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Does Monetary Policy Uncertainty Impacts Corporate Innovation? The Case of China

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Declaration of Authorship

The author hereby declares that he compiled this thesis independently; using only the listed resources and literature, and the thesis has not been used to obtain a different or the same degree.

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Prague, May 14, 2023 Jiahui Wang

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Abstract

This paper constructs a panel data model based on the China Monetary Policy Uncertainty Index and combines financial data of Chinese listed companies to investigate the impact of monetary policy uncertainty on companies' R&D investment.
The empirical findings show that an increase in monetary policy uncertainty leads to a significant decline in corporate R&D investment. It is further found that monetary policy uncertainty inhibits R&D investment by strengthening the financing constraints of firms; the more abundant the cash flow of firms, the weaker the negative effect of monetary policy uncertainty on R&D investment; and monetary policy uncertainty has a stronger inhibitory effect on innovation in non-state-owned companies than in state-owned companies.

JEL Classification	F12
Keywords	Monetary policy; R&D investment; financing constraints
Title	Does Monetary Policy Uncertainty Impact Corporate Innovation? The Case of China

Abstrakt

Tento článek vytváří model panelových dat založený na čínském indexu nejistoty měnové politiky a kombinuje finanční údaje čínských podniků kótovaných na burze s cílem prozkoumat dopad nejistoty měnové politiky na investice podniků do výzkumu a vývoje.
Empirická zjištění ukazují, že zvýšení nejistoty měnové politiky vede k výraznému poklesu podnikových investic do výzkumu a vývoje. Dále bylo zjištěno, že nejistota měnové politiky brzdí investice do výzkumu a vývoje tím, že posiluje finanční omezení podniků; čím bohatší jsou peněžní toky podniků, tím slabší je negativní účinek nejistoty měnové politiky na investice do výzkumu a vývoje; a nejistota měnové politiky má silnější brzdící účinek na inovace v nestátních podnicích než ve státních podnicích.

Klasifikace	F12
Klíčová slova	Měnová politika; investice do výzkumu a vývoje; finanční omezení
Název práce	Má nejistota měnové politiky vliv na inovace v podnicích? Případ Číny

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Acronyms

CNM	Monetary Policy Uncertainty Index
SA	Financing Constraints Index
SOC	State-owned companies
R&D	Research and Development
GDP	GrossDomesticProduct
GARCH	Generalized AutoRegressive Conditional Heteroskedasticity
VAR	Vector Autoregression model
SVAP	Structural Vector Autoregression model
RMB	RenMinBi Yuan
TBQ	Tobin's Q Ratio
FE	Fixed Effect model
ROA	Return on Asset
PBC	The People's Bank of China
SV	Stochastic Volatility Model
ST	Special treatment for companies with losses for two consecutive financial years
***ST**	Companies with three consecutive years of losses and at risk of delisting

1 Introduction

Innovation has become one of the most critical factors determining China's sustainable economic growth (Zhang and Zheng, 2018). At present, China's economy is facing downward pressure, and the core factor for the release of China's potential economic growth rate in the future depends on whether the critical core technological innovation fields of the manufacturing sector can generally achieve breakthroughs and the spillover and expansion effects of the industrial chain and product chain (Zhang, 2019), In particular, the current escalating China-US trade conflict has highlighted the urgency of innovation and upgrading of the manufacturing industry. The development of China's manufacturing industry is in a dilemma. On one hand, the domestic labour cost is rising; on other hand, the level of automation is not enough; and environmental pollution has increasingly become an obstacle to extensive expansion. At present, the impact of macroeconomic policy uncertainty on micro-company decision-making has aroused widespread concern in academic circles. Because the external macro-environment is the basis and premise of company decision-making, the investment decision-making of micro-companies will be affected by macroeconomic policy. However, whether macroeconomic policy uncertainty can promote or inhibit micro-company innovation remains to be further studied and discussed. In this context, how macroeconomic policy uncertainty relates to company innovation is still a mystery to be solved. As an important kind of macroeconomic policy, monetary policy is constantly switching between "tight," "steady," "moderate, loose," and "positive." The frequent adjustment of monetary policy will aggravate the uncertainty of monetary policy. The uncertainty of monetary policy may go against the original intention of the policy and have an adverse impact on companies. For example, although the reduction of interest rate is conducive to reducing the financing cost of a company and promoting the company to increase fixed asset investment, the adjustment range and frequency of monetary policy itself will lead to changes in financial investment decisions of companies; thus, the investment and financing decision-making behaviour of company deviates from the original intention of the adjustment goal of economic policies (Zhang and Liu, 2019). Inspired by this, in order to deeply analyze the correlation mechanism between macroeconomic policy uncertainty and company innovation, this thesis intends to explore the impact of monetary policy uncertainty on manufacturing company innovation and its influence mechanism.

External monetary policy uncertainty may directly impact company innovation activities through the channels of monetary policy. On the other hand, in the face of the external risks brought by the monetary policy uncertainty, companies continue to increase their holdings of financial products, which may reduce the limited R&D funds of companies and then indirectly have a negative impact on company innovation. Therefore, identifying the links between monetary policy uncertainty at a macro level and micro-level corporate innovation, and analyzing the direct and indirect impact of monetary policy uncertainty on company innovation at a micro level innovation , is not only conducive to deepening the research on the association between macroeconomic policy uncertainty and micro-level corporate innovation activities, but also provides a necessary micro-foundation for current monetary policy reforms.

From a practical point of view, the government can only passively launch the corresponding macroeconomic policies due to the sudden nature of external emergencies or economic fluctuations. However, for the government, the monetary and other economic policies changes are intensely subjective and controlled. Therefore, studying the impact of macroeconomic policy uncertainty on companies can have more realistic enlightenment for adjusting actual economic policies. China's economy is facing downward pressure, external trade factors and a sudden epidemic that impact China's manufacturing industry. How to promote the innovation and transformation of the real economy sector dominated by the manufacturing industry has become a core issue that needs to be focused on.

This thesis intends to explore the relationship between the uncertainty of monetary policy and the innovation activities of manufacturing companies. The result of our analysis can put forward corresponding policy suggestions based on the research conclusions， to help the central bank create a relatively stable monetary policy environment for companies, remove the obstacles hindering company innovation, and promote the R&D and innovation activities of manufacturing companies, and finally realize the upgrade of China's real economy sector.

This thesis has the following contribution to the existing literature in the field of macroeconomic policy uncertainty and company innovation. First, it further broadens the research on macroeconomic policy uncertainty and company innovation. Monetary policy uncertainty can have a significant inhibitory effect on the innovation activities of manufacturing companies, which provides theoretical enlightenment for the better implementation of an innovation-driven development strategy. Second, it helps to guide further reforms of monetary policy. The research in this thesis shows that the uncertainty of monetary policy has a significant inhibitory effect on the innovation

activities of companies. As China's monetary policy authority, the People's Bank of China should pay attention to the role of expected guidance. For example, by holding seminars, interpreting statistical data and issuing relevant monetary policy reports, strengthening the communication between the People's Bank of China (PBC) and consumers, investors, financial markets, and broader public opinion, paying attention to the use of forward-looking guidance tools, strive to guide the reasonable expectations of the market effectively, and better achieve the policy goal of monetary policy to promote the transformation of economic structure and the upgrading of industrial structure.

The rest of this thesis is explained as follows: Chapter 2 connects to the literature review in the field of the impact of macroeconomic policy and monetary policy uncertainty on companies; Chapter 3 discloses detailed information about the data that this thesis used for empirical analysis; Chapter 4 covers the theoretical analysis and hypotheses empirical analysis; Chapter 5 describes the methods; Chapter 6 is devoted to the empirical analysis; Chapter 7 concludes.

2 Literature Review

2.1 Research on the Uncertainty of Macroeconomic Policy

The study of uncertainty in economics starts from the analysis of risk and uncertainty. Risk and uncertainty are two concepts with similar meanings but are different from each other. However, classical economics has always been based on the assumption of rational people and complete information, trying to explore economic laws in an abstract and simple theoretical framework. The uncertainty problem is included in the risk problem research.

Later, the founder of the Chicago School and the economist who first studied uncertainty, Knight first studied risk and uncertainty in the classic literature "Uncertainty, Risk, and Profit" (Knight, 2013). When analyzing risks and so-called uncertainties, he believes that risks are from recurring events, so they can calculate the probability (prior probability or statistical probability) and incorporate them into decision-making. For example, insurance companies do this based on probability to calculate premiums. However, uncertainty from unpredictable events, therefore, cannot be prevented. When explaining the reasons for uncertainty, he believes that it arises from a cognitive process, that is, the events involved are unprecedented and cannot refer to existing theories or experiences. In fact, Knight's uncertainty theory was born to explain the contradiction that competitive market companies are not zero profits. He believes that whether entrepreneurs can seize opportunities under uncertain circumstances determines the amount of profit a firm can make.

Uncertainty is an essential prerequisite of Keynes's theoretical system. It is also based on uncertainty. Keynes put forward three famous laws. Compared with Knight's belief that uncertainty arises from the cognitive process, Keynes believes that uncertainty arises from human nature and unknown expectations. This is also the reason why Keynes proposed irrational and incomplete information hypotheses. According to Keynes' thoughts, uncertainty objectively exists because humans cannot know all information（Keynes，1936）.

However, Keynes's thoughts of uncertainty have not been fully recognized. In his published thesis, "Truth and Probability," Ramsey believes that the uncertainty of uncalculated probability can be measured by subjective probability. Even if economic

individuals cannot obtain the probability distribution of future conditions, they can also be replaced by subjective probability, and through continuous updating, knowledge is used to correct the deviation of subjective probability, and finally, the unity of subjective and objective probability can be achieved (Ramsey, 1926). This view was later given axiomatically by Savage, which later evolved into the subjective expected utility theory. Based on Bayes Law, Savage believed economic agents could continuously modify subjective prior probabilities through Bayes' theorem to approximate objective posterior probabilities. (Savage, 1954). However, Ellsberg put forward the phenomenon of Ambiguity Aversion in a thesis published by him, that is, economic agents hate uncertainty when making decisions, which manifests itself in making decisions based on known probabilities and avoiding uncertain probabilities (Ellsberg, 1961). Ellsberg Paradox explained that under uncertain circumstances, the behavioural decisions of economic agents are not made under the guidance of probability, and subjective probabilities cannot be found.

Later, scholars Gilboa and Schmeidler (1989) proposed Max-min Expected Utility Theory in their thesis and answered Ellsberg Paradox. Their core point is that although it is impossible to find a subjective expected probability, it can find a set of subjective probabilities. , The economic agent can first calculate the minimum value from the subjective probability set of each decision and then choose the maximum value in the minimum set as the basis for the decision.

The above classic uncertainty theory shows that since economic agents, in reality, are not entirely rational, and there is no information symmetry, uncertainty exists objectively; uncertainty cannot be directly observed, so in order to measure the monetary policy certainty, the thinking of the academic circle is to quantify the response of macroeconomic or microeconomic entities to the uncertainty of monetary policy; in order to reduce the negative impact of uncertainty, economic entities must maintain constant updates of information and maintain the stability of economic expectations.

2.1.1 Definition of Relevant Concepts - Uncertainty of Economic Policy

The main participants in economic activities, businesses and consumers, are unable to determine changes in current economic policies and future government decisions regarding the timing and implementation of new economic policies based on their own judgment. The resulting uncertainty is called economic policy uncertainty (Gulen and Ion, 2016). The uncertainty of economic policy is mainly affected by the macroeconomic environment. The government's macro-control policy mainly adjusts

the short-term economic situation through discretionary fiscal and monetary policies. For example, when the economy is depressed, the government will increase household consumption and corporate investment by expanding fiscal expenditure, transfer payments, tax cuts and interest rate cuts to stimulate economic recovery. When the economy is overheated, the government will reduce government spending, increase taxes, and raise interest rates. Increase the deposit reserve ratio and other means to curb aggregate demand and reduce corporate investment to curb overheating of the economy. When the macro-economy fluctuates wildly, the government will frequently issue related fiscal and monetary policies to adjust the economy by judging the current economic situation. Frequently changing policies will cause differences and confusion between companies and consumers about the future economic prospects, resulting in uncertainty and affecting the decision-making and behaviour of economic entities.

2.1.2 Macroeconomic consequences of macroeconomic policy uncertainty

When studying the impact on macroeconomics, most scholars' conclusions are negative. Baker et al. (2016) found that the uncertainty of macroeconomic policies has a significant negative impact on US economic growth and employment. Herro and Murray (2013) show through regression that higher monetary policy uncertainty will increase the fluctuation of the inflation rate and unemployment rate, which is not conducive to economic development. Fernandez-Villaverde et al. (2011) pointed out that higher uncertainty in monetary policy means an increased risk of capital income and increased preventive savings, leading to a decrease in consumption. Uncertainty in monetary policy makes companies and the public lack confidence in the market and begin to hoard large amounts of cash, leading to a plummet in bank loans (Talk, 2016), which leads to an increase in default risk and a decrease in output (Wang et al., 2019), and a decrease in nominal interest rates and economic growth rates (Jordà and Salyer, 2003; Sinha, 2016). Fasolo (2019) also concludes that monetary policy uncertainty significantly inhibits total output. Empirical research by Caldara et al. also found that the uncertainty of macroeconomic policies will exacerbate macroeconomic turbulence. In addition, Julio and Yook pointed out that policy uncertainty will also have a negative impact on cross-border capital flows. A few scholars also believe that monetary policy has a specific promotion effect on the macroeconomy. For example, Born and Pfeifer (2014) believe that as long as the monetary authority can respond to changes in the economic situation on time to change monetary policy, then monetary policy uncertainty will have little impact on the macroeconomy, and companies or consumers will try to increase factor productivity as much as possible to offset the negative impact of monetary policy uncertainty which will instead promote economic growth at this

time. In addition, Kaminska and Roberts-Sklar (2018) conducted model predictions on stock indexes in the United Kingdom, the United States and the Eurozone. They found that the uncertainty of price-based monetary policy helps predict stock market volatility and increases excess returns to a certain extent. Mueller et al. (2017) concluded that uncertainty would increase the excess return of transactions in the exchange rate determination framework with monetary policy uncertainty.

