American Journal of Industrial and Business Management, 2023, 13, 1256-1277
https://www.scirp.org/journal/ajibm
ISSN Online: 2164-5175
ISSN Print: 2164-5167

Does the Derivatives Usage Affect Corporate Capital Expenditure? Evidence from China

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How to cite this paper: Zhang, G. L., Guo, Z. Q., Liu, J. N., & Wang, Z. (2023). Does the Derivatives Usage Affect Corporate Capital Expenditure? Evidence from China. *American Journal of Industrial and Business Management, 13,* 1256-1277.
https://doi.org/10.4236/ajibm.2023.1311069

Received: October 23, 2023
Accepted: November 24, 2023
Published: November 27, 2023

Abstract

Based on hand-collected data of financial derivatives in listed firms of China, this paper discusses the impact of derivative usage on capital expenditures in emerging markets. It is found that the capital expenditure of derivative users is lower than non-users, and the mechanism is that derivative usage reduces the company's borrowing capacity. The results remain robust after the test of sensitivity test and control of endogeneity. Further research shows that the higher derivative usage intensity, the lower the capital expenditure; The implementation of accounting standards such as Fair Value Measurement has mitigated the adverse impact of derivative usage on capital expenditures; The effect of using derivative to reduce capital expenditures mainly occurs in non-SOEs. From the perspective of economic consequences, the corporate value of derivative users is lower, and the change of derivative accounting standards helps to alleviate the adverse impact of derivatives on corporate value.

Keywords

Derivatives, Capital Expenditures, Risk Management, Borrowing Capacity, Corporate Value

1. Introduction

The academic research on derivatives originated from the impact on corporate value and has obtained rich research results (Graham & Rogers, 2002; Guay & Kothari, 2003; Carter & Simkins, 2006; Jin & Jorion, 2006; Bartram et al., 2009; Belghitar et al. 2013; Gilje & Taillard, 2017); however, due to the differences in sample industry selection, sample period, development level of derivative markets in different countries, types of hedging risks and types of derivatives, etc., scholars have not reached consistent research conclusions. Moreover, there are

few researches on how do derivative usages influence corporate value (Gilje & Taillard, 2017).

According to the classic MM theory, corporate value depends on investment behavior, so the influence of derivative usage on investment is the key to open the "black box" that derivative usage affects corporate value. The effect of the use of derivatives on investment is the real effect of derivatives (Campello et al., 2011), but there are few studies on the relationship between them. Besides, most of the existing literatures are based on developed country samples. For example, Stulz (2004) found that the use of derivative instruments can protect the future cash flows of the Company from market risks, thus reducing the possibility of financial crisis and reducing the problem of under-investment; At the same time, it can mitigate the under-investment and over-investment behavior caused by the information asymmetry between investors and management. Froot et al. (1993) found that the use of derivative can improve the borrowing ability, thereby increasing the leverage of the company, expanding the source of funds, and thus avoiding the problem of under-investment caused by insufficient funds; Using the firm fixed effect model, Berrospide et al. (2011) found that the use of derivative improves the level of firm capital expenditure, and non-derivative users are more sensitive to investment cash flow, while derivative users are not sensitive to cash flows. The use of derivative reduces the cost of debt and imposes binding terms on the investment, which in turn enhances the ability of the company to invest (Campello et al., 2011). Gilje and Taillard (2017) used the Canadian light oil price and the unexpected interruption of WTI US West Texas Light Crude Oil Quotation System as natural experiments, and found that after the impact, compared with the US light oil manufacturers, the Canadian light oil manufacturers reduced investment and had lower corporate valuation, and the hedging affected corporate value by mitigating the cost of debt crisis and under-investment.

In summary, while the literature on the use of derivative and firms' investment behaviour is rich, there has little research on the impact of derivative use on investment behaviour in emerging markets. The development history and regulatory environment of emerging market countries are quite different from those of developed countries, and the existing western theories on derivatives cannot fully explain the current situation of derivatives use and its impact on investment behaviour in developing countries. China, as the world's largest emerging market countries, in the early 1990s, attempted to develop the derivatives market; after the financial crisis in 2008, the derivatives market has been strictly regulated; in recent years, the government has introduced a relevant system to guide the use of derivative by enterprises for risk hedging, and the use of derivative in the company begins to increase year by year. As coordination of investment and financing mechanism, the impact of derivative on company's investment behaviour is also becoming more and more important. Derivative usage of Chinese firms is highly representative of emerging markets. Based on this, this paper takes Chinese listed companies as a sample to study the impact of derivative use on

investment level and its mechanism of action.

The possible contributions of this paper are: first, it investigates the path of the impact of derivative usage on firm value and finds that derivative use reduces the level of firm capital expenditure, which in turn reduces firm value. Second, relevant changes in accounting standards can help alleviate the adverse effect of derivative usage on investment; third, based on data from Chinese listed companies, this paper investigates the impact of derivative use on firms' investment levels in emerging capital markets and derivative markets, further enriching the literature on the economic consequences of derivative use.

The remainder of the paper is organized as follows. In Section 2, we review related literature and develop our hypotheses. In Section 3, we describe the sample, data, study sample, and research design. We present and discuss the empirical results in Section 4. Lastly, we summarize and conclude the study in Section 5.

2. Research Hypotheses

Derivative usage is an important part of corporate risk management and can influence investment behaviour by coordinating the relationship between corporate finance and investment behaviour (Froot et al., 1993), which in turn influences capital expenditure.

