THE UPSTREAM AND DOWNSTREAM RISKS' EFFECTS ON THE CHANGE OF COMPANIES' CASH HOLDINGS

A Thesis

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ABSTRACT

With the constant promotion of globalization, companies have expanded their supply channels and sales network to the whole world, putting more importance on supply chain risks. Based on the precautionary motive for firms' holding cash (Keynes, 1934), the thesis put forwards the first two hypotheses of the thesis: 1) keeping other variables the same, when the upstream risks of a company get higher, there will be an increase in the company's cash holdings; 2) keeping other variables the same, when the downstream risks of a company get higher, there will be an increase in the company's cash holdings, where the thesis utilizes the percentage of the cost from top 5 suppliers to describe the upstream risks and the percentage of revenue from top 5 clients to describe the downstream risks.

The research utilizes the balanced panel data from CSRC (China Securities Regulatory Commission) manufacturing industry companies (3305 public companies in total) from 2015 to 2021, from the Wind database, an authoritative database of Chinese public companies. Then, the research utilizes a multi-linear regression model with fixed-effect to test the first two hypotheses. As a result, the experimental results are consistent with the hypotheses that a one percentage point increase in upstream and downstream risks (the percentage of major upstream suppliers) would result in an increase in the company's cash holdings of around 9 million RMB which has passed 10% t-test keeping other variables controlled.

Moreover, the thesis chooses the Chow test to test whether the structure of the effects has changed before and after the outbreak of Covid-19 (hypothesis 3), and the Chow test results show that it did.

BIOGRAPHICAL SKETCH

Zisu Xie is a master's student from Zhengzhou City, Henan Province, China. In 2021, she obtained her bachelor’s degree from Zhejiang University (Double Degrees: Bachelor of Arts in Translation and Interpreting and Bachelor of Economics in Finance). In the same year, she was admitted to the Cornell Applied Economics and Management MS program, concentrating on management and finance, in order to explore more about how finance helps to improve public welfare. After obtaining her master’s degree from Cornell, she will go into the investment banking industry, joining Citi as a full-time analyst.

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TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

With the constant promotion of globalization, companies have expanded their supply channels and sales network to the whole world. On the one hand, the global supply chain can support the companies' development and minimize the cost; however, on the other hand, it leads to high risks when unexpected supply chain interrupts or shocks (such as the outbreak of Covid-19) happen.

While there has been a large amount of research on companies' cash holding policies, such as capital structure theories, which well explained the patterns of firms' cash holding, including tradeoff theory, peaking order theory, and free cash flow theory, the issues about companies' cash holding have never failed to attract researchers' attention since there are many factors that can influence companies' cash holding behaviors. The determinants of cash holdings can be divided into internal factors (characteristics of a company) and external factors (the external environment). Internal factors can include companies' financial situation, firms' scale, operating capacity, profitability, growth rate, etc.; while external factors include macro-economy, policy risks for the industry, supply chain risks and etc. Former capital structure theories focus more on the companies' internal financial situation's effect on cash holdings, while few research studied the external factors' effect on cash holdings, especially the supply chain risks' effect. Nevertheless, the effect of the supply chain's upstream and downstream risks on companies' cash holding behaviors is important, since the risks from the supply chain's upstream, the concentration of suppliers (percentage of the cost from top 5 suppliers), and downstream, the concentration of buyers (percentage of the cost from top 5 suppliers) can cause trade credit reduction, large bank loans, and equity financing, leading to companies' financial constraints (Pal et al., 2012). Also, with globalization, companies have expanded their supply channels and sales network to the whole world. On the one hand, the global supply chain can support the companies' development and minimize the cost; however, on the other hand, it leads to high risks when unexpected

supply chain interrupts, such as the outbreak of Covid-19. Thus, how the company adjusts its cash holding policies to deal with upstream and downstream risks is worth studying.

Keynes (1934) pointed out three motives for firms' holding cash: the transactions motive, the precautionary motive and the speculative motive. Precautionary motive refers to firms' holding money for safety reasons, which means holding money for unforeseen fluctuations and protecting themselves from risks (Keynes, 1934). Based on Keynes' precautionary motive, companies would hold money for unforeseen fluctuations and protect themselves from risks, companies are supposed to hold more cash if there are more upstream and downstream risks emerging on the supply chain. Therefore, the thesis initiates the first two research hypotheses. Moreover, the outbreak of Covid-19 can be regarded as a shock to the global supply chain, so the thesis points out the third hypothesis, as follows:

- ✓ Hypothesis 1: Keeping other variables the same, when the upstream risks of a company get higher, there will be an increase in the company's cash holdings.
- ✓ Hypothesis 2: Keeping other variables the same, when the downstream risks of a company get higher, there will be an increase in the company's cash holdings.
- ✓ Hypothesis 3: Covid-19 has an effect on companies' cash-holding behaviors influenced by upstream and downstream risks.

In the thesis, the research collects CSRC (China Securities Regulatory Commission) manufacturing industry companies' balanced panel data from 2015 to 2021 from the Wind database (3305 public companies in total), an authoritative database of Chinese public companies. The thesis utilizes a multi-linear regression model with fixed-effect to test the first two hypotheses. As a result, the experimental results are consistent with the hypotheses that higher upstream and downstream risks can lead to a higher level of cash holdings. The thesis chooses the Chow test to test whether the structure of the effects has changed before and after the outbreak of Covid-19 (hypothesis 3), and the Chow test results show that it did.

