatives, the current research conclusions at home and abroad are not consistent, mainly in the following two aspects: On the one hand, some scholars believe that the use of derivatives by firms can reduce firm risk. Abroad, Smith and Stulz (1985) found that the use of derivatives can be done to reduce the probability of firms in financial distress based on the construction of risk hedging model of firm value maximization, and Kuersten and Linde (2011) also proved this conclusion. Allayannis and Ofek (2001) studied 378 U.S. non-financial firms and showed that the use of derivatives by firms significantly reduced the exchange rate risk exposure of the sample firms. Abdel-Khalik and Chen (2015) found that the cumulative amount of cash flow hedges in other comprehensive income is negatively related to surplus volatility, and the effect of hedging to reduce surplus volatility is stronger in a short period of time. There are relatively few domestic studies on the effect of derivatives risk hedging. Some scholars have found that the use of derivatives by enterprises can effectively hedge corporate risks and enhance corporate value, and some scholars have found that the use of derivatives by enterprises can effectively reduce the cash flow volatility of non-state-owned enterprises.

On the other hand, there are many scholars who question the effectiveness of risk hedging of derivatives. Abroad, Copeland and Joshi (1996), Hagelin and Pramborg (2004) have argued that the use of derivatives can weaken the effectiveness of risk hedging and lead to the interests of the company and shareholders being at excess risk if a company chooses the wrong derivatives or uses derivatives for unusual purposes. Hentschel and Kothari (2001) analyzed the effect of using derivatives on corporate risk by analyzing the financial statement data of 425 U.S. companies, and the results showed that the use of derivatives did not significantly increase or decrease the volatility of corporate surplus. Through research, Jin and Jorion (2006) found that there was no significant relationship between the use of derivatives and the risk level. Domestic scholars took the companies listed in Shanghai and Shenzhen Stock markets in China that used derivatives from 2005

to 2011 as the research objects. The results show that the risk hedging effect of derivatives used by Chinese enterprises is very weak, and some scholars even find that the use of foreign exchange derivatives by banks increases the short-term and long-term foreign exchange risk exposure.

Based on the above analysis, this paper concludes that derivatives can mitigate the risk of unpredictable future volatility and prevent firms from incurring losses, thus reducing corporate risk. Due to the differences in the degree of capital market development, intensity of derivative use and information disclosure, the risk management effects of using derivatives by Chinese listed companies may be unique. Therefore, this paper puts forward the following hypothesis:

H1: The use of derivatives by firms can reduce firm risk.

2.2. Derivatives, Internal Control and Firm Risk

Internal control is an important mechanism for corporate governance and risk prevention, so the quality of internal control is an important criterion for measuring the level of corporate governance. The legal compliance of the company's operation and management, the authenticity and completeness of financial reports and the presentation and disclosure of relevant information are inseparable from good internal control. Enterprise internal control will affect the risk hedging effect of derivatives. On the one hand, there is information asymmetry between managers and shareholders, and managers will choose investment and financing decisions in their favour. Insider control will lead to self-interest behavior of the management, which will improve the subjective randomness of the management's use of financial derivatives, and ultimately affect the risk hedging effect of derivatives (Bodnar et al., 1998). On the other hand, due to the complex economic essence and accounting standards of derivatives, enterprises with low quality of internal control are more likely to use derivatives for the purpose of speculative arbitrage, which will cause earnings fluctuations, and then affect the risk hedging effect of derivatives. Lel (2012) researched that firms with strong corporate governance engage in exchange rate derivatives trading to maximize firm value, while firms with weak corporate governance engage in exchange rate derivatives trading for the personal interests or speculation of managers. Some Chinese scholars believe that in companies with low governance level, the management is more likely to use derivatives for speculative arbitrage, or use derivatives for earnings management, thus affecting the risk hedging effect of derivatives. The weaker the corporate governance, the weaker the risk hedging effect of derivatives may be.

Internal control will strengthen the review of the use of derivatives and supervise the risk fluctuation of derivatives. High-quality internal control can restrain the self-interest behavior of managers, give more effective play to the effect of restriction and supervision (Cho et al., 2009), and restrain the management from misuse or excessive use of derivatives, so as to improve the risk hedging effect of derivatives. The better the quality of internal control, the higher the level of corporate governance. The improvement of the company's governance level will

strengthen the supervision and restriction of the board of supervisors on the board of directors and other personnel, make the company's operation more standardized (Jensen, 2010), restrict the opportunistic behavior of the management, ensure the effective allocation of resources and the effective implementation of various business decisions, and effectively play the risk hedging role of derivatives. David and Mark (1999) found that management incentives and external regulation encourage management to use derivative instruments for risk hedging. Smith and Stulz (1985) also argued that a good level of corporate governance contributes to the risk management role of derivatives. Some Chinese scholars have taken Chinese non-financial enterprises as the research object and found that good corporate governance is conducive to the risk hedging effect of derivatives.

This paper argues that the use of derivatives is a financial decision-making behavior used by firms to speculate or hedge risks. If management uses derivatives to make investment decisions for speculative purposes, adverse selection will occur, which will increase the volatility of cash flow and earnings. There is information asymmetry between managers and shareholders, and managers will choose investment and financing decisions in their favour. A good internal control environment regulates the use of derivatives, reduces information asymmetry between management and shareholders, and restrains management's speculative behavior, which contributes to the effective performance of the risk hedging role of derivatives. Therefore, this paper puts forward the following hypothesis:

H2: Internal control quality can strengthen the risk hedging effect of derivatives.

