International Oil Price Uncertainty, Operating Net Cash Flow and Corporate Investment Analysis Based on Stata and Python

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Abstract: Under the influence of supply and demand, politics and other factors, international oil prices have been in sharp fluctuations. As a large crude oil consumption country, oil prices frequent fluctuations will affect China's economic growth. It is important to study the microeconomic effects of oil price fluctuations. Based on this, this paper downloads the company's data from CASMA, and uses Python software to crawl missing data from the annual financial report. Then this paper takes the panel data of all A-share listed companies from the first quarter of 2014 to the fourth quarter of 2019 as samples and uses Stata software to build OLS regression model to study the impact of international oil price uncertainty on corporate investment. The empirical results show that: (1) International oil price uncertainty has a significant inhibitory effect on the investment; (2) The negative effect between two is partly caused by the decrease of operating net cash flow; (3) International oil price uncertainty has a more significant inhibitory effect on small-scale corporate investment.

Keywords: International Oil Price Uncertainty, Corporate Investment, Operating Net Cash Flow, Stata, Python.

1 INTRODUCTION

Economic growth and the continuous expansion of enterprises continue to drive the demand for oil. From 2019 to 2021, China's annual crude oil imports exceeded 500 million tons, which is the world's largest oil importing country. The high dependence on crude oil imports makes China’s economy very sensitive to oil price changes. In addition, with the reform of the pricing mechanism of refined oil products, the relationship between domestic crude oil prices and international crude oil prices is increasingly close. However, in recent years, international oil price has fluctuated frequently under the influence of supply and demand, macroeconomic policies and politics, which has exerted a great influence on our economic growth and development. In recent years, China has vigorously deployed new energy industries to replace traditional energy consumption. However, now China's energy system has problems such as the bottleneck of new energy development and overcapacity of traditional energy. A reliable solution to these problems is to rely on the information technology industry. The risks brought

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by oil price fluctuations will affect the smooth operation of the stock market. At this stage, new energy and information technology enterprises will be greatly affected by oil price fluctuations.

As one of the important factors of production in enterprises, the wild fluctuation of crude oil price has a great impact on the development of Chinese macro and micro economy. Crude oil is the direct or indirect input cost of most enterprises. The uncertainty of its price makes the investment decision of enterprises more difficult. Besides, corporate investment is also one of the important channels for crude oil price to be transmitted to the macro economy. Under the complicated economic situation, it is of great practical significance to study the impact of international oil price on corporate investment and its transmission mechanism, which is helpful to improve the economic benefits of enterprises and promote the healthy development of our real economy. Financing constraint is an important factor affecting enterprise investment as well, which is largely determined by enterprise scale. Therefore, the influence of enterprise size on the relationship between the two is also the focus of this paper.

2 LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1 Literature Review

Scholars have explored some research on the impact of oil price uncertainty on micro-firm behaviour, focusing on corporate performance, cash holdings, and investment. Oil price uncertainty leads to a substantial increase in the uncertainty of enterprises' production and operation, which leads to a decline in corporate performance [11]. When oil price uncertainty ascends, companies tend to increase their cash holdings for precautionary reasons. Cash holdings can reduce external financing costs and hedge future investment risks, which is of great significance for enterprises to deal with oil price uncertainties [15]. Some studies have also found that there is an inverted U relationship between oil price uncertainty and corporate cash holdings [17]. Companies tend to view investments as a waiting option, and uncertainty increases the value of their investments in waiting options. Henriques et.al (2011)[6] found a positive U-shaped relationship between oil price uncertainty and corporate investment. Some scholars have found a negative correlation between the two. Han (2016)[5] found a significant negative correlation between the two in manufacturing firms. Yang (2018)[18] found a significant negative correlation between the two in the oil industry.

Corporate investment is affected by a variety of factors, not only by the internal conditions of the company, such as capital structure and profitability, but also by the impact of the external environment, such as macroeconomic impact and external environmental uncertainty. The net cash flow generated from operating activities is an important pillar of enterprise development. The more cash flow an enterprise generates in its business activities, the stronger its willingness to invest, and this influence is more significant in small and medium-sized enterprises [8]. Most enterprises use debt for investment. Enterprises with excessive debt face high operating risks and debt repayment pressure, and are also subject to large financing constraints, which results in a very low willingness to invest [7]. From external conditions, GDP growth reflects a country's economic progress and consumer spending power, the faster GDP grows, the more enterprises are inclined to invest [4]. External environment uncertainty leads to a substantial increase in the

business and financial risks of enterprises, and the cash flow expected to be generated by investment fluctuates greatly, which leads to the decision of enterprises to delay investment. Most studies find that uncertainty has a negative impact on enterprise investment.