2.1.3 The impact of macroeconomic policy uncertainty on micro-company.

The impact of the US trade war on China's economy and the outbreak of COVID-19, and the black swan event have expanded the uncertainty encountered by China's primary economy. In order to ensure steady economic growth, the government needs to use monetary policy to adjust the scale of currency circulation, accurately control the flow of funds, maintain a moderate growth of the real economy and financial market, and reduce the impact of uncertainty on economic fluctuations. Therefore, the influence and mechanism of monetary policy on micro-subjects have also become a hot field and focus topic of current scholars, corporate policymakers and relevant government departments.

2.1.3.1 Uncertainty in macroeconomic policies will have a negative impact on companies.

Bernanke et al. (1995) distinguished the macro-effects of monetary policy in the past. They explored its micro-effects from the credit transmission channels of monetary policy, which also broadened the boundaries of monetary policy impact research. Gaiotti et al. (2001) analyzed the micro-effects of Italian monetary policy and found that it has a heterogeneous impact on the investment of different types of companies. Benito (2002) combined economic data from the United States and Spain to analyze the impact of different monetary policies on corporate inventories. Delis et al. (2011) empirical research found a significant correlation between monetary policy and bank risk-taking based on micro-data at the bank level. Under tightening monetary policy, bank risk-taking is reduced; under the expansionary monetary policy, banks' willingness to take risks has risen, and banks are more willing to extend loans to companies with a high risk of default. After studying the relationship between the uncertainty of macroeconomic policies and the supplement of micro-company commercial credit, empirical research shows that the increase in uncertainty of macroeconomic policies will significantly reduce the commercial credit provided by companies (Chen and Liu, 2018). SMEs are more sensitive to changes in interest rates in tightening monetary policies. Masuda's (2015) research on Japan also got the same

conclusion: the tightening monetary policy environment restricts market liquidity, and SMEs are more affected. The research of Huseyin and Mihai (2016) pointed out that corporate investment will be inhibited by the uncertainty generated by changes in fiscal policy and monetary policy. In view of the high irreversibility of part of corporate investment, when the uncertainty rises, Companies will delay investment. The study of Gulen and Ion (2016) found that the uncertainty of macroeconomic policies has led to a substantial decline in US corporate investment; Gulen further pointed out that an essential reason for the economic recession may be the uncertainty of the macroeconomic policy itself. The investment level of Chinese companies has also been negatively affected by rising economic policy uncertainty (Li and Yang, 2015). After studying the relationship between the uncertainty of macroeconomic policies and the supply of micro-company commercial credit, empirical research shows that the increase in uncertainty of macroeconomic policies will significantly reduce the commercial credit provided by companies (Chen and Liu, 2018). Research has found that during periods of poor economic conditions and rising economic policy uncertainty, companies will frequently change investment decisions, especially for companies that are subject to strong financing constraints (Campello ,2010).

A higher level of monetary policy uncertainty will increase the cost of corporate capital structure adjustment through credit channels, and reduce the speed of corporate capital structure adjustment (He et al., 2020). Moreover, increase the risk premium of companies through financial friction amplification mechanisms, Making private companies and small and medium-sized companies face more serious credit rationing problems, thereby reducing the level of investment of companies.

2.1.3.2 Uncertainty in macroeconomic policies may have a positive impact on companies.

Gu et al. (2018) used the data of Chinese listed companies; studies have found that the uncertainty of macroeconomic policies has increased the value of long-term earnings and encouraged companies to increase R&D investment, thereby enhancing the level of innovation of Chinese companies. Rao et al. (2013) pointed out that the increasing uncertainty of macroeconomic policies will cause Chinese companies to consider economic factors more in the decision-making stage of daily operations, promoting the investment efficiency of Chinese companies.

2.1.4 Relevant research on economic policy uncertainty and innovation R&D investment

Companies are the building blocks of the "Great Wall" of macroeconomics, and macroeconomic conditions will have a great impact on business decision-making (Korajczyk and Levy, 2006; Klein and Marquardt, 2006). Because macroeconomic fluctuations are generally sudden and exogenous, it is difficult for the government to control them, and changes in economic policies are relatively more controllable. Therefore, the uncertainty of research on economic policies has more impact on companies—practical significance. Many related works of literature adopt the uncertainty index of China's economic policy constructed by Baker et al. (2013) using text data mining methods. The index is based on a search of keywords in the "South China Morning Post" article, describing the uncertainty of China's economic policies in terms of currency, finance, and industry. The current literature focuses on business decision-making under specific macroeconomic policies (Korajczyk and Levy, 2006), but there are few studies on the impact of macroeconomic policy uncertainty on corporate R&D. The uncertainty of macroeconomic policies will affect the company's investment behaviour (Julio & Yook, 2012; Wang and Song, 2014) and dividend policy (Huang et al., 2015). As a long-term investment project with big risk and return uncertainty, R&D investment is more sensitive to the uncertainty of macroeconomic policies. Based on the stochastic dynamic optimization model to study the impact of macroeconomic policy uncertainty on company R&D investment, the study found that macroeconomic policy uncertainty will promote companies to achieve their own development through R&D. Among them, the more risk-averse companies, the higher the promotion effect (Meng and Shi, 2017). However, when we analyzed the impact mechanism of economic policy uncertainty on corporate innovation based on the real options theory, we found that the increase in economic policy uncertainty would cause companies to postpone R&D investment. These companies are waiting for more

relevant policy information to be disclosed, thereby inhibiting corporate innovation, and it has a more substantial inhibitory effect on the innovation of state-owned companies (Hao et al., 2016). There is no consensus on the impact of economic policy uncertainty on R&D activities.

2.2 Research on measuring the Uncertainty of Monetary Policy

When researchers measure the uncertainty of monetary policy, they often default to equating the uncertainty of monetary policy with the uncertainty of the overall economic policy. This is because, in essence, whether it is measuring the uncertainty of monetary policy or measuring the uncertainty of the economic environment, it is essentially measuring the uncertainty of macroeconomic policy. The difference only uses monetary policy variables or the overall economic policy variables. There are three main types of methods for measuring macro-uncertainty at home and abroad:

2.2.1 Using the GARCH model to measure the uncertainty of monetary policy.

Scholars use the generalized autoregressive conditional heteroscedasticity (GARCH) model to measure the historical volatility of macroeconomic indicators as a proxy variable of uncertainty. For example, they were using the GARCH model to estimate the conditional variance of multiple economic indicators such as GDP, industrial output value, and CPI. Jorda et al. (2003) calculated the volatility level of currency growth based on the GARCH model to measure the uncertainty of monetary policy. The GARCH model was used to calculate the conditional heteroscedasticity of the European dollar's three-month interest rate, non-borrowed reserves, federal funds rate and non-borrowed reserves, and the nominal exchange rate volatility. The conditional heteroscedasticity of these indicators is used as the currency Proxy variables of policy uncertainty. Kumo (2015) uses the GARCH model to calculate the conditional heteroscedasticity of the inflation level based on South Africa's inflation control policy system to measure the impact of monetary policy uncertainty. In order to study the impact of inflation fluctuations on output growth, a multivariate autoregressive conditional heteroscedasticity model (M-GARCH) was used to estimate inflation fluctuations. However, it was not related to uncertainty (Zhou and Wu, 2008). The indicator data used are the inflation rate and the real GDP growth rate, which are then substituted into the vector autoregressive (VAR-GARCH) model with conditional

heteroscedasticity, and then the conditional volatility estimated by the model is used as the macroeconomic uncertainty Proxy variables (Liu and Pan, 2012).

Some scholars also use the SV model (stochastic volatility) to measure the uncertainty of monetary policy. Because uncertainty fluctuations will be affected by the iteration of their own volatility shocks, which is not a certainty function of historical data, uncertainty can be better obtained through simulation (Mumtaz et al., 2018). The volatility of structurally identifiable shocks is regarded as uncertainty, and the uncertainty is measured by the structural vector autoregressive (SVAR-SV) model, including random fluctuations. He et al. (2020) used the Monte Carlo simulation parameter estimation method based on Gibbs sampling to measure the uncertainty of monetary policy using the SV model (random volatility model), fully considering the volatility between forecast divergence and future changes. Correspondingly, the uncertainty of the daily data of the 7-day weighted interest rate of the interbank pledged bond repurchase is extracted as the proxy variable of the uncertainty of monetary policy (He et al., 2020).

Based on the above summary of existing research results, it can be found that whether using the GARCH model, SV model, standard deviation calculation or fitting regression calculation method, the process of measuring the uncertainty of monetary policy is only based on one or two economic indicators. Although this method has the obvious advantages of strong operability and convenient calculation, it is inevitable to be biased when the fluctuation characteristics of an economic variable are used as a proxy variable of monetary policy uncertainty in the actual economic operation. Because time series is prone to endogenous problems, such as series volatility often contains macroeconomic uncertainties (Kelly et al., 2016). Moreover, differences of opinions and forecast deviations of economic entities are often subjective, which will result in lower accuracy of indicators based on the opinions and forecasts of the entities. The monetary policy uncertainty obtained by calculation can only measure the uncertainty of the variable and cannot be accurately regarded as the uncertainty of the monetary policy.

2.2.2 Estimate uncertainty through the standard deviation or volatility of relevant monetary policy variables

Extract the standard deviation to measure the uncertainty of monetary policy. This method is relatively simple, by extracting the standard deviation of a specific economic variable data as a proxy variable for the uncertainty of monetary policy. For example, using the standard deviation of the credit growth rate as a proxy variable for monetary policy uncertainty (Giordani and Soderlind, 2003);The standard deviation of the

difference between the predicted interest rate and the actual interest rate based on Michigan households is used as a proxy variable for monetary policy uncertainty (Rich and Tracy, 2010). Sun et al. (2017) measured the standard deviation between the interest rate predicted by the Survey of Professional Forecasters and the interest rate in the actual economic operation as a proxy variable for the uncertainty of monetary policy. Xu et al. (2020) used the annual standard deviation of the Shibor interest rate (Shanghai Interbank Funding 7-day interest rate) as a proxy variable for monetary policy uncertainty to calculate its impact on the Chinese economy, and the monetary policy uncertainty is measured by the volatility characteristics of a single change in the market or policy. Some scholars define volatility as economic uncertainty, and measure economic uncertainty indirectly through the volatility of market or policy proxy variables. This method is simple to calculate and has strong generalization. On the macro level, the daily overall return rate of the US stock market was collected and sorted out, and the unconditional variance was constructed as a measure of economic uncertainty (Pindyck et al., 1994). The volatility of stock market returns weighted by market capitalization is used as a proxy variable to measure market uncertainty. Bloom et al. (2018) used total factor productivity and the degree of dispersion of firm prices to measure the micro-uncertainty faced by companies. Ding et al. (2020) used the regression fitting method to measure the uncertainty of the Chinese economy from the perspective of policy interest rates.

Some scholars believe that uncertainty is an attribute that is difficult to predict. It is difficult to reflect the volatility characteristics of a single variable fully. The monetary policy uncertainty should be measured by the common volatility of the unpredictable part of monetary policy. Jurado et al. (2015) obtained the common volatility measure of the unpredictable part of monetary policy, which is the most scientific of monetary policy uncertainty, that is, the uncertainty of a particular period is manifested in the fact that the decision made in this period is different from the actual decision. The gap between expected decisions is based on all information in the base period. This method is based on multiple economic data and extracts the common volatility characteristics in the unpredictability of these data, thereby forming a comprehensive indicator that can more fully reflect the uncertainty of monetary policy. Chinese domestic scholar Wang et al. (2019) started from the construction framework of this measurement method and defined a parameter model to extract the uncertainty in the variable forecasting process. The selected indicators include monetary policy, bond market, securities market, macroeconomics, and price. A total of 45 variables are used to measure the uncertainty of China's monetary policy, and the overall monetary policy

uncertainty index is obtained through the weighted average method and the principal component analysis method.

2.2.3 Calculated indicators based on news media.

The uncertainty of macroeconomic or macroeconomic policies is often manifested in information shocks. The main channel for economic entities to obtain relevant information to support decision-making is the news media. The news media will convey the latest economic data and professional opinions to economic entities, and the greater the volume of news about the economy, the more likely each economic entity will update its expectations for the future of the economy (Doms and Morin, 2004) . Therefore, relevant data from news media can be used as the uncertainty of macroeconomic or macroeconomic policies. The idea of identifying uncertainty based on information in the newspaper was proposed as early as 1989. Romer (1989, 2004) used the meeting minutes of the Federal Open Market Committee to construct an indicator of monetary policy uncertainty. Subsequent researchers changed newspaper sources according to their research purposes, such as using newspapers such as Business Weekly to measure fiscal policy uncertainty (Ramey, 2008); using the New York Times to measure macro-uncertainty shocks (Cohen and Alexopoulos, 2009). However, the sources of newspapers selected by the scholars mentioned above are few, and the vocabulary is not comprehensive enough. The post-researcher Baker et al. (2016) inherited the above ideas. They enriched the newspapers referred to, updated them to the top ten influential newspapers in the United States, and then calculated the news including keywords related to economic policy uncertainty, on a monthly basis. According to the frequency of related words, the uncertainty index of economic policy is generated. The index has a longer span in time, and also refers to more representative newspapers. It also provides a basis for later scholars to study the uncertainty of macroeconomic policies further, so it has become an index commonly used by scholars in recent years. For example, Rogers et al. (2016) calculated the uncertainty-related articles in the "New York Times "and three other newspapers, and constructed the U.S. monetary policy uncertainty index since 1985. Zhu and Cai (2018) adopted the "Guangming Daily" newspaper databases, including China’s fiscal policy uncertainty and monetary policy uncertainty, put forward proxy indicators. Huang and Luk (2020) used ten major newspapers in mainland China, including "People's Daily (Overseas Edition)", "Southern Metropolis Daily", "Jiefang Daily" to calculate the uncertainty,

and increased it to 114 newspapers in the robustness test so that the calculated indicators can better describe the uncertainty of China's monetary policy.