First, the impact of the risk management effectiveness of derivatives. When the risk management of derivative is more effective, it can protect the company's future cash flow from market risk, and ensure that the company has sufficient internal funds to avoid unnecessary fluctuations in capital expenditure or external financing, and stabilise the level of the company's capital expenditure. When external financing costs are high and financing is more difficult, hedging allows the company to continue with investments that have a NPV greater than 0 at a lower level of cash flow (Froot et al., 1993). Berrospide et al. (2011) found that the cash flow sensitivity of derivative users is lower than that of non-users. That is, derivative use allows companies to engage in investment activities even when internal cash flow levels are low. Derivatives risk hedging reduces the likelihood of financial crises and thus underinvestment. When a company is in financial distress, shareholders bear the risk of investment, while investment returns are mainly paid to creditors as interest, thus shareholders and management may abandon investment projects with a NPV greater than 0, triggering the underinvestment problem (Gilje & Taillard, 2017). If the risk management of derivative is ineffective or even speculative, it will have a negative impact on the volatility of the company's cash flow, which will be detrimental to the company's investment behaviour.

Second, the impact of derivative use on financing capacity. Financing is a prerequisite for the investment. In China, the issuance shares are strictly regulated. Listing to raise capital requires compliance with a number of requirements such as financial performance, non-financial performance and multiple layers of approvals, taking at least one year from the time of application to the final listing.

As a result, corporate finance is dominated by debts, which are particularly important for companies. The impact of the use of derivative on investment behaviour depends first and foremost on the impact on the ability to borrow; if the use of derivative enhances borrowing capacity, it can increase the company's gearing ratio and the role of debt tax shields, expanding the company's sources of funding and thus avoiding underinvestment due to insufficient funds (Mayers & Smith, 1987; Froot et al., 1993); If derivatives adversely affect the ability to raise debt, they reduce the level of investment.

Based on this, the opposing hypotheses are proposed as follows:

Hypothesis 2a: Compared to non-users, derivative users have higher level of investment.

Hypothesis 2b: Compared to non-users, derivative users have lower level of investment.

3. Research Design

3.1. Sample Selection and Data Source

The Chinese Accounting Standards (CAS) in 2006 included Hedging Accounting Standards for the first time, which made it possible to do a large sample of Chinese listed companies related to the use of derivative. However, in 2007, the subprime mortgage crisis rapidly spread into a global financial crisis, and the use of derivative became the hardest hit, and the use of derivative by Chinese firms was also quite affected. Derivative use gradually returned to normal after the post-crisis era in 2009. Based on this, this paper takes A-share listed companies from 2010-2016 as the initial sample to study the impact of derivative use on companies' investment level.

Firms with no risk exposure during the sample period are deleted from this paper as the use of derivative is mainly used to hedge against the risk of exchange rate, interest rate and commodity price fluctuations. Exposures are judged as follows: a company is considered to have foreign exchange risk exposure if it has foreign income or foreign subsidiaries (Makar & Huffman, 2001); Commodity exposure is typically industry-specific, and an industry is considered to have commodity exposure if the derivatives users percentage of commodity derivative exceeds 10 per cent (Purnanandam, 2008); It is also considered that firms that use interest rate derivatives and other derivatives are also exposed. Since financial sector firms are both users and providers of derivatives, this paper removes the financial sector firms; And due to the higher probability of financial anomalies in ST companies, companies that were ST during the sample period and those with missing data were removed, resulting in 2083 companies and 10,710 observations.

Drawing on Triki (2006), Chang et al. (2015), and Guo et al. (2021), data on the use of derivative are collected manually in firms' annual reports in the following way: Search for derivatives, hedges, forwards, futures, options, swaps, swaps, financial assets (liabilities) held for trading, assets (liabilities) at fair value through profit or loss, other (non) current assets (liabilities), etc., gains and

losses on changes in fair value, investment income, and risks associated with (related to) financial instruments in the annual report, and determine whether the company uses derivatives, the fair value of derivatives and the impact of t derivatives on the gains and losses on changes in fair value and on investment income, etc., according to the context.

Foreign currency statement translation differences data from Reset database, R&D related data from CCER database, and other financial data from Wind database.

3.2. Variables and Model

To test the effect of derivative usage on the level of investment, following Froot et al. (1993), Berrospide et al. (2011), model (1) is constructed:

$$\text{Capx}_{it+1} = \alpha_0 + \alpha_1 \text{DT}_{it} + \text{Controls}_{it} + \sum \text{Industry} + \sum \text{Year} + \varepsilon_{it} \quad (1)$$

Capx_{it+1} is the capital expenditure level, and following Trapp and Weiβ (2016), capital expenditure is measured by the proportion of cash paid for the purchase and construction of fixed assets, intangible assets and other long-term assets in operating income. In order to mitigate the possible reverse causality between derivative use and investment, the effect of derivative use in period t on the level of investment in period $t + 1$ is examined. DT is a dummy variable for the use of derivative and takes the value of 1 if derivatives are used and 0 otherwise.

Controls are control variables including firm size (Size), tangible assets (PPE), profitability (ROA), gearing ratio (Debtratio), quick ratio (Quickratio), firm's financial crisis likelihood (Z-value), non-debt tax shield (SGA), firm's growth (MB), share of overseas business (Oversea), Dibble's internal control index (Icindex), nature of ownership (Ownership), firm's age (Age), cash dividend per share (Dividend), and net cash flow from operating activities as a percentage of operating income (OCF).