To sum up, studies on the relationship between oil price uncertainty and investment mainly focus on the direct impact. A few studies analyse the mechanism of the impact of international oil price uncertainty on investment. In addition, the relationship between oil price uncertainty and investment is also affected by many other factors, such as scale, but relevant studies are few and mainly focused on a certain industry, such as manufacturing and petroleum industry.

2.2 Theoretical Analysis and Hypothesis

Crude oil is one of the basic inputs for the production of most goods and services. Although some companies may not directly consume or produce crude oil, in most cases crude oil can be regarded as an indirect cost for the company. The sharp fluctuation of oil price leads to greater uncertainty for enterprises. Based on the real option theory, when an enterprise is faced with a high degree of uncertainty, the cash flow generated by investment in the future is highly volatile, and the value of the enterprise's investment waiting option will rise significantly (Bernanke, 1983). From the perspective of financing, on the one hand, oil price uncertainty increases the enterprises' risk and information asymmetry, so banks and other credit institutions will increase the lending rate [3]. On the other hand, oil price uncertainty leads to increased volatility in corporate stock prices and the necessary yield demanded by investors will also rise. Together, corporate investment will fall.

Hypothesis 1: International oil price uncertainty has a significant inhibitory effect on the investment.

Oil price fluctuations can lead to substantial declines in consumer spending expectations, especially for consumer durables. The decrease of consumer demand will lead to the decline of enterprise product sales and the deterioration of corporate performance [10-11]. Besides, in order to cope with oil price uncertainty, enterprises will take a series of measures to reduce risks, which will undoubtedly increase the capital expenditure of enterprises in the current period. Under the joint action of the two, corporate operating net cash flow will decline. According to the neoclassical investment theory, when making investment, enterprises usually consider whether the internal capital is sufficient first. The more internal capital, the stronger the investment intention. Cash flow in business activities is the basis of sustainable operation of enterprises and an important source of enterprise funds, which can reflect the financial situation of enterprises to a certain extent. The more abundant the cash flow, the less external financing constraints it faces, the stronger the investment will be [8].

Hypothesis 2: The negative effect of international oil price uncertainty on corporate investment is partly caused by the decrease of operating net cash flow.

External financing constraints are also important factors affecting corporate investment. The capital strength of small-scale enterprise is weak, and the ability to resist risks is also low. Banks, investors and others are reluctant to provide more capital to small companies for safety reasons, or demand a big increase in the necessary return rate. Therefore, in the face of external uncertainties, small companies are more inclined to retain funds and reduce investment for security reasons. In contrast, large-scale enterprises have very strong financial strength, more

resources, and more financing channels. In addition, large-scale enterprises have the ability to improve the skill level of their employees and thus improve the efficiency of resource utilization. It is also possible to hedge against adverse cost changes by buying futures or other energy derivatives hedging instruments. Although the rise in international oil prices will lead to a decrease in corporate profits and a small decrease in investment to some extent, the extent is weaker than that of small-scale enterprises.

Hypothesis 3: International oil price uncertainty has a more significant inhibitory effect on small-scale corporate investment.

3 METHODS AND MATERIALS

3.1 Data Processing

This paper selects Chinese A-share listed companies from the first quarter of 2014 to the fourth quarter of 2019 as samples for research. The sample cut-off time is December 31, 2019 for the following reasons: the COVID-19 pandemic has had a huge impact on the production and operation of enterprises from 2020, and the investment of most enterprises has shown a downward trend since 2020. The impact of the COVID-19 pandemic on corporate investment has seriously interfered with the impact of oil price fluctuations on the investment.

The company data studied in this paper is mainly from CSMAR and oil price data is from the U.S. Energy Information Administration. Since all the data in this paper are quarterly data, the data directly obtained from the website is seriously missing. So we also use Python software to crawl the missing data from the company's annual report.

Then we use Stata software to integrate data and build OLS regress model perform multi-regression analysis. The procedures for processing data with computer software are as follows. First, import the acquired data into Stata software and convert it from “xlsx” format to “dta” format; Second, use the “merge” and “append” commands to integrate data from different sources to form a total “dta” file; Third, use “tsset” “gen” and other commands to process data and generate proxy variables required by this paper; Fourth, use “drop” commands to exclude the data with financial industry, with total assets less than 0 and listed for less than one year. Fifth, use the “winsorize” command to shrink the 1% and 99% of company level data. After processing, we obtained a total of 58,280 company quarters of unbalanced panel data. Finally, use the “sum” and “reg” commands to perform descriptive statistics and regression analysis on panel data.