3. Research Design

3.1. Sample Selection and Data Source

Following on Bartram et al. (2009), we manually collect relevant data of firm derivatives use. In 2020, the "Notice on Matters Related to Effectively Strengthening the Management of Financial derivatives Business" issued by SASAC increased the requirements for the management of financial derivatives business, which was officially implemented from 2021. In order to avoid the impact of this document on the hedging effect of derivatives on corporate risks, We select A-share listed companies in Shanghai and Shenzhen Stock exchanges from 2010 to 2020 as initial samples, and exclude the following observations: (1)samples from the financial industry; (2) ST and PT firms; (3)the samples with missing main financial data; Finally, a total of 23,657 observations were obtained. In order to eliminate the influence of extreme values, the continuous variables are winsorized by 1%. The internal control data are from the DIB, and the rest are from the CSMAR.

3.2. Definition of Variables

1) Dependent variable

Following Bartram et al. (2009), we manually collect annual report data of listed companies and search for keywords such as "derivatives" "forwards" "foreign

exchange" "options" "futures" "swaps" "swaps" in financial reports to determine whether a company use derivatives. We build a dummy variable DT for whether to use derivatives. If the company uses derivative instruments in the current year, DT is assigned a value of 1, otherwise it is assigned a value of 0.

2) Independent variable

Stock return volatility is a commonly used indicator of corporate risk as opposed to general financial indicators, which is not constrained or limited by financial statements and can better reflect the amount of risk in a company. Referring to Nakano and Nguyen (2012), Koerniadi et al. (2014), we use the logarithm of the standard deviation of the annualized daily rate of return to measure the risk of the firm (Risk). The calculation formula is as follows:

$$Risk_{i,j,t} = \ln\left[\sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(r_{i,j,t} - \frac{1}{T}\sum_{t=1}^{T} r_{i,j,t}\right)^2}\right] \quad (1)$$

Where *i, j, t* represents the return of firm i on day t in year *j*, and T is the total number of days in each fiscal year. The larger the logarithm of the standard deviation of the annualized daily return, the greater the firm risk.

3) Moderating variable

The internal control quality index can more objectively and comprehensively reflect the internal control quality of Chinese listed companies, and the internal control index has been recognized by many scholars and applied in related research. The internal control data(Ic) in this paper are from the DIB. The larger the Ic, the better the internal control quality of the firm.

4) Control variables

Based on John et al. (2008), the control variables are as follows: firm size (lnMV), Asset-liability ratio (LEV), return on assets (ROA), growth rate of operating income (Growth), cash holding level (Cas), total asset turnover rate (Turnover), board of directors size (Bsi), proportion of independent directors (Ind), executive shareholding (Mas), dual roles of chairman and general manager (Dua), and equity concentration (TOP). Industry and Year are industry and year control variables respectively, to control the impact of different investment opportunity in different industries, macro-economy such as GDP and inflation on firm risks. The specific definitions of the main variables are shown in Table 1.

Table 1. Variables and definitions.

variables	Definitions
Independent variable	
Risk	Three-year standard deviation of return on total assets from year t-2 to year t
dependent variable	
DT	Dummy variable equal to 1 using derivatives and 0 otherwise
Moderating variable	
Ic	The internal control index disclosed by Shenzhen Dib company and the logarithm of the internal control index plus one

Continued

Control variables	
lnMV	Logarithm of market value
ROA	Return on total assets, EBIT/Average of total assets at beginning and end of period
LEV	Total liabilities/total assets at the end of the period
Growth	Growth of operating income/total operating income of last year
Cas	Balance of cash and cash equivalents at the end of the period
Turnover	Operating income/total assets
Bsi	Number of directors
Ind	Number of independent directors/number of board of directors
Mas	Shareholding ratio of general manager
Dua	If the chairman and the general manager are the same person, the value is 1; otherwise, the value is 0
TOP	Shareholdings of the top ten shareholders
Year	Year control variables
Industry	Industry control variables

3.3. Model

In order to test the H1 and H2, this paper constructs Model (2) and Model (3) based on previous achievements.

$$Risk_{it} = \beta_0 + \beta_1 DT_{it} + \beta_n \sum Controls_{it} + \sum year_{it} + \sum industry_{it} + \varepsilon_{it} \quad (2)$$

$$Risk_{it} = \beta_0 + \beta_1 Ic_{it} + \beta_2 DT_{it} * Ic_{it} + \beta_n \sum Controls_{it} + \sum year_{it} + \sum industry_{it} + \varepsilon_{it} \quad (3)$$

In models (2) and (3), the subscript i represents the firm and t represents the year; Risk refers to the level of firm risk; DT is a dummy variable for whether a company uses derivative instruments. If the company uses derivative instruments, it is 1; otherwise, it is 0; DT_{it}*Ic_{it} is the interaction term of DT and Ic; Controls are control variables. If β_1 is negative in model (2), it means that the use of derivatives by the firm reduces the firm's risk. If the positive and negative of in model (3) is in the same direction as the positive and negative in model (2), it indicates that the quality of internal control has a promoting effect on the impact of derivative instruments on firm risk, and vice versa.