The thesis makes two contributions to the literature: First, it provides a new research perspective. On the one hand, there are a large number of studies on companies' cash holding issues, such as studies on the relationship between corporate cash sensitivity and cash holdings, the determinants of cash holdings, and cash holdings and corporate governance (Almeida, Campello & Weisbach, 2004; Bates, Kahle & Stulz, 2009; Dittmar & Mahrt-Smith, 2007), but there are few research on upstream and downstream supply risk and cash holdings. On the other hand, research about how to govern the upstream and downstream risks in the supply chain has been relatively abundant, but few have examined the impact of the upstream and downstream risks' effect on the firm's cash holdings. Therefore, the research's perspective is kind of innovative and new. Second, the research selects the percentage of sales value from the top 5 buyers as downstream risks and the percentage of purchasing value from the top 5 suppliers as upstream risk.

CHAPTER 2

LITTERATURE REVIEW

Cash-holding policies have never failed to attract people's attention. Former theories have well explained the benefits and costs of holding cash. The cost of holding cash (liquidity assets) refers to lower profits from this kind of liquidity assets (lower return rate from cash) due to liquidity premium (Opler, Pinkowitz, Stulz, Williamson, 1999). Firms can also lose money in the long term if the interest rate of cash is lower than the inflation rate. Also, Opler (1999) mentioned that the interest from cash holding can be charged tax, leading to tax disadvantages for companies. As for the benefits of cash holding, Keynes (1936) argued that there are two main benefits to holding cash. First, transaction and financing costs can be saved if companies use cash to make payments and transactions without the help of liquidating assets and external financing. Second, and more important, cash reserves can help companies offset the risks (Kimball & Miles S, 1991).

2.1 Motivation of Firms' Cash Holdings

Keynes (1934) also described three motives for firms' holding cash: the transactions motive, the precautionary motive, and the speculative motive (Harcourt, 2001). Keynes introduced a fourth motive, the finance motive, a special case of the transactions motive after the publication of *The General Theory* (Gilbert & John, 1993).

Transaction motive refers to cash held for daily operations, such as routine payments and everyday transactions (Gill, Amarjit, & Charul Shah, 2012). Since there is a cost of external financing, Hicks (1982) mentioned that it will not pay money for less than a minimum period and return. Thus, firms have to hold cash themselves to reduce the costs of investment and avoid the troubles caused by disinvestment. As it takes time for humans to raise money, firms would like to hold cash for on-time everyday transactions. Also, Myers and Majluf (1984) show that it is more costly to raise external capital than simply use firms' own cash holding as internal guaranteed financing; thus, it is beneficial for firms to hold cash as liquidity assets to reach the

requirement of investment expenditures, due to asymmetric information, which is also applied to speculative motive.

Precautionary motive refers to firms' holding money for safety reasons, which means holding money for unforeseen fluctuations and protecting themselves from risks (Keynes, 1934). Precautionary motive can lead to agency costs of managerial discretion since firms' managers have a greater preference for cash holdings because of their reducing risk and increasing their discretion (Opler, Pinkowitz, Stulz, Williamson, 1999). Opler et al. (1999) argued that companies would like to hold more cash to hedge risks when the industry has a higher cash flow volatility (Han, Seungjin, & Jiaping Qiu, 2007). However, the Precautionary motive can also lead to agency costs of managerial discretion, since firm managers have a greater preference for cash holdings because of its reducing risk and increasing their discretion (Tim Opler, Lee Pinkowitz, René Stulz, Rohan Williamson, 1999).

Speculative motive, proposed by Keynes (1934), refers to cash reserved to seize the occasional investment opportunities. Cash's liquidity feature can help capture good investment opportunities. Myers and Majluf (1984) also proposed that firms' external financing costs are comparatively higher than self-guaranteed cash cost. The company can miss good investment opportunities without sufficient cash holdings.

2.2 Patterns of Cash Holdings

Firms hold cash in several patterns. Capital structure theories have well explained the patterns of firms' cash holding, which mainly include tradeoff theory, peaking order theory, and free cash flow theory. Trade-off theory utilizes leverage to form capital structure and find out an optimal level of cash holding, which is achieved by comparing the benefits and costs of cash holding (Ahmadimousaabad, Aiyoub, et al, 2013). The benefits of cash holding refer to avoiding financial risks, decreasing the costs of external financing, and seizing fleeting speculation opportunities (Ferreira, Miguel A., and Antonio S. Vilela, 2004). Pecking order theory discussed that to companies will follow a particular financing order to minimize external financing costs due to information asymmetry (Myers, 1984; Myers & Majluf, 1984). More specifically, Myers (1984)

argued that companies would be supposed to get financing firstly with retained earnings (the cash they hold), then go to safe debt and risky debt, and finally with equities issued. As for free cash flow theory, Jensen (1986) argued that leaders or managers in firms prefer increasing the percentage of cash in companies' assets since it can be under their control and help them gain discretionary power over the companies' investment policies (Jensen & Michael, 1986). However, at the same time, Ferreira & Vilela (2004) argued that managers' investment decisions may not be in the shareholders' best interests, since they have stronger decision-making power using cash to invest, which can lead them investing for their own interests.

2.3 Determinants of Corporate Cash Holdings

As has been mentioned above, determinants of companies' cash holding have been discussed and argued in the literature. Firms' cash holdings can be affected by many factors, such as companies' growth rate, scale, operating capacity, profitability, credit ratings (ability to lend money), macro-economy, policy risks for the industry and etc. These factors can be divided into internal ones and external ones. Firms' cash holding behaviors can be determined by external determinants, such as external risks (for the precautionary motive) and external investment opportunities (for the speculative motive), and internal determinants, such as firms' capital structure, transaction requirement, free cash flow requirements, working capital, dividend payments, investment strategies, firm's scale, industry dummy and etc. (Opler et al., 1999). In this thesis, I would like to focus on external risks' effect on companies' cash holding behaviors, more specifically, upstream and downstream risks' effects. Although determinants of companies' cash holding have been well studied in former literature, upstream and downstream risks' effects on cash holding hardly ever appear in previous research.