3.2 Variable Definitions

Following Wang (2017), we use “Funds paid for the purchase and construction of fixed assets, intangible assets and other long-term assets” as the proxy variable of corporate investment.

Following Phan et al. (2019)[9], calculating the quarterly standard deviation based on the logarithmic return of WTI daily crude oil price ($Z_i = \ln(p_i / p_{i-1})$)and the actual trading days of each quarter. And using the mean standard deviation with a lag of 1 to 4 periods as the proxy variable of oil price uncertainty.

$$\delta_t = \sqrt{\frac{1}{N-1}\sum_{i-1}^{N}(Z_i - E(Z_i))^2} \quad (1)$$

$$SDOIL_t = (\delta_{t-1} + \delta_{t-2} + \delta_{t-3} + \delta_{t-4}) / 4 \quad (2)$$

Referring to the existing literature, this paper controls variables such as corporate leverage, cash flow, growth capacity to consider the firm related heterogeneity that affects corporate investment.

Table 1: Variables description

Variables	Name	Description
Dependent variables	Invest	"Funds paid for the purchase and construction of fixed assets, intangible assets and other long-term assets"/ total assets at the beginning of the quarter
Intermediate variable	CF	Operating net cash flow/ total assets at the beginning of quarter
Independent variables	SDOIL	Reference model (1) and (2)
Controls variables	TQ	Tobin Q
	Lev	total liabilities/ total assets at the beginning of the quarter
	Growth	Growth rate of revenue
	Size	The natural log of total assets
	TOP5	Shareholding ratio of the top five shareholders
	Management	overhead/ Prior quarter sales revenue
	Cash	Cash and cash equivalents/ Total assets
	GDP	GDP growth rate
	Ndts	overhead and expense of sales /Prior quarter sales revenue
	SIZE	Dummy Variables: equal 1 if firm size is larger than the median

3.3 Model Design

Following Phan et al.(2019)[9], this paper use Stata software to build OLS multiple regression model (3) to test hypothesis 1. Except for international oil price uncertainty, the model (3) also controls nine additional variables, including variables at the enterprise level, such as *Q*, *Lev* etc., as well as macro-level influences, such as *GDP*.

$$\begin{aligned} Invest1_{i,t} = {} & \beta_0 + \beta_1 SDOIL_t + \beta_2 Q_{i,t-1} + \beta_3 Cash_{i,t-1} \\ & + \beta_4 Growth_{i,t-1} + \beta_5 Lev_{i,t-1} + \beta_6 Size_{i,t-1} + \beta_7 TOP5_{i,t-1} \\ & + \beta_8 Management_{i,t-1} + \beta_9 GDP_{i,t-1} + \beta_{10} Ndts_{i,t-1} \\ & + \sum QUARTER + \sum YEAR + \varepsilon_{i,t} \end{aligned} \quad (3)$$

where i is firm and t is time. β_0 control company fixed effects. Model (3) also includes annual and quarterly dummy variables. In this model, β_1 reflects the influence of international oil price uncertainty on corporate investment, β_1 <0 verify the hypothesis 1 is true.

Referring to the research design of Xue (2020), "operating net cash flow" is taken as the proxy variable of *CF*. Following Wen (2014), we establish models (4) and (5) and form a recursive model with model (3) to test hypothesis 2.

$$\begin{aligned} CF_{i,t} &= \alpha_0 + \alpha_1 SDOIL_t + \alpha_2 Q_{i,t-1} + \alpha_3 Cash_{i,t-1} \\ &+ \alpha_4 Growth_{i,t-1} + \alpha_5 Lev_{i,t-1} + \alpha_6 Size_{i,t-1} \\ &+ \sum QUARTER + \sum YEAR + \varepsilon_{i,t} \end{aligned} \tag{4}$$

$$\begin{aligned} Invest1_{i,t} &= \gamma_0 + \gamma_1 SDOIL_t + \gamma_2 CF_{i,t} \\ &+ \sum_{\gamma_j} Controls_{it} + \sum QUARTER + \sum YEAR + \varepsilon_{i,t} \end{aligned} \tag{5}$$

where i is firm and t is time. Both model (4) and Model (5) control firm fixed effect and time effect. Based on the expectation of hypothesis 2, α_1 in the model (4) is negative, γ_2 is positive, and γ_1 is negative in the model (5).