4. Empirical Findings

4.1. Descriptive Statistics

Table 2 shows the descriptive statistical results of the main variables. From Table 2, it can be seen that the average and standard deviation of DT are 0.183 and 0.387, respectively, indicating that derivative users account for 18.3% of the total company. The average and standard deviation of Risk are −3.601 and 0.291, respectively, indicating that listed companies generally have risks, but the severity of risks varies among companies; The average and standard deviation of Ic are 6.276

and 1.158, respectively, indicating that listed companies can generally establish sound internal control systems, but there are differences in the quality of internal control among companies; In addition, the statistical results of control variables such as firm size (lnMV) and return on assets (ROA) are basically consistent with the results of previous studies.

Table 2. Descriptive statistics.

Variable	N	Mean	SD	Min	p50	Max
DT	23657	0.183	0.387	0.000	0.000	1.000
Risk	23657	−3.601	0.291	−4.342	−3.606	−2.895
Ic	23657	6.276	1.158	0.000	6.508	6.747
lnMV	23657	22.78	1.114	20.80	22.63	26.27
ROA	23657	0.059	0.067	−0.242	0.055	0.252
LEV	23657	0.422	0.204	0.054	0.415	0.894
Growth	23657	0.170	0.395	−0.575	0.109	2.451
Cas	23657	20.08	1.338	16.95	19.98	23.97
Turnover	23657	0.649	0.438	0.076	0.549	2.566
Bsi	23657	8.590	1.681	5.000	9.000	15.00
Ind	23657	0.375	0.053	0.333	0.333	0.571
Mas	23657	5.151	11.22	0.000	0.000	51.43
Dua	23657	0.277	0.447	0.000	0.000	1.000
TOP	23657	58.26	14.87	23.85	59.14	90.08

4.2. Analysis of Correlation

From Table 3, it can be seen that the correlation coefficient between DT and Risk is −0.05 and significant at the 1% level, indicating that the use of derivative instruments can reduce corporate risk, which preliminarily verifies H1; There is a significant correlation between control variables such as lnMV, ROA, LEV, and Growth and risk, which proves the necessity of selecting these control variables in this article. According to the multicollinearity test, the VIFs are all less than 10, indicating that there is no serious multicollinearity problem among the variables.

Table 3. Correlation of variables.

Variable	Risk	DT	Ic	lnMV	ROA	LEV	Growth	Cas	Turnover	Bsi	Ind	Mas	Dua	TOP
Risk	1													
DT	−0.050***	1												
Ic	−0.036***	0.029***	1											
lnMV	−0.153***	0.234***	0.050***	1										
ROA	−0.097***	0.016**	0.260***	0.132***	1									
LEV	−0.079***	0.144***	−0.134***	0.433***	−0.260***	1								

Continued

Growth	0.038***	0.013*	0.064***	0.057***	0.262***	0.031***	1						
Cas	−0.244***	0.197***	0.144***	0.775***	0.182***	0.258***	0.056***	1					
Turnover	−0.049***	0.228***	0.079***	0.058***	0.197***	0.155***	0.136***	0.090***	1				
Bsi	−0.155***	0.032***	0.028***	0.251***	0.039***	0.156***	−0.012*	0.242***	0.030***	1			
Ind	0.039***	0.032***	−0.00700	0.015**	−0.029***	−0.00500	−0.00200	0.00300	−0.029***	−0.497***	1		
Mas	0.129***	−0.031***	0.049***	−0.242***	0.074***	−0.212***	0.051***	−0.172***	−0.039***	−0.175***	0.105***	1	
Dua	0.102***	−0.00600	0.00700	−0.150***	0.00700	−0.130***	0.020***	−0.125***	−0.041***	−0.184***	0.115***	0.528***	1
TOP	−0.062***	0.068***	0.086***	0.107***	0.206***	−0.097***	0.094***	0.175***	0.051***	0.015**	0.031***	0.158***	0.032***

4.3. Basic Regression

Table 4 reports the regression results of DT and Risk. Column (1) shows the regression results without controlling for relevant control variables, while column (2) shows the regression results after controlling for relevant control variables. From Table 4, it can be seen that the coefficient between DT and Risk is significantly negative, indicating that the use of derivative instruments by firms can reduce firm risk. The regression results validate hypothesis H1.

Table 4. The baseline results.

	(1)	(2)
VARIABLES	Risk	Risk
DT	−0.0476***	−0.0079**
	(−12.85)	(−2.14)
lnMV		−0.0175***
		(−7.12)
ROA		−0.1702***
		(−6.96)
LEV		0.0411***
		(4.58)
Growth		0.0614***
		(16.17)
Cas		−0.0365***
		(−20.67)
Turnover		−0.0028
		(−0.76)
Bsi		−0.0087***
		(−8.63)
Ind		−0.0524*
		(−1.78)

Continued

Mas		0.0013***
		(9.02)
Dua		0.0108***
		(3.15)
TOP		0.0002*
Year	Yes	Yes
Industry	Yes	Yes
Constant	−3.5026***	−2.3478***
	(−291.21)	(−61.12)
Observations	23,657	23,657
Adjusted R^2	0.456	0.520

a. The values in the brackets are t test values. *, **, and *** indicate that the significance levels are less than 1%, 5%, and 10%, respectively.