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 capital expenditure. The definition and measurement of variables are shown in Table 1.

Table 1. Variable definitions and metrics.

Variables	Definitions
Explained variable	
Capx	The level of capital expenditure, cash paid for the purchase and construction of fixed assets, intangible assets and other long-term assets as a percentage of operating income.
TQ	Tobin Q value, [(Total shares − B shares) * Closing price A-share current value + B shares*Closing price current value * Exchange rate for the day]/Total assets
RD	R&D intensity, total R&D expenditure as a percentage of operating revenue.
OCFVOL	Volatility of cash flow from operating activities, standard deviation of net cash flow from operating activities as a percentage of operating income for periods $t-1$, t, and $t+1$.
Debt cap	Level of new debt, new debt for the year as a percentage of total assets at the end of the previous period.

Continued

Explanatory variable	
DT	Dummy variable for the use of derivative, taking the value of 1 if derivatives are used and 0 otherwise.
DT ratio	Intensity of use of derivative, fair value of derivatives as a percentage of total assets at the end of the period.
POST2014	The value is taken as 1 after the implementation of the 2014 standards on Presentation of Financial Instruments, Fair Value Measurement, and 0 otherwise.
Control variable	
Size	Firm size, the natural logarithm of the firm's total assets at the end of the period.
PPE	Fixed assets, fixed assets as a percentage of total assets at the end of the period.
ROA	Return on total assets, EBIT/Average of total assets at beginning and end of period
Debt ratio	Gearing ratio, total liabilities /total assets at the end of the period.
Quick ratio	Quick ratio, quick assets/current liabilities.
Z	The likelihood of a firm's financial failure or bankruptcy, the lower the z-value, the more likely the firm is to experience bankruptcy.
SGA	Non-debt tax shield, (administrative expenses + selling expenses)/operating income
MB	(Market value of equity + book value of liabilities)/Total assets.
Oversea	The percentage of overseas revenue, overseas revenue as a percentage of operating revenue.
Ic index	Dibble Internal Control Index, the higher the internal control index, the better the quality of internal control.
Ownership	The dummy variable for the nature of firm ownership, takes the value of 1 for SOEs and 0 for others.
Age	Firm age, The number of years since the company has been established.
Frisk	Exposure to exchange rate risk, absolute value of the regression coefficient of the company's monthly stock return on the monthly effective exchange rate change of the CNY for the past three years (including the current year) (Zhang, 2009; Chang et al., 2015; Donohoe, 2015).
I risk	Interest rate risk exposure, absolute value of the regression coefficient of the company's monthly stock return on the monthly change in SHIBOR over the past three years (including the current year) (Zhang, 2009; Chang et al., 2015; Donohoe, 2015).
C risk	Commodity price exposure, absolute value of the regression coefficient of the company's monthly stock return on the monthly PPI change over the past three years (including the current year) (Zhang, 2009; Chang et al., 2015; Donohoe, 2015).
MI	Management compensation performance sensitivity, change in directors' and supervisors' income due to change in company value as a proportion of total directors' and supervisors' income, which is measured by number of shares held by directors and supervisors * closing price of shares/(number of shares held by directors and supervisors * closing price of shares + total annual remuneration of directors and supervisors) (Chang et al., 2015).
CETR	The cash effective tax rate, the weight of the sum of the current year's and the following year's ($t+1$) tax liabilities to the sum of operating profits, is reset to 1 if it exceeds 1, or to 0 if it is less than 0 (Chang et al., 2015).
ROAVOL	Volatility of return on total assets, standard deviation of return on total assets over the last five years (including the current year).
NCFVOL	Volatility of cash flows from operating activities in the past five years (including the current year), standard deviation of net cash flows from operating activities as a percentage of operating income in the past five years (including the current year).
Industry	Industry control variables
Year	Year control variables

4. Empirical Findings

4.1. Descriptive Statistics

The results of the descriptive statistics are shown in Table 2, and as can be seen from Panel A, the average proportion of capital expenditure to total assets is 11.6%. The mean of Tobin Q 2.372, the average proportion of R&D expenditure to operating revenue is 10%.[1] During the sample period, 21.1% of companies used derivatives. The proportion of derivative users is much lower than the proportion of developed countries such as Europe and the United States, as well as developing countries such as South Africa and Malaysia. For derivative users, the fair value of derivative accounts for 10% of total assets. In terms of control variables, on average, the proportion of fixed assets to total assets is 21.5%, the return on total assets is 5.64%, the mean gearing ratio is 40.8%, the mean quick ratio is 2.267, the mean Z-value is 8.417, the sum of administrative expenses and selling expenses as a percentage of operating income is 16.2%, the mean MB of the company is 2.802, the mean percentage of overseas business is 17.5%, the mean value of the Dibble Internal Control Index is 607.6, 33.1% of companies are SOEs, the mean cash dividend per share is 0.119, and the mean value of the company's net cash flow from operating activities as a percentage of operating income is 7.59%.

As can be seen from Panel B, the number of derivative users increased year by year, from 216 in 2010 to 431 in 2016. The proportion of derivative users also showed an overall upward trend, from 12.4% to 16.2%. And as can be seen from Panel C, the mean and median values of capital expenditure are lower for derivative users compared to firms that do not use derivatives. The T-value for the test of difference in means is 7.8429 and the Z-value for the median rank sum test is 8.221, respectively, which are both significant at the 1% level. The results of Panel C indicate that the capital expenditure level of derivative users is lower than non-users, supporting hypothesis H1b to some extent.