This paper divides the enterprise scale according to the total assets and set the dummy variable of *SIZE*. Enterprises whose total assets are higher than the average level are classified as large-scale enterprises and *SIZE*=1. On the contrary, it is a small-scale enterprise and *SIZE*=0. Based on the research design of Phan (2019)[9] and Aktham (2020)[1], we establish model(6) to test hypothesis 3.

$$\begin{aligned} Invest1_{i,t} &= \varphi_0 + \varphi_1 SDOIL_t + \varphi_2 SIZE_{i,t-1} \\ &+ \varphi_3 SDOIL_t \times SIZE_{i,t-1} + \sum_{\varphi_j} Controls_{it} \\ &+ \sum QUARTER + \sum YEAR + \varepsilon_{i,t} \end{aligned} \tag{6}$$

If φ_1 is negative and φ_3 is positive, it can be verified that firm size has a positive moderating effect.

4 REGRESSION ANALYSIS

4.1 Descriptive Statistics

Table 2 presents the results of descriptive statistics after tailoring (1% before and after) each variable. *Invest1* is a relative value that indicates how much capital expenditures account for total assets, and it fluctuates widely. The mean value is 0.013, indicating most firms invest about 1% of total assets, which is relatively low overall. *SDOIL* also varies considerably between quarters, with some quarters having very high oil price volatility during the sample period.

Table 2: Descriptive statistic

variable	N	Mean	Median	Min	Max
Invest1	58280	0.013	0.008	0	0.085
SDOIL	58280	0.082	0.080	0.043	0.129
CF	58280	0.013	0.012	-0.102	0.149
Q	58280	2.139	1.733	0.892	8.353
Cash	58280	0.143	0.112	0.010	0.555
Growth	58280	0.138	0.036	-0.799	3.698
Lev	58280	0.414	0.401	0.053	0.888
Size	58280	22.20	22.03	19.95	26.17
TOP5	58280	54.24	54.51	21.19	88.39
Management	58280	0.101	0.078	-0.037	0.604
GDP	58280	0.027	0.090	-0.164	0.117
Ndts	58280	0.180	0.137	0.004	0.853

4.2 Regression Result Analysis

The first column of Table III shows the coefficient β_1 between *SDOIL* and *Invest1* is -0.014, and is significant at 1% level, indicating oil price uncertainty has a significant inhibitory effect on corporate investment, and verifying Hypothesis 1 is true. The coefficients between *Q*, *Cash*, *Growth* and *Invest1* are significantly positive, indicating enterprises with stronger profitability, more cash and higher operating income are more willing to invest. The coefficient between *Lev* and *Invest1* is significantly negative, indicating enterprises are reluctant to invest when debt burden is high, and will reduce the scale of investment.

The second and third columns of Table III show the coefficient α_1 between *SDOIL* and *CF* is significantly negative at the 5% level. The coefficient γ_2 between *CF* and *Invest1* is significantly positive, indicating oil price uncertainty reduces investment through the channel of reducing corporate net cash flow from operations. Hypothesis 2 is supported. Specifically, every increase of one unit of oil price uncertainty decreases operating net cash flow by 0.0266 units on average, and every increase of one unit of operating net cash flow increases corporate investment by another 0.0229 units on average. The coefficient symbols of control variables and investment in the model (5) are basically the same as those in the model (3).

Table 3: Empirical results of hypothesis 1 and 2

	Invest1	**CF**	**Invest1**
SDOIL	-0.0140***	-0.0266*	-0.0137***
	(-3.00)	(-1.89)	(-2.96)
CF			0.0229***
			(15.48)
Q	0.001***	0.001***	0.001***
	(8.64)	(4.03)	(8.34)

Cash	0.0089***	0.050***	0.0102***
	(11.59)	(29.85)	(13.25)
Growth	0.002***	0.006***	0.002***
	(18.21)	(15.77)	(15.61)
Lev	-0.005***	-0.012***	-0.004***
	(-6.76)	(-11.71)	(-6.39)
Size	-0.001***	0.003***	-0.001***
	(-3.69)	(18.18)	(-3.59)
TOP5	0.000***		0.000***
	(6.13)		(6.02)
Management	-0.003*		-0.003
	(-1.80)		(-1.44)
GDP	0.007		0.009
	(0.76)		(0.97)
Ndts	-0.004***		-0.004***
	(-3.14)		(-3.01)
_cons	0.027***	-0.070***	0.026***
	(6.36)	(-19.17)	(6.16)
Firm/Time FE	Yes	Yes	Yes
r2	0.055	0.176	0.059
N	58,280	58,280	58,280

Table IV shows the coefficient of *SDOIL* and *Invest1* is significantly negative, while the coefficient of SD*OIL*×*SIZE* is significantly positive, indicating firm size alleviates the negative effect of oil price uncertainty on investment. Hypothesis 3 is supported. The coefficient of another control variables is the same as hypothesis 1.