The above empirical results have proved that the use of derivatives can reduce corporate risk, further in order to test whether the quality of internal control affects the role of derivatives in reducing corporate risk, this paper re-runs the regression using model (3) and the results are shown in Table 5. Column (1) shows the regression results without controlling for relevant control variables, while column (2) shows the regression results after controlling for relevant control variables. From Table 5, it can be seen that the coefficient of DT*Ic is negative, and the coefficient of DT in Table 4 is also negative, indicating that the higher the quality of internal control in the firm, the more significant the role of derivative tools in reducing firm risk, thus verifying hypothesis H2.

Table 5. The results of internal control.

	(1)	(2)
VARIABLES	Risk	Risk
DT	0.0430*	0.0957***
	(1.74)	(3.89)
Ic	−0.0078***	0.0014
	(−5.29)	(0.89)
DT*Ic	−0.0141***	−0.0164***
	(−3.68)	(−4.30)
lnMV		−0.0174***
		(−7.07)
ROA		−0.1677***
		(−6.82)
LEV		0.0411***
		(4.59)

Continued

Growth		0.0612***
		(16.17)
Cas		−0.0366***
		(−20.65)
Turnover		−0.0024
		(−0.64)
Bsi		−0.0087***
		(−8.64)
Ind		−0.0526*
		(−1.79)
Mas		0.0012***
		(8.96)
Dua		0.0110***
		(3.21)
TOP		0.0002*
		(1.79)
Year	Yes	Yes
Industry	Yes	Yes
Constant	−3.4519***	−2.3575***
	(−227.00)	(−60.02)
Observations	23,657	23,657
Adjusted R^2	0.458	0.520

a. The values in the brackets are t test values. *, **, and *** indicate that the significance levels are less than 1%, 5%, and 10%, respectively.

5. Robustness Test

5.1. Instrumental Variable Method

In order to alleviate the endogenous problems caused by two-way causality, missing variables and other factors, this paper uses instrumental variables for robustness test. Due to the influence of institutional environment and regional economic development level and other factors, the use of derivatives by a single enterprise at a certain point in time may be related to the use of derivatives by other listed enterprises in the same province, but the use of derivatives by other listed enterprises in the same province will not have a direct impact on the current enterprise risk of the enterprise. Therefore, this paper selects the average value (IV1) of the use of derivatives by other listed enterprises in the same province in the same year as the first instrument variable. In addition, the use of derivatives is time series data. The use of derivatives in the current year is related to the use of derivatives in the previous year. The use of derivatives in the previous year is a pre-determined variable and will not directly affect the enterprise risk in the current year. Therefore, the use of derivatives in the previous year (IV2) is taken as the second

instrument variable. To further test the effectiveness of instrumental variables (IV1, IV2), Kleibergen-Paap rk LM is used to test the unidentifiable problem, and Kleibergen-Paap rk Wald F is used to test the weak instrumental variable problem. Because the number of instrumental variables is greater than the number of dependent variables, Hansen J is used to test the over identification problem.

The regression results of instrumental variable method are shown in Table 6. From column (1) of Table 6, it can be found that IV1, IV2 and derivative instrument use (DT) are significant at the level of 1%, which meets the characteristics of instrument variable correlation; Kleibergen-Paap rk LM is 3993.864, corresponding to a p value of 0.000, rejecting the original assumption that the identification of instrumental variables was insufficient; Kleibergen-Paap rk Wald F is 7709.145, which is obviously higher than the 10% critical value of Stock-Yogo weak instrumental variable test of 19.93, so there is no weak instrumental variable; Hansen J is 1.361, and the corresponding p value is 0.2434, which cannot reject the original assumption that all instrumental variables are exogenous, that is, all instrumental variables meet exogenous. To sum up, the tool variables selected in this paper are relatively appropriate.

From column (2) of Table 6, it can be seen that after alleviating the endogenous problem, the correlation coefficient between DT and Risk is significantly negative at the 10% level, that is, derivatives can reduce firm risk, indicating that the research result of this paper is robust.

Table 6. The results of instrumental variable method.

	(1)	(2)
	Step 1	Step 2
VARIABLES	DT	Risk
IV1	−0.3895***	
	(−5.3733)	
IV2	0.8028***	
	(122.8492)	
DT		−0.0088*
		(−1.7328)
lnMV	0.0139***	−0.0061**
	(4.9037)	(−2.2957)
ROA	−0.0728***	−0.2241***
	(−2.7162)	(−8.7665)
LEV	0.0285***	0.0352***
	(2.8108)	(3.6663)
Growth	0.0147***	0.0670***
	(2.7537)	(16.3125)
Cas	0.0059***	−0.0391***
	(2.8708)	(−20.2447)

Continued

Turnover	0.0458***	−0.0029
	(9.3634)	(−0.6951)
Bsi	−0.0009	−0.0095***
	(−0.7476)	(−8.6469)
Ind	0.0290	−0.0529*
	(0.8119)	(−1.6635)
Mas	0.0003*	0.0012***
	(1.7017)	(7.8270)
Dua	0.0008	0.0078**
	(0.1807)	(2.0850)
TOP	0.0001	−0.0004***
	(1.2539)	(−3.4256)
Year	−0.0113	−0.0112
Industry	−0.0301	−0.0091
Constant	−0.4125***	−2.6645***
	(−8.9149)	(−63.6863)
Observations	20,017	20,017
R-squared		0.535
Kleibergen-Paap rk LM		LM = 3993.864 P = 0.0000
Kleibergen-Paap rk Wald F		7709.145
Hansen J		1.361 P = 0.2434

a. The values in the brackets are t test values. *, **, and *** indicate that the significance levels are less than 1%, 5%, and 10%, respectively.