2.4 Upstream and Downstream Risks' Effect on Cash holdings

It is significant to study upstream and downstream risk effects in the supply chain on companies' policies and behaviors, since the risks from the supply chain's upstream and downstream can cause trade credit reduction, large bank loans, and equity financing,

leading to companies' financial constraints (Pal et al., 2012). The risks from the supply chain's upstream and downstream can include sudden breakdown of raw materials suppliers, unfavorable changes in contracts with buyers, and costs of changing suppliers and buyers in the supply chain.

In this thesis, I use the concentration of companies' suppliers as firms' upstream risks and the concentration of buyers as their downstream risks. Zhang, Zou & Liu (2020) argued that a high degree of supplier concentration can result in companies' risks and additional costs. To begin with, companies' bargaining power will be significantly reduced with a high concentration of suppliers and buyers in the supply chain, where these large suppliers and buyers with strong negotiating power can require spot payment, pre-payment (for suppliers), and credits account (for buyers). These behaviors can increase companies' financial risks. Moreover, high supplier concentration can lead to high risks when unexpected supply chain interrupt or shock (such as the outbreak of Covid-19) happens, since changing the partner in the supply chain is costly (Zhang, Zou, Liu & Zhang, 2020).

CHAPTER 3

THEORIES AND RESEARCH HYPOTHESIS

This research focuses on upstream and downstream risks' effect on companies' change of cash holdings. According to Keynes's (1934) precautionary motive, firms hold money for unforeseen fluctuations and protect themselves from risks, companies should hold more cash if there are more upstream and downstream risks emerging on the supply chain.

Therefore, we have two research hypotheses:

- ✓ Hypothesis 1: Keeping other variables the same, when the upstream risks of a company get higher, there will be an increase in the company's cash holdings.
- ✓ Hypothesis 2: Keeping other variables the same, when the downstream risks of a company get higher, there will be an increase in the company's cash holdings.

Moreover, the research examines Covid-19's effects to figure out whether upstream and downstream risks' effects on companies' cash holdings will be different before and after the outbreak of Covid-19. As Covid-19 caused a lockdown and transportation limits across the whole world, it broke many companies' supply chains and led to high upstream and downstream risks to companies. Thus, the research regards that it should be different before and after the outbreak of Covid-19.

- ✓ Hypothesis 3: Covid-19 has an effect on companies' cash-holding behaviors influenced by upstream and downstream risks.

CHAPTER 4

DATA AND MODEL

To test the hypotheses, the study collects data from the Wind database, an authoritative database of Chinese public companies. The study selects CSRC (China Securities Regulatory Commission) manufacturing industry companies' balanced panel data from 2015 to 2021 (3305 public companies in total).

Data cleaning is also done. Companies with ST and *ST (companies with special treatment because of bad management or earnings performance) are excluded, for their financial data may be abnormal. To further deal with abnormal data, the study utilizes the "Winsor" command of Stata to shrink the tails of the total sample data: the data outside (1%, 99%) are replaced by the values in the 1% and 99% quartiles.

The research utilizes a fixed-effect multiple regression model, with upstream and downstream risks as independent variables and change in cash holding of companies as dependent variables, and selects companies' scale, ROA, Tobin's Q ratio, ratio of sustainable growth rate to actual growth rate, free cash flow, and debt-assets ratio as the control variable.

Independent Variable:

1) Upstream Risk:

The research utilizes the percentage of purchasing value from the top 5 suppliers as upstream risks, which can show the concentration of the suppliers of the company. Since a high degree of supplier concentration can result in companies' risks and additional costs (Zhang, Zou & Liu, 2020). To begin with, companies' bargaining power will be significantly reduced with a high concentration of suppliers in the supply chain, where these large suppliers with strong negotiating power can require spot payment and pre-payment. These behaviors can increase companies' financial risks. Moreover, high supplier concentration can lead to high risks when unexpected supply chain interrupt or shock (such as the outbreak of Covid-19) happens, since it required a high cost of changing the partner in the supply chain (Zhang, Zou, Liu &

Zhang, 2020). Thus, the study selects the percentage of purchasing value from the top 5 suppliers as upstream risks.

2) Downstream Risk:

The research utilizes the percentage of sales value from the top 5 buyers as downstream risks, which can show the concentration of the buyers of the company. Similar to the concentration of suppliers, the high concentration of buyers can also lead to companies' risks and additional costs, since buyers have strong power and can ask for credits account, which can put companies at financial risk. Moreover, a high concentration of buyers in a supply chain can also be risky if unexpected events happen. Thus, the study selects the percentage of sales value from the top 5 buyers as downstream risks.

Dependent Variable:

This thesis selects the change in cash holdings as the dependent variable. The change of cash holding of a company can well describe its cash holding behaviors.

Control Variables:

1) Enterprise Scale: this research utilizes the value of "log(total assets)" to describe the scale of a company. Adding the control variable "scale" into the model can help control the company scale's effect on cash-holding behaviors.
2) ROA: the research selects ROA (Net Income/Total Assets) as a control variable in the model to control the effect of companies' profitability on their cash-holding behaviors.
3) Free Cash Flow to Equity (FCFE): FCFF is defined as the cash flow companies can use after daily operating expenses, taxes, principal and interest repayments and all capital expenditures required to secure projected cash flow growth requirements. FCFF is added to the regression model to control the effect of companies' liquidity on cash-holding behaviors.
4) Tobin-Q: The research chooses Tobin-Q (Market Cap / Total Assets) to control the effect of companies' growth ability on cash-holding behaviors.
5) Debt-Assets Ratio: the research chooses the debt-assets ratio (Debt / Total

Assets) as a control variable to control the leverage on the cash holdings of a company.