Table 4: Empirical results of hypothesis 3

	Invest1
SDOIL	-0.018***
	(-3.59)
SDOIL*SIZE	0.008**
	(2.06)
Controls	Yes
Firm/Time FE	Yes
r2	0.055
N	58,280

4.3 Robustness Tests

This paper uses the alternative measures of oil price uncertainty to test robustness. Following Sadorsky (2006) and Wang(2017), for the uncertainty of international oil prices, this paper uses

GARCH(1,1) to estimate the volatility of the logarithmic return of WTI daily crude oil spot price, and then takes the arithmetic mean value of the quarter with a lag of 1 to 4 periods as the proxy variable of international oil price uncertainty(*GARCHOIL*).

$$e_i = Z_i + 0.0256Z_{i-1} - 0.0146Z_{i-2} + 0.0368Z_{i-3} - 0.0091Z_{i-4} - 0.0187Z_{i-5} - 0.0188 \quad (7)$$

$$h_i = 0.0351 - 0.0630e_{i-1}^2 - 0.9317h_{i-1}^E \quad (8)$$

$$GARCHOIL_t = (h_{t-1}^q + h_{t-2}^q + h_{t-3}^q + h_{t-4}^q)/4 \quad (9)$$

Specifically, the measurement period of GARCH (1,1) model is from January 1, 2013 to December 31, 2019. When choosing the order of auto-regressive lag, this paper found that the data with lag period 5 passed the most criteria, so the paper adopted the model with lag period 5. The specific GARCH model is shown in equations (7) and (8). h_i represents the daily yield fluctuation amplitude predicted by GARCH (1,1) model, and e_i is the residual of model (8). Z_i is the logarithmic return of WTI daily crude oil price ($Z_i = \ln(p_i / p_{i-1})$). The quarterly oil price uncertainty h_t^q is the quarterly average of the daily yield fluctuation range h_i.

Table 5: Robustness test results of hypothesis 1 and 2

	Invest1	**CF**	**Invest1**
GARCHOIL	-1.161***	-3.015**	-1.131***
	(-2.74)	(-2.41)	(-2.67)
CF			0.023***
			(15.48)
Controls	Yes	Yes	Yes
r2	0.055	0.176	0.059
N	58,280	58,280	58,280

The coefficient of *GARCHOIL* and *Invest1* is significantly negative, while the coefficient of *GARCHOIL* and *CF* is significantly negative and the coefficient of *CF* and *Invest1* is significantly positive, which is consistent with the above regression results.

Table 6: Robustness test results of hypothesis 3

	Invest1
GARCHOIL	-1.580***
	(-3.34)
GARCHOIL*SIZE	0.777**
	(2.00)
Controls	Yes
r2	0.055
N	58,280

The coefficient of *GARCHOIL* and *Invest1* is significantly negative and the coefficient of *GARCHOIL*×*SIZE* and *Invest1* is significantly positive. This result supports hypothesis 3, which can fully verify size alleviates the inhibitory effect between two.

5 CONCLUSIONS

This paper uses the complete data from the first quarter of 2014 to the fourth quarter of 2019 that are downloaded from CASAM and EIA and that obtained from Python crawlers, then uses Stata software to build an OLS regression model to empirically analyse the relationship between international oil price uncertainty and corporate investment. The results show that international oil price uncertainty has a significant inhibitory effect on corporate investment. The uncertainty of the international oil price will cause the decrease of operating net cash flow, then inhibit the investment of enterprises. The size of enterprises mitigated the negative effect of the uncertainty of international oil price on investment.

Based on the above conclusions, this paper has important practical implications. First of all, the government should continuously improve the stability of price transmission and the flexibility of price adjustment, so as to reduce the severe impact of oil price uncertainty on enterprises and the harm to the real economy. Secondly, the establishment of domestic oil security early warning mechanism, continue to improve the domestic oil price volatility hedging system, maximize the futures market hedging and risk management functions. Finally, in the critical period of national transformation, enterprises should constantly improve their own risk management system to effectively cope with external shocks and maintain steady development of enterprises, especially new energy and information technology enterprises.

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