5.2. Treatment Effect Model

Using derivatives is an endogenous choice for enterprises, not a random choice. The proportion of overseas income (foreiSR), dividend payout ratio (PayOut1), company size (SIZE), and asset liability ratio (LEV) (John et al., 2008; Froot et al., 1993) all affect the use of corporate derivatives. Therefore, this article needs to mitigate the impact of sample self selection on the results. Whether the firm uses derivative instruments does not result in the absence of independent variables. Therefore, this article is suitable for using the Treatment Effect Model to alleviate the problem of sample self selection.

Table 7 reports the regression results after using the treatment effects model. From Table 6, it can be seen that column (1) is the regression result of the first stage, which indicates that companies with a higher proportion of overseas income, higher dividend payout ratios, larger firm sizes, and higher asset liability ratios are more inclined to use derivative instruments. From columns (2) and (3)

in Table 7, it can be seen that λ is significant at the 1% level, indicating that there is a self selection problem. After considering self selection bias, it can be seen that the results of column (2) indicate that derivative instruments can reduce corporate risk; The results of column (3) indicate that in firms with high internal control quality, the role of derivative instruments in reducing firm risk is more significant. The research conclusions still hold true.

Table 7. The results of treatment effects model.

	(1)	(2)	(3)
VARIABLES	DT	Risk	Risk
DT		−0.1124***	−0.0269
		(−5.80)	(−0.54)
Ic			0.0028
			(0.78)
DT*Ic			−0.0135*
			(−1.86)
foreiSR	0.0166***		
	(29.70)		
PayOut1	0.1741***		
	(4.15)		
SIZE	0.3254***		
	(24.77)		
LEV	0.6395***	−0.1042***	−0.1042***
	(7.32)	(−5.77)	(−5.75)
lnMV		0.0637***	0.0640***
		(14.46)	(14.52)
ROA		−0.3990***	−0.3996***
		(−6.53)	(−6.54)
Growth		0.0692***	0.0689***
		(9.74)	(9.70)
Cas		−0.0710***	−0.0712***
		(−20.68)	(−20.70)
Turnover		−0.0112	−0.0109
		(−1.62)	(−1.57)
Bsi		−0.0145***	−0.0144***
		(−7.29)	(−7.28)
Ind		−0.1467***	−0.1469***
		(−2.61)	(−2.62)
Mas		0.0019***	0.0019***
		(7.32)	(7.29)
Dua		0.0093	0.0095
		(1.44)	(1.47)

Continued

TOP		−0.0005**	−0.0005**
		(−2.55)	(−2.53)
λ		0.0648***	0.0653***
		(5.44)	(5.48)
Constant	−8.6361***	−3.3263***	−3.3472***
	(−30.80)	(−45.50)	(−44.17)
Observations	11,081	11,081	11,081

a. The values in the brackets are t test values. *, **, and *** indicate that the significance levels are less than 1%, 5%, and 10%, respectively.

5.3. One Period Lag

The use of derivative instruments by firms can reduce firm risks, but it is also possible that the greater the firm risk, the stronger the willingness to use derivative instruments, which can lead to endogeneity problems of reverse causality. To overcome the endogeneity problem of reverse causality, this paper lagged the independent variables by one period and conducted regression analysis on the processed data for model (2) and model (3) respectively.

Table 8 reports the relevant regression results. From Table 8, it can be seen that the results of column (1) indicate that derivative instruments can reduce corporate risk; The results of column (2) indicate that in firms with high internal control quality, the role of derivative instruments in reducing firm risk is more significant, and the research conclusions still hold true.

Table 8. The results of one-period lag.

	(1)	(2)
VARIABLES	Risk	Risk
L.DT	−0.0078*	0.0879***
	(−1.89)	(3.37)
Ic		0.0022
		(1.31)
L.DT*Ic		−0.0152***
		(−3.75)
lnMV	−0.0048*	−0.0047*
	(−1.79)	(−1.73)
ROA	−0.2272***	−0.2270***
	(−8.66)	(−8.59)
LEV	0.0303***	0.0304***
	(3.09)	(3.09)
Growth	0.0675***	0.0675***
	(16.21)	(16.26)

Continued

Cas	−0.0398***	−0.0400***
	(−20.23)	(−20.22)
Turnover	−0.0021	−0.0018
	(−0.51)	(−0.43)
Bsi	−0.0094***	−0.0094***
	(−8.36)	(−8.37)
Ind	−0.0469	−0.0462
	(−1.45)	(−1.43)
Mas	0.0012***	0.0012***
	(7.62)	(7.55)
Dua	0.0083**	0.0085**
	(2.17)	(2.24)
TOP	−0.0003***	−0.0003***
	(−3.07)	(−3.04)
Year	Yes	Yes
Industry	Yes	Yes
Constant	−2.6908***	−2.7061***
	(−64.05)	(−62.83)
Observations	19,444	19,444
Adjusted R^2	0.533	0.533

a. The values in the brackets are t test values. *, **, and *** indicate that the significance levels are less than 1%, 5%, and 10%, respectively.