Before regression, this paper conducts correlation coefficient analysis on the main variables. The Pearson correlation coefficient matrix shows that the use of derivative is negatively related to the level of capital expenditure and significantly at the 1% level, which supports H1b to some extent too. Most of the correlation coefficients between the main independent variables are less than 0.3, with a maximum of 0.6, and the mean variance inflation factor (VIF) is 2.35, indicating that there is no serious covariance between the main independent variables.

4.2. Analysis of Regression Results

To control for possible fixed effects and sequence related issues in companies, this paper uses the cluster regression method recommended by Petersen (2009) and Gow et al. (2010) to perform dual clustering by company and year.

[1]Due to a small number of companies not disclosing Tobin Q values and R&D intensity, we ignore those missing values.

Table 2. Descriptive statistics for the main variables. (a) Full sample descriptive statistics; (b) Derivatives usage by year; (c) Difference test of capital expenditure.

(a)

variable	N	mean	sd	min	p50	max
CAPX	10,710	0.116	0.142	0.0009	0.0694	0.933
TQ	10,403	2.372	1.962	0.208	1.798	10.20
RD	9170	0.0406	0.0394	0.0002	0.0333	0.253
DT	10,710	0.211	0.408	0	0	1
DT ratio	1823	0.0042	0.0143	0	0.0004	0.109
Size	10,710	22.04	1.279	19.74	21.82	25.96
PPE	10,710	0.215	0.148	0.0024	0.186	0.720
ROA	10,710	0.0564	0.0470	−0.0880	0.0502	0.226
Debt ratio	10,710	0.408	0.209	0.0462	0.398	0.861
Quick ratio	10,710	2.267	2.924	0.174	1.270	18.55
Z	10,710	8.417	10.87	0.478	4.557	65.34
SGA	10,710	0.162	0.115	0.0162	0.134	0.653
MB	10,710	2.802	1.885	0.920	2.196	10.63
Oversea	10,710	0.175	0.223	0	0.0813	0.876
Ic index	10,710	607.6	212.9	0	673.0	905.5
Ownership	10,710	0.331	0.471	0	0	1
Age	10,710	15.19	5.338	4	15	28
Dividend	10,710	0.119	0.154	0	0.0700	0.810
OCF	10,710	0.0759	0.156	−0.673	0.0691	0.690

(b)

Variable	2010	2011	2012	2013	2014.	2015	2016
sample size	1736	1967	2096	2144	2260	2455	2657
derivatives user companies	216	265	278	303	376	416	431
Percentage of derivatives used	12.4%	13.5%	13.3%	14.1%	16.6%	16.9%	16.2%

(c)

DT = 0 (1)			DT = 1 (2)		Diff [(1)-(2)]		Diff [(1)-(2)]	
Variable	Mean	Median	Mean	Median	Mean	T-value	Median	Z-value
Capx	0.121	0.0734	0.0947	0.0560	0.0264***	7.8429	0.0174***	8.221

To test hypothesis 1, model (1) is regressed and the results are shown in column (1) of **Table 3**, the derivative use dummy variable DT is significantly negatively correlated with firms' capital expenditures at the 1% level, suggesting that the level of capital expenditures of derivative users is lower as compared to firms that do not use derivatives, and Hypothesis 1b passes the test.

Table 3. Derivative use and firms' investment levels.

	(1)	(2)	(3)	(4)
		Replace dependent variables		After pairing
VARIABLES	Capx	Capx1	RD	Capx
DT	−0.0226***	−0.0265***	−0.0061***	−0.0284***
	(−5.03)	(−5.35)	(−4.88)	(−3.88)
Size	0.0126***	0.0147***	0.0013	0.0219***
	(4.78)	(5.20)	(1.32)	(5.07)
PPE	0.1354***	0.0985***	−0.0385***	0.2178***
	(7.39)	(4.47)	(−9.35)	(8.00)
ROA	0.0138	0.1445*	−0.1206***	−0.0022***
	(0.24)	(1.76)	(−5.86)	(−3.27)
Debt ratio	−0.0351	−0.0522**	−0.0250***	−0.0388**
	(−1.58)	(−2.55)	(−5.97)	(−1.97)
Quick ratio	0.0138***	0.0147***	0.0038***	0.0159***
	(4.65)	(4.05)	(6.48)	(7.22)
Z	−0.0030***	−0.0028***	−0.0007***	−0.0037***
	(−3.42)	(−2.59)	(−3.65)	(−10.34)
SGA	0.0816***	0.0912***	0.0258***	0.0367***
	(3.29)	(3.27)	(2.62)	(3.72)
MB	0.0107***	0.0127***	0.0064***	0.0143***
	(4.30)	(4.08)	(7.13)	(4.82)
Oversea	0.0303***	0.0408***	−0.0011	0.0173
	(3.40)	(4.03)	(−0.29)	(1.40)
Ic index	−0.0001***	−0.0000***	0.0000***	−0.0000**
	(−6.20)	(−4.51)	(3.82)	(−2.13)
Ownership	−0.0338***	−0.0424***	−0.0026*	−0.0338***
	(−7.87)	(−8.28)	(−1.67)	(−6.48)
Age	−0.0013***	−0.0018***	−0.0006***	−0.0013
	(−3.02)	(−3.69)	(−4.88)	(−1.23)
Dividend	−0.0608***	−0.0892***	−0.0087*	−0.0429***
	(−4.69)	(−6.71)	(−1.76)	(−2.64)
OCF	0.0701***	0.0830***	0.0189***	0.1254***
	(4.03)	(3.89)	(3.52)	(3.75)
Industry	Controlled	Controlled	Controlled	Controlled
Year	Controlled	Controlled	Controlled	Controlled
Constant	−0.1798***	−0.0221	−0.0090	−0.3574***
	(−3.44)	(−0.14)	(−0.40)	(−3.50)
Observations	10,710	10,710	9174	3174
Adjusted R2	0.1493	0.1285	0.2903	0.1627
F	38.28	39.89	119.7	22.76