6) The ratio of sustainable growth rate to actual growth rate:

Higgins (1981) defined sustainable growth rate (g*) as "the maximum rate at which sales can grow without depleting the financial resources of the firm".

$$g* = Profit\ Margin \times Retention\ Ratio \times Asset\ Turnover \times Leverage$$

$$= \frac{NI}{Sales} \times \frac{Sales}{Assets} \times \frac{Assets}{Beginning\ Equity} \quad (1)$$

Actual growth rate (g):

$$g = \frac{NI}{Sales} \times \frac{Sales}{Assets} \times \frac{Assets}{Actual\ Equity} \quad (2)$$

To get the ratio of sustainable growth rate to the actual growth rate, the research utilizes the ratio of equity at T+1 to equity at T as a control variable.

$$\frac{g^*}{g} = \frac{Equity}{Beginning\ Equity} = \frac{Beginning\ Equity+Retained\ Earning}{Beginning\ Equity} = \frac{E_{t+1}}{E_t} \quad (3)$$

The research adds the ratio of sustainable growth rate to actual growth rate into the regression model to control the effect of companies' sustainable ability on cash-holding behaviors.

Table 1: Variables Description of the Fixed Effect Model

	Variables	**Description of Variables**	**Variable Symbol**
Dependent Variable	Change in Cash-holding	The amount of change in a firm's annual reported cash holdings	dcash
Independent Variable	Upstream Supply Chain Risk	Percentage of Cost from Top 5 Suppliers	sup
	Downstream Supply Chain Risk	Percentage of Revenue from Top 5 Clients	dem
Control Variable	Enterprise Scale	Log (total assets of the company)	scale
	Profitability	ROA	ROA

	Liquidity	Free Cash Flow	FCFF
	Growth	Market Cap / Total Assets	Q
	Leverage	Debt / Total Assets	DA
	Sustainable Growing Ability	Sustainable Growth Rate / Actual Growth rate	SGR

Also, since the data used to simulate the model is panel data, time fixed effect and companies' fixed effect are added into the regression model.

Thus, the thesis gets its multi-regression model with fixed effects.

$$dcash_{it} = \beta_0 + \beta_1 sup_{it} + \beta_2 dem_{it} + \beta_3 scale_{it} + \beta_4 ROA_{it} + \beta_5 FCFF_{it} + \beta_6 Q_{it} + \beta_7 DA_{it} + \beta_8 SGR_{it} + \sum_t Year + \sum_i Company + \varepsilon \quad (4)$$

CHAPTER 5

EXPERIMENTAL RESULTS AND ANALYSIS

5.1 Descriptive Statistics Analysis

Table 2: Descriptive Statistics Analysis

Variables	Mean	Standard Deviation	Maximum	Minimum	Sample Size
dcash	1.1351	5.8575	35.2402	-16.6715	22079
sup	36.3742	19.3315	92.0900	5.28	20657
dem	37.2475	23.8175	98.4500	3.83	20632
scale	3.1715	1.3599	6.9732	0.2369	21931
ROA	4.2328	22.2244	183.2642	-47.7542	23135
Q	5.3371	9.0893	63.8111	0.2311	21931
SGR	1.4768	8.1822	48.3021	-37.8855	20728
FCFF	0.8204	9.1425	52.5058	-32.3688	21580
DA	0.9654	1.1562	8.1068	0.0528	22119

The form is the descriptive statistics analysis of all the data the research collected at the very beginning, which includes a balanced data set.

5.2 Correlation Analysis

Table 3: VIF Analysis

Variables	VIF	1/VIF
sup	1.16	0.8591
dem	1.16	0.8641
scale	1.49	0.6708
ROA	1.25	0.7999

Q	1.19	0.8420
SGR	1.01	0.9929
FCFF	1.05	0.9479
DA	1.38	0.7262

Table 4: Variables' Correlation Analysis

	dcash	sup	dem	scale	**ROA**	Q	SGR	FCFF	DA
dcash	1.0000								
sup	-0.0386	1.0000							
dem	-0.0284	0.2915	1.0000						
scale	0.2468	-0.2914	-0.2741	1.0000					
ROA	-0.0472	0.0260	-0.0074	-0.0415	1.0000				
Q	-0.0245	0.2005	0.1622	-0.3805	0.0076	1.0000			
SGR	0.0932	0.0151	0.0131	-0.0008	-0.0538	0.0145	1.0000		
FCFF	0.2812	-0.0575	-0.1130	0.2103	-0.0247	-0.0328	-0.0285	1.0000	
DA	0.0298	-0.0714	-0.0191	0.2970	0.4092	-0.1095	-0.0668	0.0394	1.0000

The variance inflation factor (VIF) is the ratio of the variance of estimating some parameter in a model that includes multiple other terms (parameters) by the variance of a model constructed using only one term (Wikipedia). A variance inflation factor (VIF) quantifies how much the variance is inflated. The maximum value of VIFs is less than 10, which means that there is no obvious multicollinearity problem in the regression model.