5.4. Adding Control Variable

In order to reduce the impact of omitted variables on the main test results, this article further increases compensation incentives (Compensation), CEO age (C_age), CEO gender (C_Gender), and CEO education (Degree) as control variables, and regresses model (1) and model (2) separately. Compensation is the logarithm of the total compensation of the top three executives; C_age is a dummy variable. If the CEO is male, it is assigned a value of 1; otherwise, it is assigned a value of 0; Degrees are assigned to 7 levels, including technical secondary school and below, associate degree, undergraduate degree, master's degree, doctoral degree, other (such as honorary doctorate, correspondence, etc.), MBA or EMBA, with values of 1, 2, 3, 4, 5, 6, and 7 respectively.

The regression results are shown in Table 8. From Table 9, it can be seen that the regression coefficient of DT in column (1) is −0.0099, which is significant at the 5% level, indicating that derivative instruments can reduce corporate risk; The regression coefficient of DT*Ic in column (2) is −0.0146, which is significantly negative at the 1% level, indicating that in firms with high internal control quality,

the role of derivative instruments in reducing firm risk is more significant, and the research conclusions still hold true.

Table 9. The results of adding control variables.

	(1)	(2)
VARIABLES	Risk	Risk
DT	−0.0099**	0.0833***
	(−2.36)	(2.86)
Ic		0.0007
		(0.40)
DT*Ic		−0.0146***
		(−3.24)
lnMV	−0.0178***	−0.0177***
	(−6.28)	(−6.24)
ROA	−0.1997***	−0.1956***
	(−7.27)	(−7.07)
LEV	0.0365***	0.0367***
	(3.54)	(3.56)
Growth	0.0731***	0.0728***
	(15.79)	(15.76)
Cas	−0.0376***	−0.0377***
	(−18.69)	(−18.63)
Turnover	−0.0056	−0.0054
	(−1.32)	(−1.26)
Bsi	−0.0084***	−0.0084***
	(−7.26)	(−7.26)
Ind	−0.0687**	−0.0680**
	(−2.06)	(−2.04)
Mas	0.0011***	0.0011***
	(7.64)	(7.62)
Dua	0.0148***	0.0149***
	(3.81)	(3.85)
TOP	0.0003***	0.0003***
	(3.06)	(3.12)
Compensation	0.0081***	0.0082***
	(2.93)	(2.96)
C_Age	−0.0015***	−0.0015***
	(−6.17)	(−6.17)

Continued

C_Gender	−0.0113*	−0.0112*
	(−1.87)	(−1.84)
C_Degree	0.0010	0.0010
	(0.89)	(0.86)
Year	Yes	Yes
Industry	Yes	Yes
Constant	−2.3575***	−2.3654***
	(−48.61)	(−47.67)
Observations	18,435	18,435
Adjusted R^2	0.528	0.528

a. The values in the brackets are t test values. *, **, and *** indicate that the significance levels are less than 1%, 5%, and 10%, respectively.

5.5. Replace the Explained Variable

To further test the robustness of the findings, this paper refers to Nakano and Nguyen (2012), Koerniadi et al. (2014) and regresses models (2) and (3) separately using the logarithm of the standard deviation of the annualized weekly returns (Risk2) as a proxy variable for Risk. The regression results are shown in **Table 10**. From **Table 10**, it can be seen that the regression coefficient of DT and Risk2 in column (1) is −0.0083, which is significantly negative at the 10% level, indicating that derivatives can reduce corporate risk; the regression coefficient of DT*Ic in column (2) is −0.0169, which is significantly negative at the 1% level, indicating that derivatives have a more significant role in reducing corporate risk in firms with high quality of internal control. The conclusions of the study remain valid.

Table 10. The results of explained variable replacement.

	(1)	(2)
VARIABLES	Risk2	Risk2
DT	−0.0083*	0.0998***
	(−1.70)	(3.07)
Ic		−0.0099***
		(−5.22)
DT*Ic		−0.0169***
		(−3.36)
lnMV	−0.0122***	−0.0127***
	(−3.83)	(−4.00)
ROA	−0.2823***	−0.2442***
	(−8.64)	(−7.44)

Continued

LEV	0.0554***	0.0472***
	(4.68)	(4.00)
Growth	0.0733***	0.0729***
	(14.89)	(14.75)
Cas	−0.0491***	−0.0474***
	(−21.07)	(−20.34)
Turnover	−0.0078	−0.0060
	(−1.60)	(−1.22)
Bsi	−0.0110***	−0.0110***
	(−8.33)	(−8.41)
Ind	−0.0532	−0.0532
	(−1.39)	(−1.39)
Mas	0.0014***	0.0015***
	(7.82)	(8.03)
Dua	0.0085*	0.0086*
	(1.87)	(1.90)
TOP	0.0003**	0.0003***
	(2.51)	(2.58)
Year	Yes	Yes
Industry	Yes	Yes
Constant	−1.4470***	−1.4048***
	(−29.24)	(−27.91)
Observations	23,651	23,651
Adjusted R^2	0.436	0.438

a. The values in the brackets are t test values. *, **, and *** indicate that the significance levels are less than 1%, 5%, and 10%, respectively.