a. The numbers in parentheses represent the T-value of the robust standard error for double clustering at the company and year levels; *, **, and *** represent significant at the 10%, 5%, and 1% levels, respectively.

Different from studies on companies in developed Western countries, the use of derivative not only do not improve the investment level of Chinese listed companies, but on the contrary, the use of derivative reduces the company's capital expenditure level. From the perspective of control variables, consistent with previous studies, the level of capital expenditure is higher, when the total asset (Size) is larger, the proportion of tangible assets is higher, the company's liquidity is better, the non-debt tax shield is higher, the company's growth is better, the proportion of overseas business income is higher, and the internal cash flow is more abundant.

4.3. Robustness Test

1) Replacement of dependent variable

In order to test the robustness of the research results, the dependent variable is replaced. Two measurement methods are adopted for the level of capital expenditure: The first approach is to use the sum of cash paid for the purchase and construction of fixed assets, intangible assets and other long-term assets and net cash paid for the acquisition of subsidiaries and other business units, less the net cash recovered from the disposal of fixed assets, intangible assets, investment properties and other long-term assets and the net cash received from the disposal of subsidiaries or other business units, the result is Capx1, which is the level of the company's capital expenditure, and standardised by operating income; The second way to measure capital expenditure is by the level of R&D expenditure. R&D expenditure is also an important component of corporate capital expenditure, which is the sum of expensed and capitalized R&D expenditure, to operating income.

The regression results, as shown in columns (2) and (3) of **Table 3**, indicate that the dummy variable for derivative use DT, is still significantly negatively correlated with capital expenditures after replacing the capital expenditures measure, and both are significant at the 1% level, suggesting that the results of this paper are unaffected by the choice of the dependent variable indicators.

2) Endogeneity test: propensity score matching method

Bartram et al. (2011) use propensity score matching to control for the endogeneity problem of derivative use, and this paper draws on that approach to pair a sample of derivative users with a sample of non-users.

Based on Chang et al. (2015), Donohoe (2015), and Campbell et al. (2023), the paired variables are factors affecting the use of derivative as well as factors affecting the level of investment, including market value of the firm (MV), gearing (Debt ratio), ROA of total assets, ROA volatility (ROAVOL), cash flow volatility (OCFVOL), firm bankruptcy likelihood (Z), firm growth (MB), cash dividends per share (Dividend), and net cash flow from operating activities (OCF), industry and year effects. In this article, the propensity score matching method uses logit to estimate propensity scores, and only matches individuals within a common value range. The specific pairing method is nearest neighbor one-on-one

and put back matching.

The difference in capital expenditure of derivative users and non-users before and after pairing is shown in Table 4, from which it can be seen that after pairing, the level of capital expenditure of derivative users is lower, with a T-value of −5.89, which is greater in absolute value than the critical value of 1.96, indicating that the level of capital expenditure of derivative users is low, which, to some extent, indicates that the findings of this paper are robust.

Continuing the regression after pairing, the results are shown in column (4) of Table 3: consistent with the results of the main regression in this paper, after pairing, the use of derivative is significantly negatively correlated with the company's capital expenditure level, and the findings are robust.

3) Endogeneity tests: treatment effects model

Derivative use is an endogenous choice for companies (Pincus & Rajgopal, 2002; Choi et al., 2015), company size, asset-liability ratio, exchange rate, interest rate and commodity price exposure, potential for financial crisis, performance sensitivity to management compensation, tax, growth, profit and cash flow volatility all affect the use of derivative. For this reason, this paper employs a treatment effects model to mitigate the problem of self-selection of the sample. The process is described below: Examining the effect of factors influencing the use of derivative by constructing model (2), from which we get Inverse Mills Ratio λ_i, and then add to model (1) for correcting the effect of derivative use on the level of firms' capital expenditures in the second-stage regression. If the coefficient of λ_i is significant, then there is indeed sample selection bias and the use of the treatment effects model is valid.

$$\Pr\left(\mathrm{DT}_{it}=1\right)=\Phi\left(\alpha_i Z_i\right) \tag{2}$$

Z_i is the influencing factor for the use of derivative. Following on Chang et al. (2015) and Campbell et al. (2023), firm size (Size), gearing ratio (Debt ratio), exchange rate exposure (F risk), interest rate exposure (I risk), commodity price exposure (C risk), financial crisis likelihood (Z), management compensation performance sensitivity (MI), cash effective tax rate (CETR), growth (MB), the volatility of return on total assets (ROAVOL), and cash flow volatility (NCFVOL) are included, and are lagged one period for all variables except firm size (Size).