5.3 Regression Analysis

Model 1: Basic Regression Model without Fixed Effects

Model 2: Multi-regression Model with Time Effect

Model 3: Multi-regression Model with Company Fixed Effect

Model 4: Multi-regression Model with both Year and Company Fixed Effects

Table 5: Basic Model Regression Analysis (Unit: billion RMB for cash; a one percentage point for sup and dem)

dcash	dcash (Model 1)	dcash (Model 2)	dcash (Model 3)	dcash (Model 4)
sup	0.0054*** (2.34)	0.0054*** (2.35)	0.0183** (2.06)	0.0091* (1.74)
dem	0.0129*** (6.82)	0.0127*** (6.70)	0.0089* (1.68)	0.0093* (1.75)
scale	1.1254*** (29.84)	1.1248*** (29.52)	1.4166*** (9.67)	2.3109*** (13.00)
ROA	-0.0034* (-1.72)	0.0031*** (-1.54)	-0.0003 (-0.11)	0.0029 (1.13)
Q	0.0513*** (8.27)	0.0516*** (8.24)	-0.0263* (-1.86)	-0.0131 (-0.93)
SGR	0.0728*** (14.05)	0.0708*** (13.67)	0.0710*** (12.53)	0.0646*** (11.42)
FCFF	0.1549*** (34.68)	0.1547*** (34.68)	0.1724*** (31.15)	0.1783*** (32.15)
DA	-0.1787*** (-4.09)	-0.1827*** (-4.17)	-0.2402*** (-3.10)	-0.2988*** (-3.86)
Year Fixed Effect	No	Yes	No	Yes
Company Fixed Effect	No	No	Yes	Yes
N	18840	18840	18840	18840

Within_R^2	0.1335	0.0836	0.0823	0.0947

The thesis utilizes 4 kinds of models including the upstream effect (sup) and downstream effect (dem) as independent variables to make significance tests. The four models are a simple regression model, a regression model with a time fixed effect, a regression model with a company fixed effect, and a regression model with both fixed effects. In this way, we can also test whether the experimental results are consistent and robust.

The results are consistent in these 4 models, showing that upstream and downstream risks have a significantly positive effect on companies' change of cash holdings. In the simple regression model, keeping other variables controlled, one unit increase in upstream risks (the percentage of major upstream suppliers) would result in an increase in the company's cash holdings of 5.3607 million RMB, which has passed the 5% t-test, while one unit increase in downstream risks (the percentage of major downstream clients) would result in an increase in the company's cash holdings of 12.9407 million RMB, which has passed 1% t-test. In the regression model with time fixed effect, keeping other variables controlled, one unit increase in upstream risks (the percentage of major upstream suppliers) would result in an increase in the company's cash holdings of 5.3644 billion RMB, which has passed 5% t-test, while one unit increase in downstream risks (the percentage of major downstream clients) would result in an increase in the company's cash holdings of 12.723 million RMB, which has passed 1% t-test. In the regression model with company fixed effect, keeping other variables controlled, one unit increase in upstream risks (the percentage of major upstream suppliers) would result in an increase in the company's cash holdings of 10.8304 million RMB, which has passed 5% t-test, while one unit increase in downstream risks (the percentage of major downstream clients) would result in an increase in the company's cash holdings of 8.907 million RMB, which has passed 10% t-test. In the regression model with both fixed effects, keeping other variables controlled, one unit increase in upstream risks (the percentage of major upstream suppliers) would result in an increase in the company's cash holdings of 9.0925 million RMB, which has passed 10% t-test,

while one unit increase in downstream risks (the percentage of major downstream clients) would result in an increase in the company's cash holdings of 9.2593 million RMB, which has passed 10% t-test.

Based on the test results, upstream risks and downstream risks have significant positive effects on companies' cash holdings in a consistent and robust way. That means companies would like to hold more cash if there are more upstream and downstream risks emerging in the supply chain, which also complies with the hypothesis according to Keynes's (1934) precautionary motive that firms would hold money for unforeseen fluctuations and protect themselves from risks.

As for other control variables, the results are also consistent with the expectation. ROA is not significant while the ratio of equity, scale, and debt-assets ratio have positive effects on companies' cash holdings.

(1) The Ratio of Equities:

$$\frac{g^*}{g} = \frac{\frac{NI}{Sales}*\frac{Sales}{Assets}*\frac{Assets}{BoE}}{\frac{NI}{Sales}*\frac{Sales}{Assets}*\frac{Assets}{E}} \tag{5}$$

$$\frac{g^*}{g} = \frac{E}{BoE} \tag{6}$$

$$\frac{g^*}{g} = \frac{E}{BoE} = \frac{BoE+Retained\ Earnings}{BoE} = 1 + Retained\ Earnings * \frac{E_t}{E_{t-1}} \tag{7}$$

$$\frac{d\Delta cash}{dRetained\ Earning} > 0;\ \frac{d\Delta cash}{d(\frac{g^*}{g})} > 0 \tag{8}$$