6. Further Analysis

6.1. SOEs and Non-SOEs

Whether China's unique ownership structure affects the risk management role of derivatives is an issue that deserves further discussion. Compared with non-SOEs, SOEs are not singularly focused on profit maximization as their ultimate business objective, and when faced with uncertain decision-making, firms may adopt a more conservative strategy as a means of more robustly fulfilling their social responsibility objectives (Shleifer, 1998). At the same time, state-owned firms have advantages in government subsidies and external financing, it is easier to obtain the resources needed for development from the outside, so state-owned firms have less risk. State-owned firms have established a perfect risk monitoring and

prevention system, for state-owned firms, derivatives to reduce the marginal reduction of firm risk will be relatively insignificant, derivatives to reduce the role of firm risk in state-owned firms is relatively insignificant. Based on the above views, this paper is grouped according to the nature of property rights and regression model (2).

The regression results are shown in Table 11. As can be seen from Table 11, derivatives have a significant risk reduction effect on non-state-owned firms, but no significant effect on state-owned firms, which may be due to the fact that state-owned firms have stronger access to their own resources and rely less on derivatives.

Table 11. The results of SOEs and Non-SOEs.

	(1)	(2)
	SOEs	Non−SOEs
VARIABLES	Risk	Risk
DT	0.0085	−0.0210***
	(1.28)	(−4.57)
lnMV	−0.0317***	−0.0065**
	(−7.41)	(−2.07)
ROA	−0.0166	−0.2715***
	(−0.32)	(−8.84)
LEV	0.1233***	−0.0039
	(8.18)	(−0.33)
Growth	0.0660***	0.0706***
	(9.28)	(15.27)
Cas	−0.0342***	−0.0375***
	(−11.02)	(−16.69)
Turnover	−0.0058	0.0003
	(−1.01)	(0.07)
Bsi	−0.0065***	−0.0064***
	(−4.68)	(−4.11)
Ind	−0.0978**	0.0127
	(−2.15)	(0.31)
Mas	0.0059***	0.0009***
	(4.66)	(6.38)
Dua	0.0009	0.0094**
	(0.12)	(2.32)
TOP	−0.0002	0.0006***
	(−1.07)	(4.99)

Continued

Year	Yes	Yes
Industry	Yes	Yes
Constant	−2.0877***	−2.6341***
	(−35.31)	(−47.43)
Observations	8,396	14,418
Adjusted R^2	0.537	0.508

a. The values in the brackets are t test values. *, **, and *** indicate that the significance levels are less than 1%, 5%, and 10%, respectively.

6.2. Large Firms and Small Firms

Firm size is an important indicator depicting how much resources a firm has (Schiffer & Weder, 2001) and large-scale firms tend to have more stable stakeholder relationships and outperform small-scale firms in terms of capital, information, financial strength, reputation, access to resources, and risk resilience. In the face of financial losses brought about by high-risk investment projects, small-scale firms are more likely to lack sufficient funds and fall into financial difficulties due to serious information asymmetry and high financing costs. Large-scale firms are inherently more resistant to risk, so the marginal reduction in corporate risk from derivatives will also be relatively insignificant in large-scale firms, and the role of derivatives in reducing corporate risk will be relatively insignificant in large-scale firms. Based on the above observations, this paper regresses model (2) by grouping the firms in the sample according to the median asset size.

The regression results are shown in Table 12. From Table 12, it can be seen that derivatives can significantly reduce the risk of small-scale firms, while there is no significant effect on large-scale firms, which may be due to the fact that large-scale firms have stronger access to their own resources and rely less on derivatives.

Table 12. The results of large firms and small firms.

	(1)	(2)
	Large firms	Small firms
VARIABLES	Risk	Risk
DT	−0.0028	−0.0156***
	(−0.59)	(−2.65)
lnMV	−0.0121***	0.0203***
	(−3.31)	(4.67)
ROA	−0.0790**	−0.2578***
	(−1.99)	(−8.10)
LEV	0.1171***	0.0115
	(8.46)	(0.93)

Continued

Growth	0.0729***	0.0465***
	(14.32)	(8.51)
Cas	−0.0356***	−0.0308***
	(−13.38)	(−12.55)
Turnover	0.0007	−0.0085
	(0.14)	(−1.55)
Bsi	−0.0071***	−0.0108***
	(−5.57)	(−6.59)
Ind	−0.0406	−0.0965**
	(−1.01)	(−2.18)
Mas	0.0014***	0.0010***
	(5.58)	(5.84)
Dua	0.0119**	0.0084*
	(2.29)	(1.87)
TOP	−0.0005***	0.0012***
	(−3.51)	(7.97)
Year	Yes	Yes
Industry	Yes	Yes
Constant	−2.5363***	−3.2884***
	(−43.00)	(−36.08)
Observations	11,831	11,826
Adjusted R^2	0.516	0.489

a.The values in the brackets are t test values. *, **, and *** indicate that the significance levels are less than 1%, 5%, and 10%, respectively.