2.3 Research on external factors affecting Chinese company innovation

For companies, independent innovation is an important way to enhance their core competitiveness, and companies must invest in research and development if they want to achieve independent innovation. A significant harvest that R&D investment brings to a company is that its innovative behaviour may generate patents. The main difference between a patent and an ordinary product is that it is difficult to copy, and the company is legally protected against the dissemination of the patent and can prevent similar products from entering the market, thus increasing the company's competitive advantage. In addition, R&D investment can also use patent transfer to earn profits, thereby reducing the adverse impact of R&D investment irreversibility on the company. In addition to the expected benefits from the investments currently made by companies, they can also obtain development opportunities in the future. Although the total factor productivity of China's industrial sector is showing a good trend of rising, the overall innovation efficiency is low (Sun et al., 2017). Hill and Snell (1988) found that the investment and returns of R&D projects often take a long time, and there are often unexpected situations in the R&D process, which will change the returns of R&D projects. Therefore, it is very difficult to reasonably evaluate the effects of R&D investment (Laverty, 1996).

The existing literature mainly studies the influencing factors of R&D investment from the external policy environment of the company and the company's own characteristics. The existing literature mainly examines the factors influencing R&D investment in terms of the firm's external policy environment and the firm's own characteristics. No consistent conclusions have been reached on the impact of the external policy environment on the company's R&D investment.

2.3.1 Related theories of corporate investment

Investment theory needs to solve the problem of who the principal investment is and how to make the investment. The classical theory of corporate investment, based on the idea of marginalism, gradually introduces the theoretical assumptions of investment irreversibility and uncertainty by determining the goal of maximizing company value

or profit, and solving the problem of how to produce investment in the natural economic environment.

The study of investment in economics can be traced back to the ancient Greek and Roman philosophies of "output over input" and the mercantilists who sought to increase the wealth of their countries. Before neoclassicism, however, economists did not systematically address the question of who was the main subject of investment. The investment theory of this period generally studies aggregate investment. Classical scholars, for example, set up a large number of individuals and organizations as investment agents according to a uniform efficiency criterion and the assumption of a 'rational man' (Wang, 2005).

With the introduction of marginal analysis, there is a new fundamental approach to analyzing the investment behaviour of typical individuals. Neoclassical scholars first started to analyze the investment behaviour of companies from a micro perspective: Modigliani and Miller (1958) were the first to suggest that the cost of investment, i.e., the leverage of the company, does not affect the value of the company when it invests as a micro individual, and that the objective of the firm's investment is to maximize its subjective utility function. Under the assumption of a perfectly competitive market proposed by Modigliani et al., Jorgenson (1963) introduced a steady-state level of firm capital, starting from the Cobb-Douglas production function of the company, linking company investment to the achievement of the optimal steady state.

In reality, in the process of corporate investment, it is necessary to consider the use of capital to have a specific adjustment cost. However, Jorgenson's corporate profit maximization model lacks an analysis of capital adjustment costs, and its assumptions are too ideal. Tobin (1969) introduces fixed asset adjustment costs proportional to the scale of investment into the firm's profit function. He concluded that the amount of net investment in fixed assets is proportional to the shadow price of capital q. And suppose the value of q is greater than 1， in that case, the current market price of the firm is more engaged than the cost of reacquiring the firm, at which point increasing the firm's capital holdings can increase the total value of the firm, so the size of the firm's investment increases; conversely, the size of the firm's investment decreases.

2.3.2 The impact of policy uncertainty on innovation

Kulatilaka and Perottiew (1998) believe that innovation is self-evident for the development of companies and even the country. Its influence on companies' competitive strategy under the background of policy uncertainty has already attracted widespread attention. Fernández-Villaverde et al. (2015) pointed out that policy uncertainty is the potential cost of policy adjustments, and effective control over it is

extremely important. Policy uncertainty will weaken short-term economic growth, and investment will be particularly hard hit (Baker et al., 2015).

2.3.2.1 Policy uncertainty will postpone innovation investment

Investment is irreversible, so companies will be more cautious when making R&D investment decisions. Increasing policy uncertainty makes companies willing to postpone investment and wait for a more appropriate time. Therefore, R&D investment decisions often follow policy changes. Increase in certainty and delay. R&D investment is different from ordinary asset investment, in that it is more irreversible than ordinary investment. Once a decision is made, it is much more costly to change it than an ordinary investment. Once an investment is made, it is mostly a sunk cost and cannot be recouped even if the investment is subject to unexpected uncertainty (Dixit and Pindyck, 1994). The exposure of R&D investments to policy uncertainty is higher than that of ordinary investments. Companies' R&D investment decisions are susceptible to external environmental influences, and policy uncertainty will, to some extent, increase the risk of the market. Hence, companies' R&D decisions are subject to such risk shocks. R&D investment is extremely risky, as it takes a long time for companies to undertake R&D actions, but the uncertainty of returns is also great. It is likely that companies will spend a lot of human resources and other resources and end up with nothing in return. Therefore, it is difficult for companies to obtain financial support from banks for their R&D projects, and they usually have to rely on their own capital injection to promote the operation of their R&D projects. However, policy uncertainty will trigger economic volatility, and the expected return risk for companies in such an environment is further increased significantly (Goel and Ram, 2001).

Based on real options theory, policy uncertainty promotes companies' decisions to defer investment to reduce the adverse effects of uncertainty (Gulen and Ion, 2016). By constructing a cash flow volatility indicator to measure uncertainty in expected cash flows, it was found that companies will reduce funding for R&D projects if cash flow volatility increases (Minton and Schrand 1999). In the face of political uncertainty, investors and banks, for example, are more likely to demand additional compensation, and the cost of external financing for companies increases. Companies that can reasonably expect changes in government policy will also expect an increase in the difficulty of raising corporate finance and thus reduce their investment in innovation (Durnev, 2013) now. In addition, policy uncertainty will have an impact on bank credit behaviour. Faced with policy uncertainty, banks will be more cautious in controlling the size of their loans, and companies will have further reduced access to external finance, meaning that companies face higher financing costs. Economic instability caused by policy uncertainty is likely to increase companies' risk exposure through

asset price effects (Pastor and Veronesi, 2013), which may also put companies' R&D investments at risk. Policy uncertainty may lead to potential adverse selection and moral hazard, which in turn may reduce companies' incentives to invest in R&D (David et al., 2008). As the level of policy uncertainty increases, companies will invest less in R&D, while the level of bank credit strengthens the incentive to invest in R&D (Guo et al., 2016).

2.3.2.2 Policy uncertainty will advance innovative investment decisions

In addition to the difficulty of predicting returns, technology is also highly uncertain (Oriani and Sobrero, 2010). These uncertainties are inherently challenging to eliminate, so companies should not avoid investing in R&D because of uncertainty but should invest in R&D earlier to increase the likelihood of success of their investment projects. For companies, technological uncertainty in R&D projects has a more significant impact than uncertainty in the market. If the market demand for new products increases, there is a high risk that companies will lose their competitive edge and eventually be forced out of the market due to a lack of timely access to new technologies (Tegarden et al., 1999). Some literature suggests that policy uncertainty can, to a certain extent, lead companies to make decisions to increase their R&D investment (Atanassov et al., 2015; Stein and Stone, 2013). Therefore, market volatility caused by policy uncertainty may not have a negative effect on companies' R&D if the technological uncertainty of the R&D investment projects they face is taken into account. This policy uncertainty may, to some extent, reduce the opportunity cost for companies to make R&D investments. At this point, companies should instead seize the opportunity to invest funds in R&D projects (Gu et al., 2020).

2.3.3 The impact of company's own characteristics on innovation

As for the research on the impact of company characteristics on R&D investment, scholars mainly study the impact of ownership structure and incentive measures on company R&D investment. The study found that the diversification of shareholder shares can significantly increase the R&D investment of state-owned companies (Xie, 2019). When equity is concentrated, equity checks and balances, equity incentives and the size of small boards of directors are conducive to improving the R&D investment of companies (Xiao, 2016). A comparative study of different industries found that the shareholding ratio of the second to tenth largest shareholders, the shareholding ratio of funds, and the shareholding ratio of directors and supervisors had a positive effect on corporate R&D investment (Lu and Dang, 2014). Regarding the impact of incentive measures on Company R&D investment, although R&D activities are regarded as the root cause of company growth and competitive advantage, management usually only

invests in R&D when the expected income is higher than the R&D cost (Ettlie, 1998). However, by reasonably formulating and adjusting executive compensation, it will effectively reduce their inertia in R&D activities, affecting the expected costs and expected benefits of managers' R&D activities (Cheng, 2004). After using a sample of listed companies for the empirical analysis, the study found that implementing equity incentives for CEOs will help companies increase their R&D investment(Shao et al., 2019). The impact of controlling shareholder's equity pledge on company innovation investment, the results show that controlling shareholders' equity pledge will inhibit company innovation investment, and this result is more significant in companies with a low shareholding ratio of controlling shareholders and two functions in one (Li et al., 2018). The decision-making procedures within companies with different ownership concentrations are often different, and the degree of financial resources and capital support they can obtain is also different. Companies with a high shareholding ratio of significant shareholders often have a relationship-oriented dominant position, and several shareholders have a large voice. Under this background, on the one hand, in order to ensure their own interests, the willingness of major shareholders to seek personal interests is greatly reduced; on the other hand, they tend to have sufficient willingness and motivation for supervision and are willing to spend more time and energy on the long-term development planning of companies. When the uncertainty of economic policy increases, the senior management of companies will have some difficulty in judging the development direction and industry prospects of companies in the future, which will affect their strategic expectations. In this case, the investment decision-making of companies with high equity concentration depends more on the personal style of company managers. Suppose company executives are risk-averse because the investment period of innovative projects is generally long and closely related to the company's cash flow for a long time. In that case, company executives may be more conservative and avoid innovation to avoid risk. Although the ownership concentration is high, some major shareholders may also be more motivated to carry out innovative R&D.

2.3.4 The impact of the nature of company ownership on innovation

Because the controlling shareholders largely influence the company's decision-making, they have the ability and motivation to affect companies' business decision-making and innovation activities. Therefore, there are more and more studies on the nature of the ownership and business innovation, but most of the research conclusions are controversial. Most scholars believe that private companies have stronger innovation consciousness, motivation, and higher efficiency. The major shareholders

of state-owned companies are unable to promote corporate innovation and will have a negative impact on the company's innovation. Although many listed companies controlled by families or natural persons have the problem of checks and balances between the two rights of significant shareholders, the check and balance mechanism of major shareholders is still better than that of state-owned companies (Tang, 2014). Since the operation goal of state-owned companies dominated by the government is not to maximize profits, but to ensure employment, which acts as a machine to ensure the operation of the market mechanism to a certain extent, their decision-making is largely affected by the government and the operation of the national economy. At the same time, under the particular system, state-owned companies often have certain preferential treatment and advantages in subsidies and competition. Therefore, the innovation power is insufficient (Zhang and Zhang, 2007). At the same time, some scholars hold opposing opinions and believe that the attributes of state-owned companies will not have a negative impact on the innovation of companies, but will promote the innovation of companies. It is believed that since the state-owned company has unique resource preference advantages, from the perspective of resource allocation, they can obtain the support of resources, human resources and capital at a lower cost, which are essential factors for company innovation, and the innovation efficiency and intensity are naturally relatively higher (Meng and Shi, 2017). To sum up, both state-owned companies and private companies have their own advantages and disadvantages in innovation. At present, there is no unified conclusion on the specific impact.

3 Data

3.1 Data source

The primary sources of data used in this thesis are as follows: first, the data related to China's monetary policy. The uncertainty variables of monetary policy come from the website[1] created by Huang et al.(2020), the data of other macroeconomic variables are from the website of the National Bureau of Statistics of China. Second is company innovation data. Company patents and innovation data come from the Chinese innovation research database (CIRD). Third, the company financial data and characteristic data are derived from China Stock Market & Accounting Research Database (CSMAR): (1) Exclude financial companies; (2) Exclude ST (Special Treatment) and *ST companies, which are mainly due to the poor reliability of their operating results and abnormal financial status; (3) Exclude companies with missing data.

3.2 selection and description of main indicators

Firstly, this thesis selects A-share listed companies in China's Shanghai and Shenzhen stock markets from 2007 to 2020 as the initial research sample. The year 2007 was taken as the starting point of this period because China's new accounting standards, which were officially implemented on 1 January 2007, achieved full convergence with international accounting standards and included R&D expenses as a single account. Secondly, this thesis groups the initial sample according to the Guidelines on Industry Classification of Listed Companies (2012), retaining only the sample of manufacturing companies and removing non-manufacturing companies. Then, ST and *ST companies were excluded. Finally, unbalanced panel data covering 783 manufacturing listed companies were obtained, including non-metallic mineral products, computer, communication and other electronic equipment manufacturing, electrical machinery and equipment manufacturing, pharmaceutical manufacturing and automobile manufacturing industries, including a total of over 8,000 company annual observations. Table 1 below shows the names, descriptions and calculations of the various significant variables.

[1] https://economicpolicyuncertaintyinchina.weebly.com/

Table 1 Specific variables

Name	Description and calculation method	Variable
Dependent variable		
RD	R&D expenditure / income of the company in the current year； logarithm of RD	lrd
Number of patent applications	Obtain the number of patent, utility model and design applications filed by listed companies in each year Invention, utility model and design patent applications	Innovation
Independent variable		
CN_Monetary	China monetary policy uncertainty index, average level of the index over the year	CNM1
CN_Monetary	Average level of the last 3-6 months of last year (when budget for next year is prepared and R&D planned)	CNM2
CN_Monetary	Standard deviation to capture the "volatility" of the monetary policy uncertainty during the year	CNM3
Control variables		
Years of listing	ln(1+Listing period）	Age
Corporate scale	logarithm of total assets	size
Shareholding of top ten shareholders	shareholding ratio of top ten shareholders	SHratio
Market value	company market value / total assets	TBQ
Operating gross profit margin	gross profit	GP
Leverage	total Liabilities / total assets	Lev
Return on assets	net profit / total assets	ROA

Cash flow	logarithm of net cash flow from operating activities / total assets	Cash
Corporate growth	gross profit / operating income	IGrate
Nature of equity	company nature: 1 is a state-owned company and 0 is a private company	EPA
Financing constraints	Financing Constraint Index	SA

Source: made by author

3.2.1 Explanatory variable - uncertainty index of monetary policy

In terms of quantifying economic policy uncertainty, most of the existing literature is based on the Economic Policy Uncertainty (EPU) index calculated by Baker et al. (2016). Specifically, Baker's approach measures the frequency of words representing economic policy uncertainty appearing in media news. This method is very effective for measuring economic policy uncertainty, because the first two ideas mentioned in the literature review are both based on the performance of the market, due to the focus on macroeconomic and market performance and the opinions of microeconomic subjects, these two approaches actually measure the overall economic uncertainty, rather than highlighting the uncertainty of economic policies. Compared to the first two ideas, the frequency of words related to economic policy uncertainty in the news media puts the emphasis on the uncertainty of economic policy; in addition, since there is a certain time lag and interpretation bias in macroeconomic and market performance and microeconomic agents' opinions in response to macroeconomic policies, uncertainty based on macroeconomic and market fluctuations and market agents' divergent opinions and forecast bias cannot accurately reflect economic policy uncertainty.