(2) The Ratio of Debt to Assets:

$$cash_t = cash_{t-1} + (R - C)(1 - tax) + Depreciation \tag{9}$$

$$cash_t - cash_{t-1} = (R - C)(1 - tax) + Depreciation \tag{10}$$

$$\Delta cash = (R - C)(1 - tax) + Depreciation \tag{11}$$

$$\sigma^2(\Delta cash) = ({\sigma_R}^2 + {\sigma_c}^2 - 2cov(R, C))(1 - tax)^2 \tag{12}$$

$$\frac{\Delta cash}{d(R-C)} > 0 \tag{13}$$

$$cash_t = cash_{t-1} + (R - C)(1 - tax) + Depreciation \tag{14}$$

$$cash_t = cash_{t-1} + \frac{(R-C)(1-tax)}{E} * E + Depreciation \tag{15}$$

$$\Delta cash = ROE * E + Depreciation \tag{16}$$

$$\frac{d\Delta cash}{dROE} > 0 \tag{17}$$

$$ROE = \frac{R}{E} = \frac{R}{Assets-Debt} = \frac{ROA}{1-\frac{D}{A}} \tag{18}$$

$$\frac{d\Delta cash}{d(\frac{D}{A})} > 0 \tag{19}$$

(3) Scale:

$$scale = ln(Assets) \tag{20}$$

$$d(scale) = \frac{1}{d(Assets)} \tag{21}$$

$$ROE = \frac{R}{E} = \frac{R}{Assets - Debt} \tag{22}$$

$$\frac{d\Delta cash}{d(Assets)} < 0;\ \frac{d\Delta cash}{d(sale)} > 0 \tag{23}$$

CHAPTER 6

ROBUSTNESS TEST

6.1 Change the Format of Model

The thesis divides upstream risk and downstream risk into two regression models separately to test upstream risk's effect on companies' cash holding, upstream risk's effect on companies' cash holding, and the robustness of the original fixed-effect regression model.

$$dcash_{it} = \beta_0 + \beta_1 sup_{it} + \beta_2 scale_{it} + \beta_3 ROA_{it} + \beta_4 FCFF_{it} + \beta_5 Q_{it} + \beta_6 DA_{it} + \beta_7 SGR_{it} + \sum_t Year + \sum_i Company + \varepsilon \quad (24)$$

$$dcash_{it} = \beta_0 + \beta_1 dem_{it} + \beta_2 scale_{it} + \beta_3 ROA_{it} + \beta_4 FCFF_{it} + \beta_5 Q_{it} + \beta_6 DA_{it} + \beta_7 SGR_{it} + \sum_t Year + \sum_i Company + \varepsilon \quad (25)$$

The research still utilizes four models to test the upstream risk's model and downstream risk's model above separately:

Model 1: Basic Regression Model without Fixed Effects

Model 2: Multi-regression Model with Time Effect

Model 3: Multi-regression Model with Company Fixed Effect

Model 4: Multi-regression Model with both Year and Company Fixed Effects

Table 6: Results of Robustness Test of Upstream Risks – Changing Format

dcash	dcash (Model 1)	dcash (Model 2)	dcash (Model 3)	dcash (Model 4)
sup	0.0085*** (3.88)	0.0084*** (3.84)	0.0115** (2.31)	0.0102* (2.06)
scale	1.0906*** (29.92)	1.0859*** (29.69)	1.2770*** (9.20)	2.1816*** (12.92)
ROA	-0.0043* (-2.16)	0.0041** (-2.05)	-0.0006 (-0.24)	0.0030 (1.18)
Q	0.0528*** (8.76)	0.0516*** (8.89)	-0.0396* (-2.91)	-0.0242* (-1.78)
SGR	0.0710*** (14.38)	0.0692*** (14.03)	0.0701*** (13.05)	0.0637*** (11.89)

FCFF	0.1554***	0.1552***	0.1750***	0.1812***
	(35.49)	(35.51)	(32.34)	(33.42)
DA	-0.1509***	-0.1507***	-0.2195***	-0.2770***
	(-3.55)	(-3.55)	(-2.95)	(-3.73)
Year Fixed Effect	No	Yes	No	Yes
Company Fixed Effect	No	No	Yes	Yes
N	19779	19779	19779	19779
Within_R^2	0.1333	0.0827	0.0823	0.0952

Table 7: Results of Robustness Test of Downstream Risks – Changing Format

dcash	dcash (Model 1)	dcash (Model 2)	dcash (Model 3)	dcash （Model 4）
dem	0.0137***	0.0134***	0.0111**	0.0113**
	（7.52）	（7.39）	(2.17)	(2.22)
scale	1.0917***	1.0910***	1.3591***	2.2403***
	（29.94）	（29.58）	(9.59)	(12.93)
ROA	-0.0033*	-0.0029*	-0.0002	0.0032
	（-1.68）	（-1.51）	(-0.08)	(1.26)
Q	0.0507***	0.0510***	-0.0249*	-0.0123
	（8.55）	(8.50)	(-1.82)	(-0.90)
SGR	0.0729***	0.0708***	0.0714***	0.0651***
	(14.26)	(13.89)	(12.78)	(11.67)
FCFF	0.1548***	0.1545***	0.1715***	0.1771***
	(34.99)	(34.99)	(31.25)	(32.23)
DA	-0.1809***	-0.1848***	-0.2510***	-0.3184***
	(-4.24)	(-4.32)	(-3.34)	(-4.23)
Year Fixed Effect	No	Yes	No	Yes
Company Fixed Effect	No	No	Yes	Yes
N	18840	19179	18840	18840
Within_R^2	0.1325	0.0826	0.0814	0.0935

6.2 Endogeneity Test (2SLS)

(1) For Upstream Risks:

The thesis selects the one-period lag (sup_lag) of upstream risk (sup) as an instrumental variable (IV) to perform two-stage regression. Firstly, a one-period lag of upstream supply risk (sup_lag) is regressed on upstream risk (sup) as the independent variable.

$$sup_{it} = \beta_0 + \beta_1 sup\_lag_{it} + \beta_2 scale_{it} + \beta_3 ROA_{it} + \beta_4 FCFF_{it} + \beta_5 Q_{it} + \beta_6 DA_{it} + \beta_7 SGR_{it} + \sum_t Year + \sum_i Company + \varepsilon \quad (26)$$