6.3. Information Transparency

The higher the transparency of corporate information the more beneficial it is for investors to make effective investment decisions, and for firms with higher information transparency, less opportunistic behavior by management, more truthful and effective information about derivatives, and less intrusive information, are more likely to play a positive role. For companies with poor information transparency, derivative instruments may not necessarily reduce their risk. On the one hand, derivatives are characterized by high risk, high leverage, and high complexity, and investors in the capital market as well as industry analysts do not understand the important risk and surplus information related to the use of derivatives by listed companies (Chang et al., 2016). On the other hand, it is possible that the management discloses information about derivatives selectively. In this case, the derivatives themselves do not truly reflect the situation of the firm, so the worse the information transparency the less obvious the role derivatives play in the firm. Based on the above views, this

paper draws on Edward and George (2011) to use analysts' predictive divergence (FDISP) to measure the information transparency of listed firms and regresses the model (2) on the median grouping of predictive divergences. The higher the FDISP is, the lower the information transparency of the firms are, and vice versa.

Table 13. The results of firms with different information transparency.

	(1)	(2)
	Low information transparency	High information transparency
VARIABLES	Risk	Risk
DT	0.0016	−0.0124**
	(0.27)	(−2.07)
lnMV	−0.0401***	−0.0144***
	(−9.67)	(−3.51)
ROA	0.0325	−0.2626***
	(0.69)	(−5.62)
LEV	0.0836***	0.0087
	(5.26)	(0.56)
Growth	0.0958***	0.0892***
	(15.02)	(14.00)
Cas	−0.0291***	−0.0393***
	(−9.76)	(−12.95)
Turnover	−0.0222***	0.0032
	(−3.35)	(0.53)
Bsi	−0.0060***	−0.0099***
	(−3.53)	(−6.43)
Ind	−0.0393	−0.0258
	(−0.79)	(−0.56)
Mas	0.0005**	0.0016***
	(2.17)	(6.60)
Dua	0.0203***	0.0050
	(3.55)	(0.90)
TOP_10	−0.0002	0.0001
	(−1.24)	(0.77)
Year	Yes	Yes
Industry	Yes	Yes
Constant	−2.0063***	−2.3735***
	(−31.08)	(−37.40)
Observations	8,037	8,032
Adjusted R^2	0.567	0.605

The regression results are shown in Table 13. From Table 13, it can be seen that derivatives can significantly reduce the risk of high information transparency firms, while there is no significant effect on low information transparency firms.

7. Conclusion and Suggestion

Although China's derivatives market started relatively late, its development is more rapid, the use of derivatives by listed companies is also increasing, the scale is increasing, and the economic effects of the use of derivatives have attracted the attention of many scholars and capital markets. There is relatively extensive domestic research on derivatives and firm value, while there is relatively little research on derivatives and firm risk, and the current research has not reached a consistent conclusion. Therefore, this paper takes a sample of Chinese A-share listed companies in Shanghai and Shenzhen during the period of 2010-2020 to study and analyse the effect of the use of derivatives on corporate risk, as well as the moderating effect of internal control on the relationship between derivatives and corporate risk. We find that derivatives use can reduce corporate risk, and the quality of internal control intensifies the risk hedging effects; in order to test the robustness of the results, we adopt Instrumental variable method, the treatment effect model, lagging the explanatory variables by one period, adding control variables and replacing the explained variables, and the results show that the above conclusions are still robust. In further analysis, we find that the effect of derivatives on reducing corporate risk is only significant in non-state-owned firms, small firms and firms with higher information transparency. The findings of this paper explain, to a certain extent, the motivation for firms to use derivatives and their risk management effects, verify the moderating role of internal control in firms' risk management by using derivatives, and give certain insights for listed companies in China to carry out risk management.

The following recommendations are made based on the findings of this paper:

First of all, China should establish a perfect supervisory system for the derivatives market and strengthen the governmental supervision of the derivatives market. At present, China's derivatives market has developed rapidly, but the supervision and management system of China's derivatives market still has some defects, and the understanding of derivatives is not thorough enough. Therefore, the supervision and management system of China's derivatives market needs to be improved and the supervision of the derivatives market needs to be strengthened. China can learn from the mature supervision and management system and legal system of the derivatives market in other countries, so as to establish a supervision and management system of the derivatives market in line with the characteristics of China.

Second, China needs to strengthen the requirements for disclosure of information on derivatives and improve the legal system to combat excessive speculative behavior. Most listed companies in China do not disclose in detail the purpose of using derivatives and other related information in their financial reports, so it

is difficult to determine whether the purpose of using derivatives is hedging or speculation. Refining and enforcing the disclosure of information on derivatives can not only help investors understand the possible impact of derivatives on firms, but also inhibit the speculative behavior of management using derivatives. Therefore, the relevant departments should formulate a more detailed disclosure system for derivatives to reduce the degree of information asymmetry, to provide a basis for investors to make investment decisions, and to reduce the possibility of management using derivatives for speculative arbitrage.

Finally, firms should strengthen the risk management mechanism of derivatives and improve the awareness of risk management. Firms can start from the governance environment, internal control, risk identification and other aspects to improve the long-term mechanism of risk management of firms using derivatives. Non-state-owned firms, small firms and firms with high information transparency have a greater need to rationally select and use derivative financial instruments, enhance their governance and strengthen the risk management effect of derivatives.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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