The indicator of monetary policy uncertainty used in this thesis is China's monetary policy uncertainty index of Huang and Luk (2020). This index is constructed in the same way as the Baker et al. (2016) EPU index. However, Baker did not search for the text in the newspapers published in the Chinese mainland, but used the information from the Hongkong English newspaper" Nanhua morning post". Therefore, Huang believes that the newspaper based in Hong Kong may choose to report news closely related to the "Hong Kong economy," which may not fully reflect the uncertainty of China's economic policy. There is only one newspaper in the sample, and the change in editorial policy or preference will significantly impact the

index. The rise of the EPU index did not achieve the expected impact on China's main macroeconomic variables in the empirical study.

Based on the above background, Huang et al. (2020) built a more stable China economic policy uncertainty index with ten major Chinese mainland newspapers as sources and built their own uncertainty index of fiscal policy and monetary policy, respectively. Then Huang et al. verified that the impact of the index on China's macro-economy is reasonable through the structural autoregressive model, and in the robustness test, they increased the newspaper sources to 114 and obtained similar results. Therefore, the index has high accuracy and certain robustness.

The index is constructed by first identifying terms related to "monetary policy uncertainty", and then each selected article must contain at least one of the three criteria of "money, policy, uncertainty". The total number of articles was normalized using the number of articles containing the word 'money' in the month as the denominator, and the arithmetic mean of the monthly time series based on ten newspapers was then calculated. Finally, the index is normalized by setting the mean value for the period January to December of a given year to 100.

The situation of China's monetary policy uncertainty index constructed by Huang et al.(2020) for the past 20 years is shown in Figure 1.

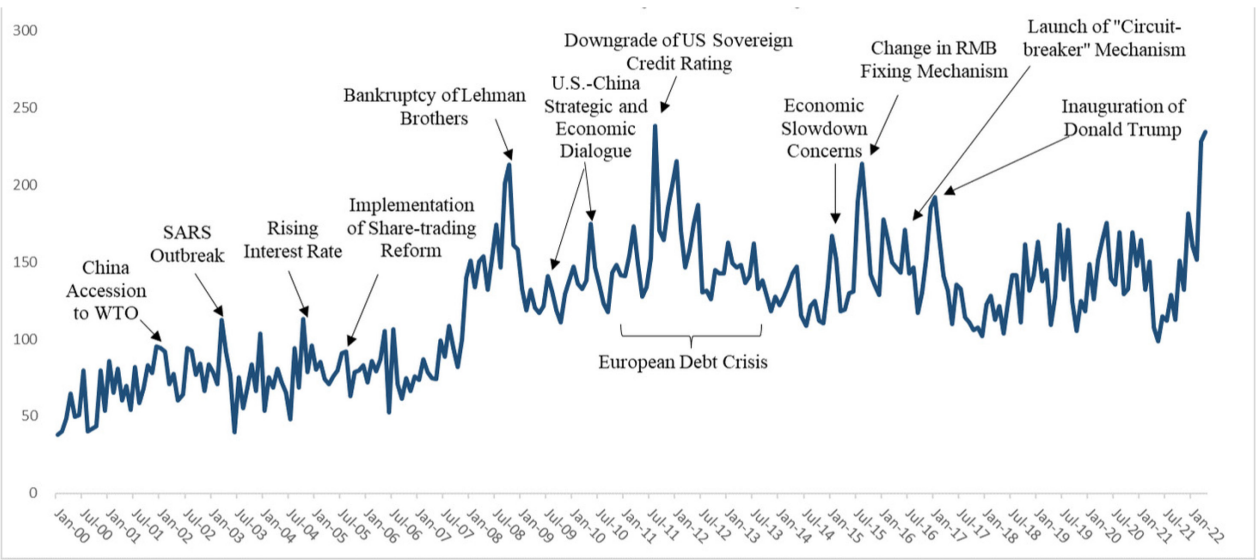


Figure 1 Monetary Policy Uncertainty Index

Source: Huang and Luk (2020)

The policy uncertainty index constructed by Huang et al. is highly consistent with China's monetary policy-related events and has strong practical credibility.

For example, the high point at the beginning of 2001 was related to the strengthening of open market operations at that time. In the first half of 2001, 29 open market operations were carried out, with 589.4 billion yuan of base currency invested and 772.6 billion yuan of base currency withdrawn, resulting in significant uncertainty. SARS broke out in 2002. At this time, in response to the slowdown of China's economic growth and the decline in consumer prices

At the same time, the deposit and loan interest rates will be lowered, and the credit supply in the open market will be increased. The high point in early 2005 stems from the central bank's promotion of the process of interest rate marketization and the reform of the RMB exchange rate formation mechanism. At this time, China fully liberalized the interbank deposit interest rate among financial institutions, and carried out the pilot of centralized management of foreign exchange funds and the reform of rural credit cooperatives. In the second half of 2008, in response to the financial crisis, the central bank timely adjusted the direction, focus and intensity of monetary policy. Such as raising the expected target of annual new loans to more than 4 trillion yuan, they were reducing the benchmark interest rate of deposits and loans five times, reducing the deposit reserve ratio four times, and explicitly cancelling the hard constraints on the credit planning of financial institutions, resulting in high uncertainty of monetary policy.

The main reason for the formation of the high point at the beginning of 2010 is that the setting tone of China's monetary policy changed from highly loose to moderately loose. Since then, the change in monetary policy reached a peak from 2011 to 2012. The central bank raised interest rates three times, cut interest rates twice, and increased reserve requirements six times and reduced reserve requirements twice. As a result, the monetary policy uncertainty in August 2011 reached the maximum since 2000. In August 2015, the RMB exchange rate mechanism was reformed, including enhancing the flexibility of exchange rate floating and strengthening the market-oriented formation mechanism of the central parity of exchange rate, which led to the devaluation of the RMB exchange rate for nearly a year and a half, accompanied by a large-scale outflow of capital. At the beginning of 2016, according to the unified deployment of the CPC Central Committee and the State Council, monetary policy needs to further enhance its pertinence and effectiveness. The central bank established a normalization mechanism for the daily operation of the open market and strengthened

the guidance and regulation of money market interest rates. The uncertainty of monetary policy is high.

At the beginning of 2017, the central bank regulated the real estate credit market and strengthened the macro Prudential Management of housing finance in accordance with the principle of "implementing policies according to the city." In 2019, in order to deepen the structural reform on the financial supply side and improve the formation mechanism of quotation interest rates in the loan market, without ensuring sufficient liquidity, the reserve ratio was reduced by 0.5 percentage points in September. At this stage, we also adhered to "precision drip irrigation" and released about 100 billion funds to support the development of private, small and micro-companies. At the beginning of 2020, when the new crown pneumonia broke out, in order to maintain reasonable and sufficient liquidity, the deposit reserve ratio was reduced three times. At the same time, a special re-loan of 300 billion yuan was set up to support key areas and key companies in epidemic prevention and control. The special quota for re-loan and rediscount was increased by 500 billion yuan. Support companies to resume work and production, and increase the re-loan and rediscount quota by 1 trillion yuan to support economic recovery and development, resulting in high monetary policy uncertainty.

3.2.2 Dependent variables

In this thesis, we use two variables to capture the company’s innovation. First, we use the ratio of R&D investment to operating income to measure the company's R&D level. The number of patent applications is measured by the number of invention patent applications, utility model patent applications and design patent applications of the company that year. As shown in Figure 2, the proportion of R&D investment of listed companies decreased under the influence of the financial crisis in 2008, and increased gently after the financial crisis. Despite the impact of the epidemic, the pace of scientific and technological innovation of listed companies did not slow

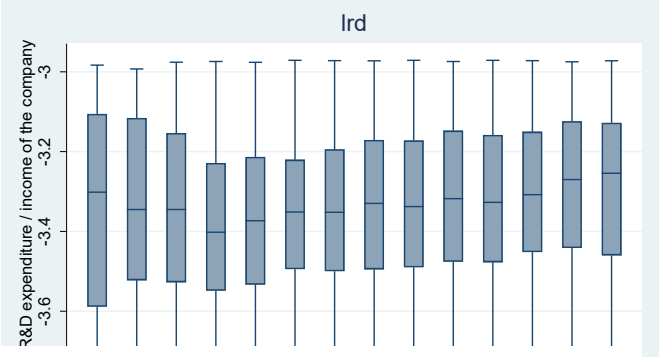


Figure 2 Averages and interquartile dispersion of lrd over time across

Source: Calculated by author

down in 2020,especially in the pharmaceutical and biological industries.

Second, we use the number of inventions to measure the company's innovation.on the whole, Figure 3 shows that from 2007 to 2018, the number of invention patent applications of listed companies showed a steady upward trend, and the patentability of companies increased significantly. After 2019, affected by the epidemic, the number of company patent applications decreased significantly. Although the proportion of R&D investment has not changed much, however, in terms of the number of applications, the innovation capacity of companies is still affected to a certain extent.

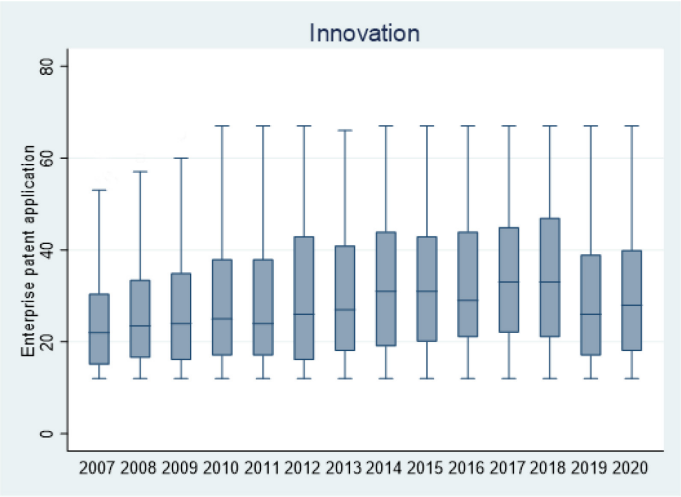


Figure 3 Averages and interquartile dispersion of Innovation over time across

Source: Calculated by author

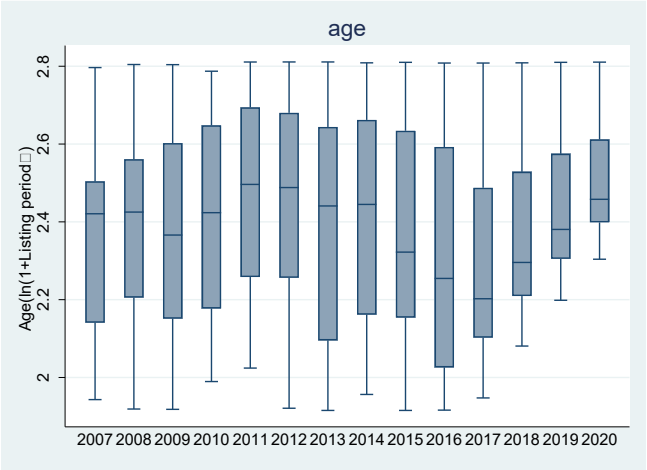
3.2.3 Control variables

There are many factors affecting company innovation. This thesis selects relevant control variables from the individual level of companies.

Company age: Mature companies will reduce innovation because of their influence in the market. Specifically, it is measured by the observation year minus the year of establishment of the company plus one and taking the natural logarithm. As can be seen from Figure 4, the mean value of company age fluctuates over time, reaching a peak in

2011 and a minimum in 2017.

Figure 4 Averages and interquartile dispersion of age over time across



Source: Calculated by author

Company size: The innovation activity itself requires a lot of capital investment. The larger the company is, the more likely it is to have scale advantages. The company has more collateral and more abundant cash flow, and the more likely it is to allocate more funds for company innovation and R&D projects. Specifically, it is expressed in the natural logarithm of the company's total assets, in Figure 5, it shows that the mean value of the size is around 2.2 and increases year by year.

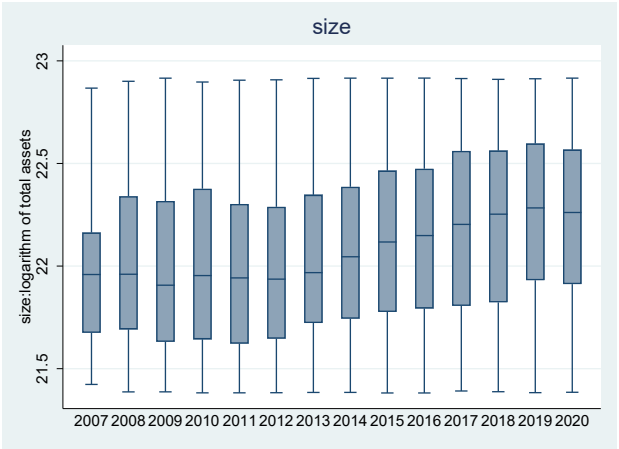


Figure 5 Averages and interquartile dispersion of size over time across

Source: Calculated by author

Tobinq: market value / total assets. The economic crisis in 2018, the European debt crisis in 2012 and the outbreak of COVID-19 in 2019 all had a great impact on the market value of companies. At these three points in time, the market value of the

company decreased significantly, so the tobinq value fell similarly, as shown in Figure 6, with three low points in the tobinq value.