The results are shown in Table 5: column (1) presents the results of the first-stage regression, in which firms that are larger and have higher debt ratios are more likely to use derivative. And column (2) is the regression results of derivative usage on the level of capital expenditure after the inclusion of λ_i, where λ_i is significant at the 1 percent level, suggesting that there is a self-selection problem and that the use of a treatment effects model is necessary; After accounting for the self-selection bias, the regression coefficients of the dummy variable for derivative use DT, remain significant at the 1% level, indicating that the level of capital expenditures by derivative users is significantly lower than that of firms that do not use derivative, and that the conclusion is robust.

Table 4. Difference in investment levels before and after matching.

VARIABLES	Treatment group	Control group	Difference	Standard error	T-value
Pre-match	0.0955	0.1278	−0.0323	0.0036	−8.97
Estimates after matching	0.0955	0.1269	−0.0313	0.0053	−5.89

Table 5. Treatment effects model results.

	(1)	(2)
VARIABLES	DT	Capx
Size	0.2340***	0.0221***
	(15.67)	(9.66)
L. Debt ratio	0.5355***	
	(5.01)	
L. F risk	−0.0017	
	(−0.21)	
L. I risk	0.1026	
	(1.12)	
L. C risk	−0.0014	
	(−0.32)	
L.ROAVOL	0.0013	
	(0.27)	
L.NCFVOL	−0.7688***	
	(−4.22)	
L.Z	0.0034	
	(1.37)	
L.MI	0.1391***	
	(3.72)	
L.CETR	−0.1699***	
	(−3.82)	
L.MB	−0.0945***	
	(−6.75)	
DT		−0.1087***
		(−4.88)
PPE		0.1626***
		(15.30)
ROA		−0.0340
		(−0.87)

Continued

Debt ratio		−0.0272**
		(−2.43)
Quick ratio		0.0145***
		(14.18)
Z		−0.0033***
		(−9.44)
SGA		0.0705***
		(5.19)
MB		0.0096***
		(6.25)
Oversea		0.0221***
		(3.49)
Ic index		0.0000
		(0.65)
Ownership		−0.0302***
		(−9.39)
Age		−0.0009***
		(−3.25)
Dividend		−0.0719***
		(−6.36)
OCF		0.0809***
		(8.59)
λi		0.0495***
		(3.86)
Industry	Controlled	Controlled
Year	Controlled	Controlled
Constant	−6.0235***	−0.4464***
	(−17.18)	(−9.29)
Observations	9582	9582

a. The numbers in brackets are z-values; *, ** and *** represent significant at the level of 10%, 5%, and 1% respectively.

4.4. Analysis of Mechanism

1) The impact of the risk management effect of derivatives.

The risk management effect of derivatives is reflected in the impact on the volatility of corporate cash flow. The fluctuation of macroeconomic factors such as exchange rate, interest rate and commodity price, will cause the fluctuation of

internal cash flow of enterprises, and then lead to the fluctuation of external financing need or investment level. When cash flow is short, if there are investment projects with net present value greater than 0, additional external financing should be carried out, or the investment projects should be postponed or even cancelled. At this time, it is a better choice to carry out unplanned financing. However, according to the pecking order theory, the cost of external financing is higher than that of internal financing, which may make the project with net present value greater than 0 unfeasible, thus reducing the investment level. When the risk management of derivatives is effective, the derivatives usage will hedge the impact of fluctuations of macroeconomic factors on cash flow, thus reducing the volatility of the company's cash flow, and stable cash flow will help the company to carry out investment and financing activities in an orderly manner. If on the contrary, it will have an adverse impact on capital expenditure behavior.

In order to further test the risk management effect of derivatives, this paper examines the impact of derivatives on cash flow volatility. The results are shown in column (1) of **Table 6**. Derivative usage dummy variable DT is positively correlated with cash flow volatility, but it does not pass the significance test, indicating that the use of derivative instruments does not play a role in reducing cash flow volatility.

2) The impact of derivatives usage on the ability to borrow.

The insufficient financing of firms may lead to a decrease in capital expenditure. The use of derivative could raise the level of capital expenditure by increasing the ability of companies to borrow and provide more funding for investment (Carter & Simkins, 2006). If derivatives adversely affect the ability to borrow, it will reduce the level of capital expenditure.

To further examine the impact of derivative usage on debt capacity, following on Zou (2010) and Trapp and Weiβ (2016), we adopt the ratio of company *i*'s new debt in year $t+1$ to the total assets at the end of year t (Debtcap_{it+1}) to measure of the company's debt capacity in year *t*. The results, as shown in column (2) of **Table 6**, show that derivatives and the level of new debt are significantly negative at the 1% level, indicating that derivative usage reduced the company's debt capacity and further reduced the company's capital expenditure level.

4.5. Further Analysis

1) The impact of the derivative use intensity of on investment level

Following on Wong (2000) and Campbell et al. (2019), the fair value of derivative to total assets (DT ratio) is used to measure the intensity of derivative use. On the basis of model (1), DT ratio is used to replace dummy variable DT for regression. The results are shown in column (1) of **Table 7**, and it is found that the intensity of derivative use (DT ratio) is negatively correlated with the level of capital expenditure, and is significant at the 1% level, indicating that among derivative users, the higher the proportion of fair value of derivatives to total assets, the lower the level of capital expenditure.

Table 6. Effects of derivative use on cash flow volatility and debt capacity.