Using Stata's function "predict" to get the fitted value $\widehat{sup}$, then, put $\widehat{sup}$ into original fixed-effect regression model as a substitute of sup:

$$dcash_{it} = \beta_0 + \beta_1 \widehat{sup}_{it} + \beta_2 scale_{it} + \beta_3 ROA_{it} + \beta_4 FCFF_{it} + \beta_5 Q_{it} + \beta_6 DA_{it} + \beta_7 SGR_{it} + \sum_t Year + \sum_i Company + \varepsilon \quad (27)$$

Table 8: Results of 2SLS Model Regression Analysis with Upstream Risks

	First Stage Regression	Second Stage Regression
sup	Dependent Variable	
dcash		Dependent Variable
sup_lag	0.8351*** (214.50)	
$\widehat{sup}$		0.0196*** (2.96)
scale	-0.4892*** (-7.32)	2.3515*** (11.78)
ROA	0.0064* (1.81)	0.0044 (1.55)
Q	0.0228* (1.87)	-0.0276 (-1.60)
SGR	-0.0033 (-0.36)	0.0654*** (10.64)

FCFF	0.0092 (1.19)	0.1833*** (30.93)
DA	-0.0691 (-0.88)	-0.3563*** (-4.06)
Within_R^2	0.7542	0.0970
F	7464.78	124.06

According to the results in the table, the coefficient of upstream risk (sup) is positive (0.0196) and significant after the two-stage regression using instrumental variables. This result is consistent with the regression results of the original fixed effects multiple regression model, indicating that the baseline regression results are robust.

(2) For Downstream Risks:

In the same way, the thesis selects the one-period lag (dem_lag) of downstream risk (dem) as an instrumental variable to perform two-stage regression. Firstly, a one-period lag of downstream supply risk (dem_lag) is regressed on downstream risk (dem) as the independent variable.

$$dem_{it} = \beta_0 + \beta_1 dem\_lag_{it} + \beta_2 scale_{it} + \beta_3 ROA_{it} + \beta_4 FCFF_{it} + \beta_5 Q_{it} + \beta_6 DA_{it} + \beta_7 SGR_{it} + \sum_t Year + \sum_i Company + \varepsilon \quad (28)$$

Using Stata's function "predict" to get the fitted value $\widehat{\text{dem}}$, then, put $\widehat{\text{dem}}$ into original fixed-effect regression model as a substitute of dem:

$$dcash_{it} = \beta_0 + \beta_1 \widehat{\text{dem}}_{it} + \beta_2 scale_{it} + \beta_3 ROA_{it} + \beta_4 FCFF_{it} + \beta_5 Q_{it} + \beta_6 DA_{it} + \beta_7 SGR_{it} + \sum_t Year + \sum_i Company + \varepsilon \quad (29)$$

Table 9: Results of 2SLS Model Regression Analysis with Downstream Risks

	First Stage Regression	Second Stage Regression
dem	Dependent Variable	
dcash		Dependent Variable
dem_lag	0.9022*** （295.71）	

$\widehat{dem}$		0.0129** (2.04)
scale	-0.5235*** （-8.31）	2.7562*** (13.72)
ROA	-0.0023 （-0.69）	0.0040 (1.44)
Q	-0.0045 （-0.40）	-0.0122 (-0.73)
SGR	0.0009 （0.10）	0.0708*** (11.32)
FCFF	-0.0004 (-0.05)	0.1997*** (33.61)
DA	0.3592 (4.79)	-0.2929*** (-3.37)
Within_R^2	0.8549	0.1135
F	13975.81	143.64

According to the results in the table, the coefficient of downstream risk (dem) is positive (0.0129) and significant after the two-stage regression using instrumental variables. This result is consistent with the regression results of the original fixed effects multiple regression model, indicating that the baseline regression results are robust.

CHAPTER 7

DISCUSSION ABOUT THE EFFECT OF COVID-19

Covid-19's outbreak has broken down parts of the supply chain over the world. As Covid-19 caused lockdowns over the world and transportation limits, it broke down many companies' supply chains and led to high upstream and downstream risks to companies.

Moreover, as Zhang, Zou, Liu & Zhang (2020) have argued, when unexpected supply chain interrupts or shock (such as the outbreak of Covid-19) happens, high supplier concentration can lead to high risks, since it required a high cost of changing the partner in the supply chain.

Thus, the research supposes that the effect on cash holdings brought about by upstream and downstream risks should be different before and after the outbreak of Covid-19, which forms the third hypothesis of the thesis.

- ✓ Hypothesis 3: Covid-19 has an effect on companies' cash-holding behaviors influenced by upstream and downstream risks.

To test hypothesis 3, the research uses the Chow test to figure out the effect before and after the COVID-19 outbreak. Since Covid-19 broke out at the beginning of 2020, the thesis uses the data from 2015 to 2019 as period 1 (before the outbreak of Covid-19) and the data from 2020 to 2021 as period 2 (after the outbreak of Covid-19). Also, the research utilizes all the data from 2015 to 2021 (including period 1 and period 2) in the regression model.