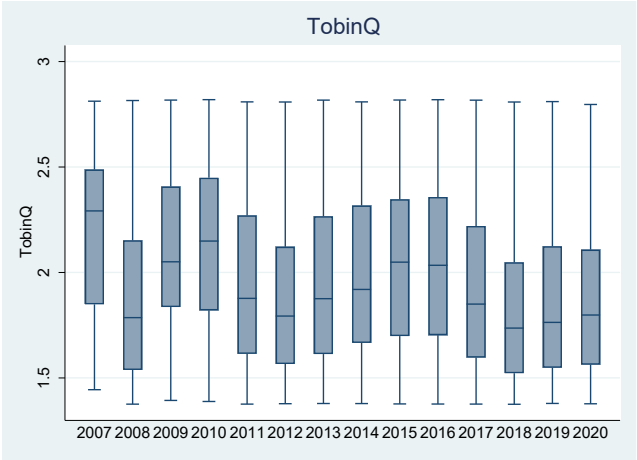


Figure 6 Averages and interquartile dispersion of TobinQ over time across

Source: Calculated by author

The shareholding ratio of the top ten shareholders(SHratio): before 2019, the median shareholding ratio of the top ten shareholders remained stable at 5.5-6, and decreased after 2019. as shown in Figure 7.

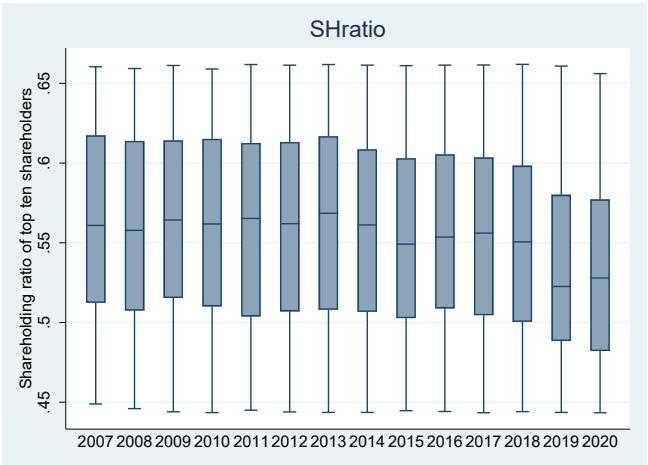


Figure 7 Averages and interquartile dispersion of SHratio over time across

Source: Calculated by author

Profitability ROA: The stronger the profitability of the company, the company can obtain more abundant endogenous funds for innovation and R&D investment, and the innovation output of the company is specifically expressed by net profit divided by

total assets. The median was stable at about 0.4 without much change. As shown in Figure 8.

Figure 8 Averages and interquartile dispersion of ROA over time across

Source: Calculated by author

Leverage ratio (Lev): existing studies have found that the company leverage ratio is closely related to company innovation, which is specifically expressed by dividing total liabilities by total assets. The leverage ratio of companies is also relatively stable, between 0.4-0.5, as shown in Figure 9.

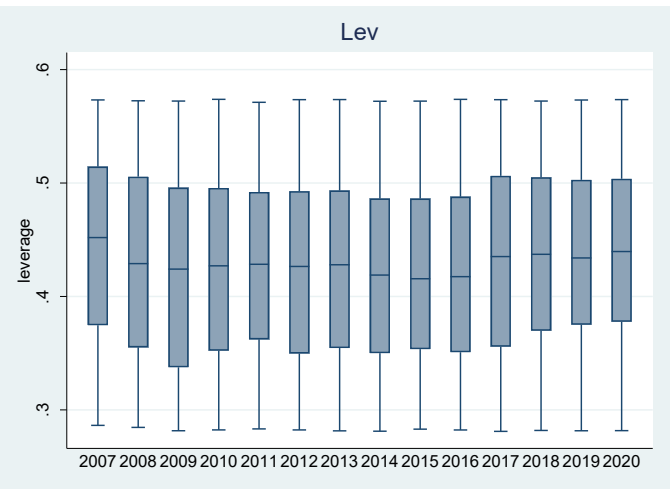


Figure 9 Averages and interquartile dispersion of Lev over time across

Source: Calculated by author

Cashflow ratio (cash): The more abundant the cash flow of a company, the more conducive it is to the development of company innovation activities. They were expressed as the ratio of cash flow from operating activities to total assets. Cash flow

generally shows a downward trend first and then an upward trend, as shown in Figure 10.

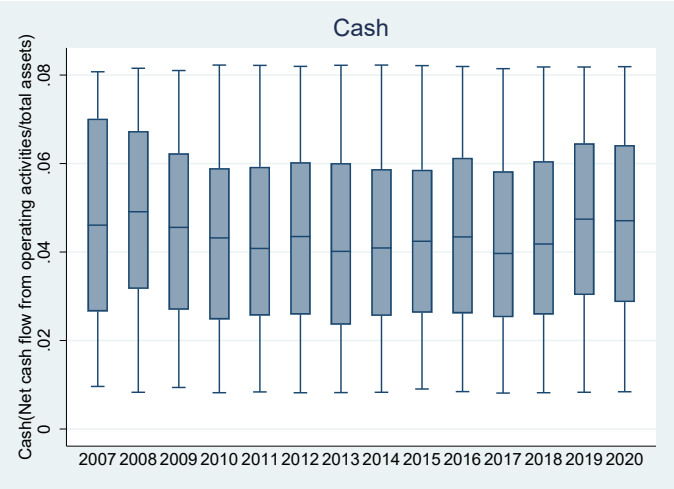


Figure 10 Averages and interquartile dispersion of Cash over time across

Source: Calculated by author

Company growth (IGrate): The growth rate of business income. During the financial crisis and COVID-19, the growth rate of company income declined, as shown in Figure 11.

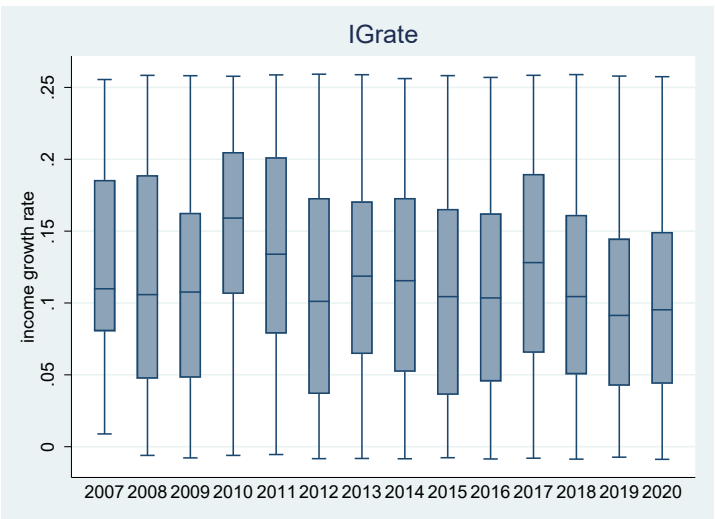


Figure 11 Averages and interquartile dispersion of income growth rate over time across

Source: Calculated by author

3.3 Summary data

Table 2 shows the descriptive statistics of variables.

Table 2: Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
lrd	-3.555	1.090	-13.069	2.996
Innovation	71.613	198.312	1	3836
CNM1	4.839	0.329	4.394	5.429
CNM2	4.973	0.366	4.439	5.613
CNM3	3.486	0.233	3.121	3.959
age	2.282	0.689	0.005	3.436
TBQ	2.375	1.600	0.219	21.040
SHratio	0.552	0.148	0.078	0.947
GP	0.264	0.156	-1.279	0.929
Lev	0.434	0.270	0.008	11.386
ROA	0.042	0.079	-1.815	0.815
size	22.243	1.216	19.025	27.547
IGrate	0.188	1.002	-0.949	55.044
Cash	0.046	0.066	-0.454	0.407
SA	-3.529	0.274	-4.347	-2.737

Source: Author's calculation in Stata

Descriptive statistics of the main variables are reported. It can be found that the average value of R&D investment (lrd) in the selected sample, that is, the logarithm of the ratio of R&D expenditure to operating income, is -3.555, indicating that China's overall R&D investment level needs to be improved. The large standard deviation of the number of patents indicates a large degree of dispersion in the data. The minimum value of the monetary policy uncertainty index (CNM1) is 4.394, the maximum value is 5.429, and the average value is 4.839; the minimum value of CNM2 is 4.439, the maximum value is 5.613, and the average value is 4.973; the minimum value of CNM2 is 3.121, the maximum value is 3.959, and the average value is 3.486, which shows that China's monetary policy is adjusted more frequently. In addition, from the statistical analysis at the company level, the standard deviation between the age and size of the company is large, indicating that the development stages of the sample companies are different and have a certain scale. The minimum value of company market value (TBQ) is 0.219, and the maximum value is 21.040, which shows that the market value of different listed companies varies greatly. The minimum value of the asset-liability ratio (Lev) is 0.008, and the maximum value is 11.386, which shows that the debt levels of different listed companies vary greatly.

Moreover, from the maximum value of asset-liability ratio, it can be seen that some listed companies have the problem of excessive debt. The minimum value of return on

assets (ROA) is -1.815, and the maximum value is 0.815, which indicates that there is a certain gap in profitability between some listed companies. The minimum value of cash flow is -0.454, and the maximum value is 0.407, which shows that the cash flow levels of different listed companies vary greatly. The average of company growth (lgrate) is 1.880, indicating that the sample companies have good growth. In addition, the standard deviation of company growth is significant, meaning that there are great differences in the development of different listed companies.

4 Theoretical Analysis and Hypotheses

4.1 The mechanism of action of China's monetary policy

The mechanism of action of monetary policy is to first set the ultimate goal, such as a stable macroeconomic environment, appropriate inflation rate and full employment, and then the central bank adjusts the intermediary target variables, such as money supply and interest rate to regulate the behaviour of to achieve the ultimate goal, and ultimately affects the aggregate macroeconomic output (Chen and Ren, 2018).

China's monetary policy has the M2 growth rate as an intermediate target, and GDP growth and inflation rate as the final target (Chen and Ren, 2018). The People's Bank of China formulates and implements monetary policy, and determines the GDP growth target value and M2 growth target value for the next year. The PBOC's decision on quarterly changes in monetary policy is strictly constrained by the ultimate goal of achieving GDP growth. In practice, the PBOC adjusts the quarterly M2 growth rate to meet the needs of current GDP growth, and also needs to make the quarterly adjustment of the M2 growth rate consistent with the set annual M2 growth target. At present, the main monetary policy tools of the People's Bank of China are as follows: ⅰ. open market business; ⅱ. deposit reserve; ⅲ. central bank loan; ⅳ. interest rate policy; ⅴ standing lending facility; ⅵ. medium-term lending facility.[2]

Chen et al. (2018) proposed a model of China's monetary policy based on the reality of China's monetary policy. The model specification are as follows:

$$g_t = g_0 + r_0 g_{t-1} + r_1(\pi_{t-1} - \pi*) + r_2(y_{t-1} - y*) + \varepsilon_t$$

g is the growth rate of M2 in period t, $g_{t-1}$is the growth rate of M2 in period t-1, π_{t-1} is the inflation rate in period t-1, $\pi*$ is the target inflation rate, and y_{t-1} is the GDP growth rate in period t-1, $y*$ is the target GDP growth rate, and ε_t is the random error term.

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[2] Source from: Official website of the People's Bank of China http://www.pbc.gov.cn/zhengcehuobisi/125207/125213/index.html

The specific meaning of China's monetary policy model setting is as follows: At the end of each year, the central government sets the M2 growth rate that matches the target GDP growth rate ($y*$) and target inflation rate ($\pi*$) for the following year, the Monetary Policy Committee of the People's Bank meets at the end of each quarter to decide on the monetary policy for the next quarter in response to the difference between the current quarter's inflation rate and target inflation ($\pi_{t-1} - \pi*$) and the gap between the current quarter's GDP growth and target GDP growth ($y_{t-1} - y*$), the People's Bank of China adjusts the money supply taking into account the output and inflation gaps.

Interest rates represent the price of money or currency and are determined by the supply and demand for money. If the central bank increases the supply of money and releases liquidity, which would represent an increase in M2, then an increase in supply would be a decrease in interest rates with relatively unchanged demand. Conversely if it is the central bank that tightens the money and withdraws liquidity, a decrease in supply would be an increase in interest rates with relatively unchanged demand.

4.2 Definition of monetary policy uncertainty

Monetary policy uncertainty means that with frequent adjustments of monetary policy, the public and companies cannot accurately grasp whether, when and how the government will change the current policy, and it is difficult to form consistent and stable expectations for monetary policy. Specifically, the uncertainty of monetary policy can be expressed as the degree of conditional deviation between the expected value predicted based on current period information and the actual value in a future period (Jurado et al., 2015). Referring to related research, the specific uncertainty theoretical model is

$$U_{jt}^{y}(h) = \sqrt{E\left[(y_{jt+h} - E\left[y_{jt+h}|I_t\right])^2|I_t\right]}$$

The uncertainty y_{jt} of the future h period of the variable $U_{jt}^{y}(h)$ can be expressed as the prediction based on the t period information I_t

The degree of conditional deviation between the measured expected value x and the real value x in the future h period. The uncertainty of China's monetary policy mainly comes from the following aspects:

The uncertainty y_{jt} in the future h period of variable $U_{jt}^{y}(h)$ can be expressed as the degree of conditional deviation between the expected value $E[y_{jt+h}|I_t]$ predicted based on the t period information I_t and the real value y_{jt+h} in the future h period. The uncertainty of China's monetary policy mainly comes from the following aspects:

Monetary policy has multiple objectives. As China is still in a period of economic transition, the socio-economic structure is in the process of adjustment, and the financial markets continue to develop, the constraints faced by the People's Bank at the policy formulation stage are more complex. In addition to the statutory objectives of price stability and, thus, economic growth, the People's Bank is also tasked with the annual objectives of balancing the payments, full employment, and the dynamic objective of supporting the reform and development of the financial sector. Since the various objectives of monetary policy may be focused at different times and have different importance, the multiple objectives of monetary policy inevitably overlap and interfere with each other, thus easily triggering a tendency for monetary policy to make camera choices in practice (Xu, 2017). This feature of multiple monetary policy objectives makes it easy for China's monetary policy to change beyond the expectations of the public and the market, leading to uncertainty in China's monetary policy. In addition, in the context of the "new normal" of economic development, industrial upgrading and economic structural transformation have also become objectives that monetary policy authorities need to consider when formulating monetary policy (Peng and Fang, 2016). The multiple objectives of China's monetary policy make it vulnerable to shocks from multiple sources of uncertainty, resulting in a high degree of uncertainty in China's monetary policy.