	(1)	(1)
VARIABLES	OCFVOL	Debtcap
DT	0.0025	−0.0372***
	(0.72)	(−3.16)
Size	−0.0106***	0.0036
	(−3.40)	(0.40)
PPE	−0.0462***	0.0689**
	(−3.38)	(2.55)
ROA	−0.0114	−0.0910
	(−0.38)	(−0.41)
Debt ratio	0.0553***	−0.3141***
	(4.70)	(−5.04)
Quick ratio	0.0010	0.0101*
	(1.44)	(1.96)
Z	−0.0002	0.0137***
	(−0.70)	(3.93)
SGA	0.2487***	−0.2282**
	(12.61)	(−2.00)
MB	0.0048***	0.0149**
	(4.12)	(2.50)
Oversea	0.0160*	0.0664***
	(1.65)	(2.73)
Ic index	−0.0000	0.0001**
	(−1.31)	(2.43)
Ownership	−0.0331***	−0.0561***
	(−3.85)	(−3.31)
Age	0.0008	−0.0053**
	(0.21)	(−2.55)
Dividend	0.0165*	−0.2421***
	(1.82)	(−5.01)
OCF	−0.0362***	−0.2585***
	(−5.54)	(−3.70)
Industry	Controlled	Controlled
Year	Controlled	Controlled
Constant	0.1649	1.3949***
	(1.59)	(4.75)
Observations	10,710	10,710
Adjusted R-squared	−0.1799	0.1067
F	13.40	19.16

a. Figures in brackets are T-values of robust standard errors of double clustering at the company and year levels; *, ** and *** represent significant levels at 10%, 5% and 1% respectively.

Table 7. Intensity of derivative use, ownership, changes in accounting standards, and capital expenditure.

	(1)	(2)	(3)
VARIABLES	Capx	Capx	Capx
DT ratio	−0.3779***		
	(−2.77)		
DT		−0.0257***	−0.0289***
		(−6.99)	(−5.29)
POST2014			−0.0524***
			(−12.22)
DT*POST2014			0.0133**
			(2.38)
DT*Ownership		0.0109*	
		(1.91)	
Size	0.0152***	0.0155***	0.0159***
	(4.31)	(9.75)	(6.48)
PPE	0.2037***	0.1605***	0.1614***
	(6.16)	(14.38)	(8.13)
ROA	0.0626	0.0032	−0.0012
	(0.62)	(0.08)	(−0.02)
Debt ratio	−0.0216	−0.0407***	−0.0400*
	(−0.70)	(−3.59)	(−1.90)
Quick ratio	0.0170***	0.0143***	0.0143***
	(5.07)	(9.75)	(4.67)
Z	−0.0044***	−0.0031***	−0.0031***
	(−5.93)	(−7.09)	(−3.57)
SGA	0.0555	0.0592***	0.0589**
	(1.41)	(3.98)	(2.38)
MB	0.0191***	0.0109***	0.0111***
	(4.65)	(6.39)	(4.52)
Oversea	0.0168	0.0243***	0.0236***
	(1.17)	(3.65)	(2.59)
Ic index	−0.0001***	−0.0001***	−0.0001***
	(−4.79)	(−7.85)	(−6.04)
Ownership	−0.0211***	−0.0331***	−0.0311***
	(−3.31)	(−10.29)	(−7.33)
Age	−0.0015*	−0.0011***	−0.0011**
	(−1.75)	(−3.83)	(−2.40)

Continued

Dividend	−0.0387*	−0.0638***	−0.0637***
	(−1.92)	(−6.36)	(−4.86)
OCF	0.1385***	0.0844***	0.0847***
	(2.67)	(5.57)	(5.03)
Industry	Controlled	Controlled	Controlled
Year	Controlled	Controlled	Controlled
Constant	−0.2399***	−0.1669***	−0.1735***
	(−2.79)	(−4.84)	(−3.13)
Observations	1831	10,710	10,710
Adjusted R-squared	0.1902	0.1286	0.1286
F	20.69	49.25	45.23

a. Figures in brackets are T-values of robust standard errors of double clustering at the company and year levels; *, ** and *** represent significant levels at 10%, 5% and 1% respectively.

2) The impact of ownership

This paper continues to examine the impact of derivative usage on capital expenditure in different ownership companies. The results are shown in column (2) of Table 7, where the coefficient of is negative and significant at the 1% level, indicating that the use of derivative has reduced the capital expenditure level of non-SOE enterprises. The coefficient of the intersection term DT * Ownership is significantly positive at the 10% level, indicating that compared to SOEs, the derivative usage has a stronger effect on reducing capital expenditure in non-SOEs.

3) Impact of Fair Value Measurement and Presentation of Financial Instruments (Revised) in 2014.