Table 9: Results of Chow Test Analysis of Covid-19's Effect

dcash	Regression 1 (All data included)	Regression 2 (Period 1)	Regression 3 (Period 2)

sup	0.0054**	0.0032***	0.0076**
	（2.43）	（1.21）	(1.72)
dem	0.0129***	0.0067***	0.0214**
	（6.82）	（3.04）	(6.01)
scale	1.1254***	0.8314***	1.6967***
	（29.84）	（19.47）	(22.47)
ROA	-0.0035*	-0.0081*	-0.0043
	（-1.72）	（-3.46）	(1.16)
Q	0.0513***	0.0394***	0.1306*
	（8.27）	(6.30)	(6.48)
SGR	0.0728***	0.0654***	0.0847***
	(14.05)	(10.81)	(8.85)
FCFF	0.1549***	0.1529***	0.1468***
	(34.68)	(28.27)	(18.65)
DA	-0.1787***	-0.0216***	-0.4077***
	(-4.09)	(-0.43)	(-4.92)
N	18840	12405	6435
RSS	592837.0290	339545.6690	247950.7620

$$F_{Chow\ test} = \frac{(S_c-(S_1+S_2))/k}{(S_1+S_2)/(N_1+N_2-2k)} \tag{30}$$

where, S_c refers to the value of RSS of the model with all the data included (regression 1), S_1 refers to refers to the value of RSS of the model with data in period 1 (regression 2), S_2 refers to the value of RSS of the model with data in period 2 (regression 3), k refers to the number of variables in the model, N_1 refers to the number of observation in the model of period 1, and N_2 refers to the number of observation in the model of period 2.

$$F_{Chow\ test} = \frac{(S_c-(S_1+S_2))/k}{(S_1+S_2)/(N_1+N_2-2k)} \approxeq 21.389 > F_{0.01} \tag{31}$$

Thus, the structure of the data before the end of 2019 and after the beginning of 2020 is significantly different at the 99% level of confidence. The result provides strong evidence that Covid-19 has a special influence on the upstream and downstream risks' effect on companies' cash holdings, which is consistent with the thesis' hypothesis 3.

CHAPTER 8

CONCLUSION

The thesis argues three hypotheses based on Keynes's (1934) precautionary motive:

- ✓ Hypothesis 1: Keeping other variables the same, when the upstream risks of a company get higher, there will be an increase in the company's cash holdings.
- ✓ Hypothesis 2: Keeping other variables the same, when the downstream risks of a company get higher, there will be an increase in the company's cash holdings.
- ✓ Hypothesis 3: Covid-19 has an effect on companies' cash-holding behaviors influenced by upstream and downstream risks.

After utilizing the fixed-effect regression model with panel data from 2015 to 2022 to test the regression model, the experimental results are consistent with hypothesis 1 and hypothesis 2 that there will be an increase in the company's cash holdings when the upstream and downstream risks of a company get higher with keeping other variables the same. Moreover, the thesis utilizes the Chow test to analyze the effect before and after the outbreak of Covid-19. The results show a difference, which is consistent with hypothesis 3 that Covid-19 has an effect on companies' cash holdings behaviors influenced by upstream and downstream risks.

Based on the conclusion, the research can implicate that other researchers can consider upstream and downstream risks as a factor and add them into the model when they study cash holdings issues in the future. Also, for companies, when they are faced with external risks, such as upstream and downstream risks, they should hold more money to protect themselves from the risks.

Reference:

[1] Ahmadimousaabad, Aiyoub, et al. "Trade-off theory, pecking order theory and market timing theory: a comprehensive review of capital structure theories." International Journal of Management and Commerce Innovations 1.1 (2013): 11-18.

[2] B. Pal, S.S. Sana, K. Chaudhuri 2012, "A three-layer multi-item production–inventory model for multiple suppliers and retailers", Econ. Modell., 29 (6) (2012), pp. 2704-2710

[3] Brady, Michael Emmett. "How JM Keynes presented the technical analysis of his IS and LM curves in the General Theory in 1936: Why D. Champernowne got it right in 1936 and Hicks (Harrod, Meade, Lange) got a big part of it wrong in 1937 and 1938." Champernowne Got It Right in (1936).

[4] Brown, Gregory W., and Zeigham Khokher. Corporate risk, market imperfections, and speculative motives. Working paper, The University of North Carolina, 2001.

[5] Ferreira, Miguel A., and Antonio S. Vilela. "Why do firms hold cash? Evidence from EMU countries." European financial management 10.2 (2004): 295-319.

[6] G. C. Harcourt. 2001. George Shackle: A Tribute. 50 Years a Keynesian and Other Essays, pages 175-176.

[7] Gilbert, John C. "Shackle and Keynes's economics." Review of Political Economy 5.2 (1993): 165-180.

[8] Gill, Amarjit, and Charul Shah. "Determinants of corporate cash holdings: Evidence from Canada." International journal of economics and finance 4.1 (2012): 70-79.

[9] Han, Seungjin, and Jiaping Qiu. "Corporate precautionary cash holdings." Journal of corporate finance 13.1 (2007): 43-57.

[10] Hicks, J., editor, 1982: Collected essays on economic theory, Volume II: https://doi.org/10.1016/j.econmod.2020.01.025.

[11] Jensen, Michael C. "Agency costs of free cash flow, corporate finance, and takeovers." The American economic review 76.2 (1986): 323-329.

[12] Myers, Stewart C., and Nicholas S. Majluf. "Corporate financing and investment

decisions when firms have information that investors do not have." Journal of financial economics 13.2 (1984): 187-221.

[13] Opler, Tim, et al. "The determinants and implications of corporate cash holdings." Journal of financial economics 52.1 (1999): 3-46.

[14] Stewart C. Myers, Nicholas S. Majluf, Corporate financing and investment decisions when firms have information that investors do not have, Journal of Financial Economics, Volume 13, Issue 2, 1984, Pages 187-221.

[15] Xindong Zhang, Meifeng Zou, Weimin Liu, Yuefei Zhang, “Does a firm’s supplier concentration affect its cash holding?”, Economic Modelling, Volume 90, 2020, Pages 527-535, ISSN 0264-9993,