Second is the impact of external monetary policy uncertainty. Because the U.S. economy plays an important role in the global economy, the U.S. dollar has a relatively special status, and the monetary policies of countries around the world will be significantly affected by the spillover effects of U.S. monetary policy. For example, after the 2008 financial crisis, in the process of implementing and withdrawing quantitative easing policies in the United States, the volatility of the Federal Reserve and the frequent manipulation of U.S. monetary policy have brought uncertainty to the U.S. monetary policy, especially in recent years. Uncertainty has also increased significantly. The impact of U.S. monetary policy uncertainty on China's monetary policy uncertainty is reflected explicitly in the following two aspects. First, the People's Bank, out of fears of significant exchange rate fluctuations and capital outflows, may change its monetary policy according to changes in U.S. monetary policy. Corresponding measures were taken, resulting in the subsequent adjustment of China's

monetary policy, which led to uncertainty in China's monetary policy; secondly, even if the Chinese monetary policy authorities did not adjust monetary policy in a timely manner, due to some targeted adjustments before, The public and companies in the Chinese market may still think that the probability of China's monetary policy changing again increases, thereby increasing the uncertainty of China's monetary policy by affecting public policy expectations. Therefore, the uncertainty of American monetary policy will affect and have a certain spillover effect on the formulation and implementation of China's monetary policy. The uncertainty of external monetary policy, especially the external impact of American monetary policy uncertainty, intensifies the uncertainty of China's monetary policy.

4.3 The effect mechanism of monetary policy uncertainty on company innovation

4.3.1 Monetary policy uncertainty and corporate R&D investment

Unlike conventional investment projects, corporate innovation projects need to go through a long-term process with great uncertainty and a high probability of failure (Manso, 2011). The innovation activities of companies are affected by both innovation resources and innovation willingness (Yang et al., 2019). The former is the ability to support innovation, and the latter is the driving force for innovation. The two primary channels through which China's monetary policy affects the real economy are the credit and stock markets (Ye and Zhu, 2009). The uncertainty of monetary policy may affect the innovation resources of companies through the credit market, and at the same time, affect the willingness to innovate through the stock market. The innovation activities of companies have a double impact, which directly inhibits the innovation of companies. However, at the same time, in the face of the risks brought by the uncertainty of external monetary policy to the company's future, the company itself may also take the initiative to make a strategic investment to hedge the risk. In addition, monetary policy uncertainty will have an inhibitory effect on corporate innovation. Based on the above analysis, this thesis proposes the following assumptions:

Hypothesis 1: *The uncertainty of monetary policy negatively affects the R&D investment of listed companies, that is, the uncertainty of monetary policy has an inhibitory effect on innovation.*

4.3.2 Financing Constraints Path

The financing constraint path refers to the fact that rising monetary policy uncertainty discourages companies from engaging in debt financing, exacerbating the financing

constraint faced by firms' innovation activities and has a direct inhibiting effect on firms' innovation in the dimension of innovation resources.

The increase in monetary policy uncertainty will affect both the borrower and the lender of companies and banks, resulting in a decline in the opportunity for companies to obtain bank loans and aggravating the degree of external financing constraints suffered by companies. ⅰ. For the borrower of the company, the external policy risks brought about by the increase in the uncertainty of macro monetary policy lead to an increase in the uncertainty of the future demand for company products (Rao et al., 2017), which increases the business risk of the company and the risk of future cash flow. Volatility (Bloom et al., 2007), which in turn leads to an increase in corporate financial risk and default risk. ⅱ. For banks, the lender, frequent adjustments of monetary policy aggravate macroeconomic fluctuations and frictions in the capital market, thereby increasing the bank's operational risks. Banks will be motivated by operational risk aversion to reduce credit supply and impose stricter lending standards (Bordo, 2016), thereby reducing banks' willingness to lend. The phenomenon of banks being unwilling to grant loans despite having the ability to lend and lending targets, borrowers having a need for loans and meeting the conditions for applying for loans has emerged, and rising uncertainty over monetary policy has led to a decline in access to loans for businesses. Rising monetary policy uncertainty will increase corporate risks and reduce banks' willingness to lend, thereby reducing corporate loan availability, increasing corporate loan costs, deteriorating the corporate external financing environment, and aggravating the degree of financing constraints faced by companies.

Financing constraints will inhibit corporate innovation. Since the innovation investment of a company is a long-term and continuous process, and often with high information asymmetry and investment risks. As a result, it is difficult to obtain bank credit as collateral for the innovation project itself, resulting in serious external financing constraints on its innovation activities (Hall and Lerner, 2010). Specifically, due to the non-exclusive nature of knowledge, in order to prevent information leakage, companies generally regard their R&D and innovation activities and other related information as business secrets within the company and will not easily release them to the outside world. The acquisition of external investors causes external investors to face more severe information asymmetry, and as an intangible asset, innovation output is mainly dependent on the human capital of scientific researchers, which is difficult to measure by itself. In addition, due to the existence of innovation output itself with more significant uncertainty, the efforts of the internal R&D personnel of the company are difficult to be assessed and supervised by external investors, which leads to high

supervision costs in the entire process of the company innovation. These two reasons lead to serious information asymmetry in the external financing market of companies' innovative R&D projects, and external investors will therefore demand a higher risk premium, resulting in companies' innovative R&D projects suffering from a high degree of external pressure financing constraints.

In the limited external financing of companies, the continuous supply of bank credit has a significant impact on company R&D (Zhang et al., 2017), mainly for the following three reasons: First, the existence of the information disclosure mechanism of the banking system is conducive to reducing The problem of information asymmetry between corporate innovation projects and external investors can alleviate the adverse selection or moral hazard problems caused by it, and reduce the external financing cost of companies ; second, in order to obtain all the benefits of innovation projects, entrepreneurs , will prefer debt financing rather than equity financing to ensure that its own equity is not transferred; third, the existence of the mandatory information disclosure mechanism of equity financing makes the R&D results of companies easily leaked to competitors in the same industry, which is not conducive to protecting the company's own Business secrets, companies are more inclined to use bank financing to meet the capital needs generated by their own innovation activities (Benfratello et al., 2008). Therefore, in order to ensure the continuous development of research and development projects, companies need to obtain continuous blood transfusion of external bank credit funds. The increase in monetary policy uncertainty will worsen the external financing environment of companies, and it will be difficult for companies to obtain a continuous and stable supply of bank credit funds, which will increase the degree of financing constraints suffered by companies' innovation activities, and eventually lead to companies lacking sufficient funds to carry out R&D innovation activities. Company innovation output has a negative impact.

Therefore, the increase in monetary policy uncertainty will increase the degree of external financing constraints suffered by companies, which will have a negative impact on company innovation. In summary, this thesis proposes the second Hypothesis.

Hypothesis 2: *The increase in monetary policy uncertainty pass through the financing constraint channels and affect corporate R&D investment.*

4.3.3 Monetary policy uncertainty, corporate cash flow and corporate R&D investment

Adequacy of cash flow is crucial to a company's R&D investment, which requires a large amount of capital. The more sufficient cash flow a company has, the more it can provide sufficient funds for its R&D investment. Therefore, when the uncertainty of monetary policy increases and the level of financing constraints of companies rises, the more sufficient cash flow companies have, the more they can smooth the external financing constraints caused by the uncertainty of monetary policy through their own cash flow, and then increase R&D investment. From the above analysis, it can be seen that an increase in monetary policy uncertainty will lead to an increase in the level of financing constraints and hence a decrease in R&D investment. However, the more cash flow a firm has, the more it can smooth out the decrease in R&D investment brought about by an increase in monetary policy uncertainty. Therefore, the following Hypothesis is proposed.

Hypothesis 3: *The more abundant corporate cash flow, the weaker the inhibitory effect of monetary policy uncertainty on corporate R&D investment.*

4.3.4 Asymmetric effects of monetary policy uncertainty

There are differences in how monetary policy uncertainty negatively affects innovation by SOCs and non-SOCs. Specifically, although SOCs play a vital role in equipment manufacturing, it is partly due to the support of state policies, rather than the competitive market power of SOCs, that enable SOCs to have absolute market power in these industries (Gu et al., 2018). This own attribute of SOCs makes them more vulnerable to changes in relevant state support policies, and SOC innovation is more negatively affected by monetary policy uncertainty than non-SOCs. On the other hand, non-SOCs grow up in a market economy. They are more likely to rely on active innovation and R&D， to enhance their market competitiveness to participate in fierce market competition. And they have the ability to adapt quickly to the market environment. Non-SOCs are more likely to proactively use market mechanisms to mitigate the negative impact of macro monetary policy uncertainty on their own innovation and R&D when monetary policy uncertainty rises, non-SOCs are more likely to be proactive in mitigating the negative impact of macro monetary policy uncertainty on their own innovative R&D through market mechanisms.

However, from another perspective, SOCs are funded by the State Council and local governments, and their behaviour is mainly determined by the will and interests of the government, which is not sensitive to changes in the economic environment and is less affected by changes in monetary policy. At the same time, the government background

of SOCs enables them to be informed of government monetary policy developments earlier, resulting in SOCs' innovation being relatively less affected by monetary policy uncertainty. Moreover, bank credit facilities are also tilted towards SOCs, resulting in lower loan costs for SOCs and higher loan costs for non-SOCs. Compared to non-SOCs, SOCs face fewer financial frictions and have more funds to withstand risks and engage in innovative activities in the face of monetary policy uncertainty. Based on the above analysis, the following hypotheses are formulated:

Hypothesis 4: *Monetary policy uncertainty has a stronger negative impact on innovation in non-SOCs than in SOCs*

5 Methodology

In order to explore how the monetary policy uncertainty affects the R&D investment of companies, this thesis tests it by constructing following Model 1. This model is set as follows:

$$lrd_{it} = \beta_0 + \beta_1 CNM + \beta_2 X'_{it} + \alpha_i + \varphi_t + \varepsilon_{it} \quad (i)$$

In the Model 1, i represents the individual listed company, t represents the year, lrd_{it} represents the proportion of R&D investment of listed companies in revenue; β_0 represents the constant term of the equation; CNM represents the uncertainty index of monetary policy; X_{it} represents a series of control variables, including profitability, ROA, company size, company age, Tobin's Q value, cash flow ratio, etc.； α_i refers to unobsered individual fixed effect, φ_t is used to control the time effect; ε_{it}represents the random error term. In Model 1, we mainly focus on the regression coefficient of the uncertainty index of monetary policy β_1. If β_1 is significantly and less than 0, the Hypothesis of 1 is verified in this thesis. This shows that the increase of monetary policy uncertainty will lead to the decrease of R&D investment of listed companies.

In order to test Hypothesis 2, this thesis builds a mediation effect model on the basis of above model to analyze the impact mechanism of financing constraints, and constructs an empirical Model 2 of the following forms:

$$lrd_{it} = \beta_0 + \beta_1 CNM + \beta_2 X_{it} + \alpha_i + \varphi_t + \varepsilon_{it} \quad (ii)$$

$$SA_{it} = \beta_0 + \beta_1 CNM + \beta_2 X_{it} + \varepsilon_{it} \quad (iii)$$

$$lrd_{it} = \beta_0 + \beta_1 CNM + \beta_2 SA_{it} + \beta_3 X_{it} + \alpha_i + \varphi_t + \varepsilon_{it} \quad (vi)$$

If β_1 is significantly less than 0 and β_2 is significantly less than 0, then Hypothesis 2 is verified in this thesis. This indicates that the increase in monetary policy uncertainty will affect corporate R&D investment through financing constraints.

Based on Model 1, Hypothesis 3 split the sample by "cashflow of company" - probably larger companies and smaller companies (above and below median) and run the regression for these two groups separately. Hypothesis 4 split the sample by EPA_dummy, 1 for state-owned companies (SOCs), 0 for non-state-owned companies (non-SOCs).

5.1 Pooled OLS regression model

OLS is the most fundamental form of regression analysis, which requires the least model conditions. The basic principle is that the optimal fitting curve should minimize the sum of squares (sum of squares of residuals) of the distance from each point to the straight line. According to the sample data, the estimators of the parameters of the simple linear regression model can be obtained by using the least square estimation formula. Linear assumption is strictly exogenous, the condition expectation of the disturbance term is 0, and there are no serious multicollinearity and spherical disturbance terms.