In 2014, the Ministry of Finance revised the accounting standards for the Presentation of Financial Instruments and formulated the standards for Fair Value Measurement. The Presentation of Financial Instruments (revised in 2014) elucidates the objectives of presenting financial instruments: to facilitate a reasonable assessment of the significance of financial instruments to enterprises' financial position and operating results, as well as the nature and extent of risks that these instruments expose enterprises to during the reporting period and at the end of the period. The "Fair value measurement" standard requires the disclosure of the three levels of fair value measurement and measurement basis, the standard emphasizes that the basis of confirmation is "contract terms and the economic substance reflected", and "not only in legal form" to determine whether it is a derivative instrument, and in many places adds the use of cases that should be recognized as derivative instruments. This paper further examines the impact that changes to accounting standards related to derivatives in 2014 on the capital expenditure behavior of derivative users. Therefore, on the basis of model (1), model (3) is constructed:

$$\begin{aligned} \text{Capx}_{it+1} = {} & \alpha_0 + \alpha_1 \text{DT}_{it} + \alpha_2 \text{DT}_{it} * \text{POST2014} + \text{POST2014} \\ & + \text{Controls}_{it} + \sum \text{Industry} + \sum \text{Year} + \varepsilon_{it} \end{aligned} \tag{3}$$

The treatment group is the derivative users (DT = 1), control group for firms that do not use derivatives (DT = 0). The value of POST2014 from 2010 to 2013 is 0; From 2014 to 2016, the value of POST2014 is 1. Controls_{it} is the control variables, which are consistent with model (1).

The results are shown in column (3) of Table 7, where the coefficient of the Intersection term DT * POST2014 is positive and significant at the 5% level, indicating that after 2014, the level of capital expenditure by derivative users is relatively high compared to companies that do not use derivatives. In other words, the revision of accounting standards related to derivatives in 2014 increases the level of capital expenditure for derivative users, that is the accounting standard revision helps to alleviate the adverse impact of derivative on capital expenditure.

4) Derivative use and firm value.

As can be seen from the above results, the use of derivatives reduces the level of capital expenditure of the company, and may therefore reduce the value of the company. In order to test the impact of the use of derivatives on corporate value, following on Froot et al. (1993) and Berrospide et al. (2011), we build model (4):

$$\text{TO}_{it} = \alpha_0 + \alpha_1 \text{DT}_{it} + \text{Controls}_{it} + \sum \text{Industry} + \sum \text{Year} + \varepsilon_{it} \tag{4}$$

TQ_{it} is the Tobin Q value of firm *i* in year *t*.

As shown in column (1) of Table 8, the use of derivative is negatively correlated with the Tobin Q value of the company, that is, the company value of the derivative user is lower than that of the company that does not use derivative. However, as shown in column (2), the coefficient of the intersection term DT * POST2014 is positive and significant at the 10% level, which suggests that after the implementation of the Fair Value Measurement Standards and the presentation of Financial Instrument Standards in 2014, the corporate value of derivative users is higher than that of companies that do not use derivatives, indicating that the reform of accounting standards help to mitigate the adverse impact of derivative on corporate value.

Table 8. Derivative instrument use and firm value.

	(1)	(2)
VARIABLES	TQ	TQ
DT	−0.0816***	0.0006
	(−3.22)	(0.01)
DT*POST2014		0.1593*
		(1.71)
POST2014		1.4024***
		(36.03)

Continued

Size	−0.3895***	−0.3889***
	(−5.06)	(−5.08)
PPE	−0.9512***	−0.9438***
	(−4.92)	(−4.92)
ROA	6.2504***	6.2408***
	(10.67)	(10.73)
Debt ratio	−0.0596	0.9412***
	(−0.25)	(3.93)
Quick ratio	−0.3146***	−0.3142***
	(−9.29)	(−9.26)
Z	0.1503***	0.1505***
	(21.20)	(20.83)
SGA	1.5611***	1.5585***
	(8.62)	(8.67)
Oversea	0.1223	0.1206
	(1.55)	(1.54)
Ic index	−0.0003	−0.0003
	(−1.50)	(−1.52)
Ownership	0.0138	0.0150
	(0.27)	(0.30)
Age	−0.0174***	−0.0172***
	(−6.03)	(−5.97)
Dividend	−0.1973	−0.1976
	(−1.48)	(−1.49)
OCF	0.0914	0.0915
	(0.85)	(0.84)
Industry	Controlled	Controlled
Year	Controlled	Controlled
Constant	9.1902***	9.1886***
	(5.04)	(5.12)
Observations	10,403	10,403
Adjusted R-squared	0.7950	0.7741

Figures in brackets are T-values of robust standard errors of double clustering at the company and year levels; *, ** and *** represent significant levels at 10%, 5% and 1% respectively.

5. Conclusions

Based on a sample of Chinese listed companies from 2010 to 2016, this paper

studies the impact of the use of derivative on capital expenditure. The study found that the capital expenditure level of derivative users is lower than that of companies without derivatives, and the mechanism is that the use of derivative reduces the company's borrowing capacity. After replacing capital expenditure metrics and controlling endogenous, the results are still robust. Further research shows that the intensity of derivative use is negatively correlated with the level of capital expenditure, indicating that the higher the intensity of derivative use, the lower the level of capital expenditure; The adverse effect of derivative usage on reducing capital expenditure is greater in non-SOEs. The reform of accounting standards such as fair value Measurement Standards and presentation of Financial Instrument Standards in 2014 has alleviated the adverse impact of derivative on capital expenditure. Compared with companies that do not use derivative, Tobin Q value of derivative users is lower, and accounting standard changes help to mitigate the adverse impact of derivative on corporate value.

Acknowledgements

Guiling Zhang thanks the support from the National Natural Science Foundation of China (grant number: 72002208), Humanities and Social Sciences General Project of Education Department of Henan Province (grant number: 2021-ZZJH-411) and Scientific Research Team Plan of Zhengzhou University of Aeronautics (grant number: 23ZHTD0).

Conflicts of Interest

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

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