5.2 Fixed effects model

For the fixed effect model, given the individual i, the time on both sides of the equation can be averaged

$$\overline{y_\iota} = \overline{x_i}'\beta + z_i'\delta + u_i + \overline{\varepsilon_\iota}$$

The deviation form of the original model can be obtained by subtracting the average equation from the equation

$$y_{it} - \overline{y_\iota} = (x_{it} - \overline{x_\iota})'\beta + (\varepsilon_{it} - \overline{\varepsilon_\iota})$$

Definition $\widetilde{y_{\iota t}} \equiv y_i, \widetilde{x_{\iota t}} \equiv x_{it} - \overline{x_\iota}, \widetilde{\varepsilon_{\iota t}} \equiv \varepsilon_{it} - \overline{\varepsilon_\iota}$, be

$$\widetilde{y_{\iota t}} = \widetilde{\overline{x_{\iota t}}}'\beta + \widetilde{\varepsilon_{\iota t}}$$

Since u_i has been eliminated in the above formula, as long as $\widetilde{\varepsilon_{\iota t}}$ and $\widetilde{x_{\iota t}}$ are not related, OLS consistent estimator β can be used, which is called "fixed effect estimator" and recorded as$\hat{\beta}_{FE}$. Because $\hat{\beta}_{FE}$ mainly uses the intra group dispersion information of each individual, it is also called "intra group estimator". Even if the individual characteristic u_i is related to the explanatory variable x_{it}, a consistent estimation can be obtained as long as the intra group estimator is used, which is a great advantage of panel data. However, in the conversion process of deviation, $z_i'\delta$ is also eliminated, so it is impossible to estimate δ。 In other words, $\hat{\beta}_{FE}$ cannot estimate the influence of variables that do not change with time, which is a disadvantage of the fixed effect model. In addition, in order to ensure that $(\varepsilon_{it} - \overline{\varepsilon_\iota})$ is not related to $(x_{it} - \overline{x_\iota})$, it is required that the i-th observation value must meet strict exogenous, $E(\varepsilon_{it}|x_{i1}, \ldots\ldots x_{it}) = 0$, because x contains all the information of $x_{i1}, \ldots\ldots x_{it}$, the disturbance term must not be related to the explanatory variables of each period (not just the explanatory variables of the current period), which is a strong assumption.

If (n-1) dummy variables (n dummy variables if there is no intercept term) are introduced into the original equation to represent different individuals, the same results as the above dispersion model can be obtained.

5.3 Time fixed effects

Time point fixed effect model is a model with different intercept for different sections (time points). If it is confirmed that the intercept of the model is significantly different for different sections, but the intercept is the same for different time series (individuals), the time point fixed effect model should be established:

$$y_{it} = \gamma_t + \sum_{k=2}^{K} \beta_k x_{kit} + u_{it}$$

5.4 Random effects model

CV remains consistent.

Data only provide information about $f(y_{it}, x_{it})$,where

$$f(y_{it}, x_{it}) = \int f(y_{it}|x_{it}, \alpha_i, \lambda_t) f(\alpha_i, \lambda_t|x_{it}) d\alpha_i d\lambda_t \cdot f(x_{it})$$

The fixed effect holds that the effect is exogenous and fixed, in the bottom line$\alpha_i$andλ_t is a definite value (it is not necessary to assume whether it is related to x_it); Random effects think that the effect is a random realization, in the bottom line $\alpha_i$and λ_t and x_{it} is independent and satisfies the specific parameter distribution.

If it actually conforms to the assumption that the random effect satisfies a specific distribution, it means that for each observation, other observations also provide information. Therefore, under the random effect, GLS estimation is more efficient than CV estimation (equivalent to ols with dummy variable).

On the contrary, if it is actually a fixed effect model, CV estimation is efficient, while GLS estimation is biased and inconsistent when only n tends to infinity (making wrong use of other observations).

The above two descriptions may be used for model selection by Hausmann test.

The parameters to be estimated for random effects are fixed (explanatory variables, plus the parameters required for random effects to meet a specific distribution), and

variables that do not change with time / individual can be estimated, but the required assumptions become stronger.

5.5 Hausman Test

Hausman test is to distinguish whether to choose fixed effect model or random effect model. And Hausman test is a test for the random effect model. The original Hypothesis is to accept the random effect model.

A Hausman test shows that the covariance between an effective estimate and the difference between it and an ineffective estimate is 0. That is, cov (b-b, b) = cov (b, b) - var (b) = 0

B the original Hypothesis is that the random effect model is valid, and the alternative Hypothesis is that the fixed effect model is valid

C the statistic w effectively constructed according to the random effect model obeys the finite chi square distribution with degree of freedom k-1. That is, VAR (b-b) = var (b) - var (b) = W

5.6 Heteroscedasticity

The classical model assumes a spherical perturbation term. Heteroscedasticity is a situation that violates the spherical perturbation term Hypothesis, that is, the perturbation term variance $Var(\epsilon_i|X)$ depends on i, not a constant σ^2.

For a multivariate linear model

$$y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \cdots + \beta_k x_{ik} + u_i \ \ (i = 1, \dots, n)$$

Homovariance assumption: $Var(u_i|X_{i1}, X_{i2}, \dots \dots X_{ik}) = \sigma_i^2 (i = 1, \dots, n)$

In other words, for different sample points, the variance of random interference terms is no longer a constant, but different from each other, then heteroscedasticity is considered to occur

5.7 Cross-sectional dependence/Contemporaneous correlation

According to Baltagi (2018), Cross-sectional dependence is a problem in macro panels with long time series (more than 20-30 time periods). The null Hypothesis was that

"there is no cross-sectional dependence or contemporaneous correlation", that is, $H0$: $Cov(\varepsilon_{it}, \varepsilon_{jt)}= 0\ (i \neq j, \forall t)$.

If the null Hypothesis is true, the correlation coefficients of different individual disturbance terms calculated according to the residual should be close to zero. If these correlation coefficients are arranged into a matrix, namely "correlation matrix of residuals," the non-main diagonal elements of the matrix should not be far from zero. According to the residual correlation coefficient matrix, Breusch Pagan LM Test can be used.

5.8 Serial correlation

When a model sequence is related, there will be some consequences, so that some measurement methods that can also be used can no longer be used. For example, when the model sequence is related, t and F tests can no longer be used to test the model, because the premise of using T and F tests is that there is no standard error, because the denominator in the test formula is standard error, However, the standard error and no error are established only when the OLS premise is established at the same time, and the sequence correlation will violate the zero conditional mean and homovariance, so it is no longer applicable. However, whether the OLS estimator is unbiased and consistent or true, there is a problem here. How to check whether a model is sequence correlation? The following is a brief explanation of how to check:

On the premise of strict exogeneity, test the sequence related problems of the first-order regression model, that is, test whether the model is AR(1)

Suppose this simple first-order regression model is$y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \cdots + \beta_k x_{ik} + u_i\ \ (i = 1, \ldots, n)$, then the sequence correlation satisfying strict exogeneity is $u_{\ t} = \rho\, u_{\ t-1} + e_t$. Check is to check whether ρ is zero, here e_t subject to i.i.d

Because $u_{\ t}$ is actually not easy to operate, it can't get the specific value, so it should be like a way to make it digitized. The method here is to use residuals instead of errors for testing. Residuals can be obtained from the data collected by the model, and then $\widetilde{u_t} = \rho\widetilde{u_t} + error$ can be established through specific data

Then test the Hypothesis of the model established by residual error, H0: ρ= 0. If the original Hypothesis is rejected, the original model has sequence related problems.

6 Empirical Results

6.1 Hausman test

In order to study the impact of monetary policy uncertainty on corporate R&D investment, this thesis uses a panel data model to conduct multiple regression analysis on sample data. The regression model of panel data mainly includes fixed effect regression model, random effect regression model and mixed regression model. Before selecting the regression model, the sample data needs to be tested by Huasman to judge whether the fixed effect model is correct. As shown in the Table 3, it is the output result of huasman test.

Table 3 Hausman (1978) specification test

	Coef.	
	Model 1	Model 2
Chi-square test value	310.31	438.97
P-value	0	0

Source: Author's calculation in Stata

According to the output of the huasman test, the P value is 0, so it is suitable to use the fixed effect model to perform regression analysis on the sample.

6.2 Heteroscedasticity, cross-sectional dependency and serial correlation test results

Firstly, we use the modified Wald test to test the heteroscedasticity problem (Table 4). The null is homoskedasticity (or constant variance). Above we reject the null and conclude heteroskedasticity. In Table 5, Wooldridge test results show that the null is no serial correlation. Above we reject the null and conclude the data does has first-order autocorrelation. As shown in Table 6, the Pasaran CD test results of all variables used in this study indicate that the variables considered for analysis experience cross-sectional dependency.

Table 4 Heteroscedasticity test results

Modified Wald test for groupwise heteroskedasticity in fixed effect regression model H0: sigma(i)^2 = sigma^2 for all i		
	Model 1	Model 2
chi2 (782)	2.2e+06	2.0e+06
Prob>chi2	0.0000	0.0000

Table 5 Wooldridge test for autocorrelation in panel data

H0: no first order autocorrelation		
	Model 1	Model 2
F(1, 562)	3.822	3.865
Prob > F	0.0511	0.0498

Table 6 Pasaran CD (cross-sectional dependence) test

	Model 1	Model 2
Pesaran's test of crosssectional independence	153.697	3.865
Pr	0.0000	0.0000
Average absolute value of the off-diagonal elements	0.423	0.418

6.3 Panel data fixed effect estimation results

6.3.1 Analysis of Hypothesis 1

As shown in Table 7, the regression was tested according to Model 1. Among them, column (1) is the benchmark test without other control variables, in which the coefficient of the monetary policy uncertainty index is -0.651 and statistically significant at 1% confidence level. Column (5) adds the time-fixed effect on the basis of column (1). At this time, the coefficient of the monetary policy uncertainty index drops to -7.475 and is still statistically significant at 1% confidence level. This shows that for

Table 7 Monetary policy uncertainty negatively affects the R&D investment

	(1) FE lrd	(2) FE lrd	(3) FE lrd	(4) FE lrd	(5) FE lrd	(6) FE lrd	(7) FE lrd	(8) FE lrd
CNM1	-0.651***	-0.357***	-0.176***	-0.174***	-7.475***	-12.417***	-11.677***	-11.691***
	(0.034)	(0.046)	(0.057)	(0.057)	(0.57)	(0.758)	(0.955)	(0.96)
age		0.133***	0.272***	0.269***		-0.64***	-0.479***	-0.479***
		(0.04)	(0.059)	(0.059)		(0.054)	(0.069)	(0.069)
size		0.157***	0.201***	0.202***		-0.066*	-0.091*	-0.091*
		(0.038)	(0.041)	(0.042)		(0.039)	(0.05)	(0.05)
SHratio			0.691***	0.675***			0.272	0.276
			(0.226)	(0.226)			(0.226)	(0.223)
TBQ			-0.012	-0.012			-0.009	-0.009
			(0.01)	(0.01)			(0.014)	(0.014)
GP			1.785***	1.779***			1.563***	1.564***
			(0.324)	(0.324)			(0.316)	(0.316)
Lev			-1.106***	-1.101***			-0.338**	-0.339**
			(0.176)	(0.177)			(0.169)	(0.169)
ROA			-1.499***	-1.492***			-0.908***	-0.909***
			(0.374)	(0.374)			(0.35)	(0.351)
lgrowth			-0.054***	-0.054***			-0.032***	-0.032***
			(0.01)	(0.01)			(0.009)	(0.009)
lCash			-0.022*	-0.022*			-0.025**	-0.025**
			(0.012)	(0.012)			(0.012)	(0.012)
EPA				-0.123				0.038
				(0.129)				(0.109)
Time fixed	No	No	No	No	Yes	Yes	Yes	Yes
Constant	-0.406**	-5.621***	-8.308***	-8.27***	29.882***	55.088***	51.431***	51.49***
	(0.165)	(0.899)	(0.986)	(0.988)	(2.529)	(3.836)	(4.964)	(4.984)
No.Obs	8897	8897	5361	5361	8897	8897	5361	5361
R-squared	0.094	0.115	0.174	0.174	0.242	0.285	0.303	0.303

Standard errors are in parentheses

*** p<.01, ** p<.05, * p<.1

every unit of increase in monetary policy uncertainty, the proportion of company investment in R&D decreases by 7.475 units. After adding control variables such as company characteristics, financial performance characteristics and company nature, the coefficient of the monetary policy uncertainty index is still negative and significant.

The test results show that the rising uncertainty of monetary policy will inhibit the innovation activities of manufacturing companies, and the uncertainty of monetary policy will reduce the proportion of R&D expenditure in the operating income of companies in that year. This verifies Hypothesis 1 that the uncertainty of monetary policy will have a negative impact on the innovation of manufacturing companies.

The regression results of control variables in benchmark regression are also basically in line with reality.

In terms of firm-specific characteristics, in columns (2)(3)(4), the age and size of the company are positively related to the proportion of firms investing in R&D. The older a company is, the greater its investment in innovation and R&D. Mature companies are technologically well-equipped, have a large R&D workforce and sufficient capital of their own, as well as fewer financing constraints, making it easier to obtain financing from external investors. Larger companies often have well-developed R&D systems and processes, and have conducted detailed research and studies on the risks and probability of success. They have also been operating in the relevant industry for many years and have a clear understanding of the benefits that innovative R&D results can bring to their company, so they have a strong incentive to invest heavily in innovative R&D activities. However, after adding the time fixed effect, columns (6)(7)(8) show that the change in the year has a greater impact on the results, with the age and size of the firm becoming negatively correlated with the investment in R&D expenditure, which suggests that from a long time perspective, the learning ability of a firm tends to be strongest at the start-up stage, when firms are under pressure to survive and have to innovate. The older a firm is established, the more likely it is to prefer conservatism and the more likely to lack the spirit of innovation, resulting in a low willingness to innovate. As a company grows older and its size becomes larger, it spends less on innovation and R&D.

From the perspective of firm-specific corporate finance characteristics, the ratio of the top ten shareholders can promote the innovation and R&D of companies. From the perspective of business strategy, there may be a conflict of interest between significant shareholders and minority shareholders, and this conflict may be the contradiction between the "company's long-term strategy" and the "investor's short-term goal". The significant shareholders pay more attention to the continuity of the company's strategy,

while the small and medium-sized investors pay more attention to the short-term stock price. The significant shareholders will increase the R&D investment of the company to make it more competitive for the long-term development of the company. However, columns (7) and (8) show that the SHratio variable is no longer significant after adding the time-fixed effect.

As companies continue to attract external shareholders as they grow up, the shareholding of founders declines, and the top ten shareholders' shareholdings become smaller overall. This means that they no longer have a strong voice in investment decisions about innovation and no longer have much influence over the company's innovative research and development. The efficiency of Tobin's Q ratio is negative, indicating that for companies with a higher degree of market value, their R&D investment will be lower, but the coefficient is not significant, so the conclusion is not convincing。 The coefficient of gross profit is positive and statistically significant at a 1% confidence level, which indicates that the company's gross profit is positively correlated with innovation. Because the greater the company's profit, they can have sufficient financing for R&D investment. The coefficient of asset liability ratio (Lev) is significantly negative at the level of 1%, which is measured by the ratio of total liabilities to total assets. The asset liability ratio reflects the degree of company financing constraints, and innovation has a negative impact. The coefficient of the company's profitability variable (ROA) is negative and statistically significant, which indicates that the company profitability is negatively correlated with innovation investment, because the company profitability is stronger, the company is more satisfied with the status quo and the innovation willingness is weaker. The company's growth rate of operating income and cash flow scale is negative and statistically significant. It may be that the R&D investment of the company is a wavy curve. After the peak of R&D investment, the company may enjoy the profits and benefits brought by the R&D achievements for a long time. the company will reduce the fund invested in R&D for a period of time. Once the product no longer has a competitive advantage, the company will invest more in R&D. Therefore, there is a negative correlation between the growth rate of operating income and the scale of cash flow with the proportion of R&D investment, maybe just because the company is at the trough of investment, and the company is enjoying the fruits of innovation, as shown in figure 12.

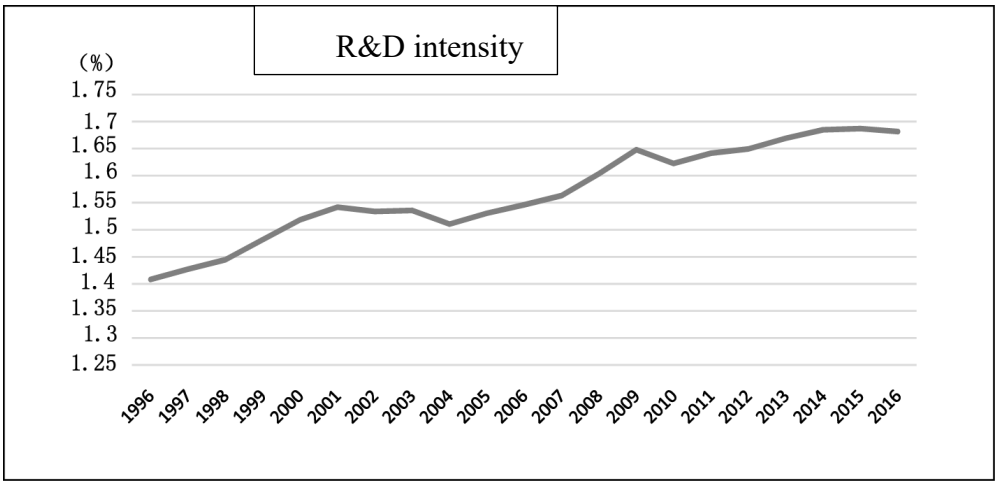

Figure 12 Global R&D Investment Trend

Source: World Bank Database

From the nature of the firm, column (8) results are not significant. But from a macro perspective, state-owned companies should focus more on innovation than non-state-owned companies, because the government's innovation and R&D subsidies may be injected into state-owned companies faster, but for currency uncertainty, the impact on innovation of state-owned and non-state-owned companies may be the same.

6.3.2 Analysis of Hypothesis 2

Next, we introduce the variable CNM2 to explore the impact of monetary policy uncertainty on company innovation under financing constraints. CNM2 is the average level of the last 3-6 months of last year (when the budget for next year is prepared and R&D planned).

Using the intermediary effect test method proposed by Baron and Kenny, this thesis constructs the following sequential recursive model to test the transmission mechanism of "monetary policy uncertainty-intermediary variables-company innovation activities" and test the financing constraint path. The intermediary variable financing constraint index (SA) is derived from the calculation formula of Hadlock and Pierce (2010)

$$SA= -0.737 \times Size+0.043\times Size^{2} -0.04\times Age$$

Size is obtained by logging the total assets of the firm and Age is the number of years the firm has been listed + 1, then taking the natural logarithm .1. The larger the SA, the smaller the corresponding size and age (small emerging companies), and the greater the financing constraints. 2. The smaller the SA (the more negative it is), the

Table 8 Monetary policy uncertainty will pass through financing constraint channels affects corporate R&D investment.

	(1)	(2)	(3)	(4)
	FE	FE	FE	FE
	lrd	SA	lrd	lrd
CNM2	-4.314***	0.972***	-0.147***	-4.417***
	(0.276)	(0.017)	(0.04)	(0.385)
SA			-2.216***	0.125
			(0.204)	(0.302)
age	-0.584***		-0.232***	-0.577***
	(0.061)		(0.057)	(0.063)
size	-0.064*		0.041	-0.065*
	(0.037)		(0.037)	(0.037)
SHratio	0.124		0.668***	0.117
	(0.182)		(0.189)	(0.182)
TBQ	-0.001		0.015*	-0.002
	(0.01)		(0.009)	(0.01)
GP	1.124***		1.145***	1.13***
	(0.251)		(0.262)	(0.253)
Lev	-0.153***		-0.317***	-0.151***
	(0.053)		(0.095)	(0.052)
ROA	-1.173***		-1.68***	-1.168***
	(0.202)		(0.222)	(0.201)
IGrate	-0.007		-0.025	-0.006
	(0.023)		(0.028)	(0.023)
Cash	-0.273*		-0.207	-0.274*
	(0.161)		(0.166)	(0.161)
EPA	0.105		-0.077	0.107
	(0.091)		(0.096)	(0.092)
Time fixed	Yes	Yes	No	Yes
Constant	8.773***	-8.055***	-11.483***	19.674***
	(0.921)	(0.078)	(0.88)	(2.834)
No.Obs	8897	8897	8897	8897
R-squared	0.242	0.899	0.194	0.297

Standard errors are in parentheses

*** p<.01, ** p<.05, * p<.1

larger the size and age (the old and big company), the smaller the financing constraint should be. Therefore, the larger the SA (the closer it is to 0), the greater the financing constraint. The figure below shows the test results of the financing constraint path.

From Table 8, in column (1), the coefficient of the monetary policy uncertainty variable is -4.314, indicating that monetary policy uncertainty has a negative impact on companies' R&D investment with p-value lower than 1%. The coefficient of the monetary policy uncertainty variable in column (2) is 0.972, the coefficient is positive and statistically significant at 1% confidence level, which indicates that monetary policy uncertainty has a positive impact on company financing constraints. This result shows that the rise of monetary policy uncertainty increases the level of company financing constraints. The coefficient of the financing constraint variable in column (3) is -2.216, negative and statistically significant, with p-value lower than 1%, which indicates that financing constraint inhibits company innovation. At the same time, the coefficient of the monetary policy uncertainty variable decreases to -0.147, and both the monetary policy uncertainty index and financing constraint have a negative impact on company R&D investment. After the time fixed effect is added to column (4), the coefficient of the monetary policy uncertainty index becomes -4.417, and the absolute value of the coefficient of monetary policy uncertainty in column (4) is greater than that in column (1). The above results mean that the uncertainty of monetary policy inhibits the R&D investment of companies by improving the financing constraint level of companies. The regression results of columns (1), (2) and (3) in the table verify that the financing constraints play a part in the intermediary effect. The uncertainty of monetary policy intensifies the financing constraints faced by companies. The smaller SA is, the greater the financing constraints are, the smaller the investment in innovation and R&D is. This result well verifies Hypothesis 2 of this thesis. Monetary policy uncertainty has a negative impact on company innovation through the financing constraint path.

Different from Hypothesis 1, the coefficient of Tobin's Q here is positive and statistically significant, with p-value lower than 10%. Companies with big tobinq are companies that investors think they are "promising", and companies have more investment opportunities. Therefore, they will generate profits in the future due to their innovative business model or market entry, and may get more external financing. Company age, size, leverage, return on assets and cash flow they all negative and statistically significant, and still have a negative impact on R&D investment.

6.3.3 Analysis of Hypothesis 3

In order to test the third Hypothesis: the more sufficient the company cash flow, the weaker the inhibitory effect of monetary policy uncertainty on the company 's R&D investment. This thesis will split the sample by "cash flow from operating activities" - probably larger companies ($Cash_L$) and smaller companies ($Cash_S$) (above and below medium) and run the region for these two groups separately.

As shown in the Table 9, it basically meets our expectations: coumpanies with sufficient cash flow are less affected by the uncertainty of monetary policy. Columns (1) and (2) are the regression results of monetary policy uncertainty of companies with small cash flow from operating activities, and columns (3) and (4) are the regression results of monetary policy uncertainty of companies with large cash flow from operating activities. The results show that the regression coefficient of monetary policy uncertainty in column (1) is -0.391, which is negative and statistically significant, with p-value lower than 1%. The regression coefficient of the uncertainty of monetary policy in column (3) is -0.163, which is negative and statistically significant, with p-value lower than 1%, and the absolute value of column (3) is less than the regression coefficient of uncertainty of monetary policy in column (1), which means that when the uncertainty of monetary policy increases, the more sufficient the cash flow of the company, the less the negative impact of the uncertainty of monetary policy on the R&D investment of the company. This shows that the level of company cash flow can indeed alleviate the negative impact of monetary policy uncertainty on Company R&D investment. Thus, Hypothesis 3 is verified.

In terms of control variables, in columns (1) and (2), there is a positive correlation between the cash flow of operating activities and the proportion of R&D investment. Cash flow has a significant positive role in promoting R&D investment. When the free cash flow owned by companies increases, the funds invested in R&D projects will increase accordingly. It shows that companies with small cash flow tend to invest in R&D to improve their core competitiveness. The cash flow coefficients in columns (3) and (4) are negative but not significant, which may be motivated by avoiding financial risks. The higher the company's cash holding level is, the more conservative the R&D decision is. The regression coefficients of financial leverage (Lev) and return on assets (ROA) are significantly negative, indicating that the more current assets the company has, the more it tends to increase its cash holding level, and the higher the

Table 9 The impact of cash flow on R&D investment

	(1)	(2)	(3)	(4)
	FE	FE	FE	FE
	lrd	lrd	lrd	lrd
CNM1	-0.391***	-11.956***	-0.163**	-11.943***
	(0.063)	(0.909)	(0.069)	(1.16)
$Cash_S$	0.587*	0.258		
	(0.333)	(0.31)		
$Cash_L$			-0.435	-0.384
			(0.365)	(0.345)
age	0.181***	-0.633***	0.316***	-0.518***
	(0.066)	(0.08)	(0.067)	(0.082)
size	0.129***	-0.039	0.161***	-0.117**
	(0.044)	(0.044)	(0.049)	(0.05)
SHratio	0.525**	0.058	0.543*	0.022
	(0.231)	(0.209)	(0.303)	(0.279)
TBQ	0.027**	0.006	-0.001	-0.002
	(0.013)	(0.015)	(0.012)	(0.015)
GP	1.378***	1.16***	1.985***	1.48***
	(0.36)	(0.329)	(0.319)	(0.274)
Lev	-0.321***	-0.172***	-0.752***	-0.246*
	(0.09)	(0.047)	(0.233)	(0.142)
ROA	-1.935***	-1.407***	-1.742***	-0.919***
	(0.28)	(0.238)	(0.449)	(0.326)
IGrate	-0.019	-0.001	-0.1***	-0.059*
	(0.026)	(0.023)	(0.035)	(0.032)
EPA	-0.166	0.079	-0.053	0.138
	(0.112)	(0.1)	(0.172)	(0.152)
Time fixed	No	Yes	No	Yes
Constant	-5.292***	52.217***	-7.532***	53.471***
	(0.992)	(4.515)	(1.23)	(5.749)
No.Obs	4864	4864	4033	4033
R-squared	0.137	0.282	0.181	0.331

Standard errors are in parentheses

**** p<.01, ** p<.05, * p<.1*

debt level, the more it tends to increase its cash holding, so as to prevent it from falling into financial difficulties.

Three conclusions are drawn, the monetary policy uncertainty index will affect corporate innovation through financing constraints or the scale of cash flow. Therefore, regarding whether the monetary policy uncertainty index will also affect other control variables, this thesis makes the following conjectures:

Larger companies usually face more investment opportunities, and at the same time their demand for capital is gradually increasing, and the capital is mainly used to expand the production scale of the company and further develop the market. Under the traditional financial service model, the source of external funds is limited, so it is easy to cause the risk of shortage of funds (Li et al., 2020). When monetary policy uncertainty rises, banks will either reduce loan origination or raise loan interest rates, causing companies to face dual funding pressures. R&D investment projects have the characteristics of a long investment cycle, large capital demand and high risk. When the uncertainty of monetary policy increases, companies will reduce R&D expenditure under the pressure of a double capital shortage. In addition, the increase in monetary policy uncertainty will lead to a complex external economic environment faced by companies, and the prospects for companies to invest in R&D will become more uncertain. Therefore, when faced with more investment opportunities and higher-risk R&D investment, larger-scale companies will choose investment opportunities with lower risk and give up R&D investment with higher risk, which will further lead to the reduction of company R&D investment. Based on the above analysis, it can be found that when the uncertainty of monetary policy increases, large-scale companies not only face the risk of shortage of funds, but also face the choice of investment opportunities, which will lead to their reduction in R&D investment. Therefore, this thesis makes the following conjectures:

A. The larger the company, the higher the inhibitory effect of monetary policy uncertainty on R&D investment.

As shown in Table 10, $size_s$ represents small-scale companies, and $size_L$ represents large-scale companies. The regression coefficients of the monetary policy uncertainty indices in (1) and (3) in the regression results are not much different, indicating that in a short period of time, the proportion of R&D investment of large-scale companies and small-scale companies is affected by the uncertainty of monetary policy. The effects of sex are not much different.

Table 10 The impact of company's size on R&D investment

	(1)	(2)	(3)	(4)
	FE	FE	FE	FE
	lrd	lrd	lrd	lrd
CNM1	-0.267***	-2.407***	-0.264***	-11.755***
	(0.055)	(0.19)	(0.083)	(1.046)
size S	0.179***	0.033		
	(0.052)	(0.048)		
size L			0.298***	-0.047
			(0.062)	(0.069)
age	0.095	-0.794***	0.301***	-0.517***
	(0.076)	(0.106)	(0.09)	(0.095)
SHratio	0.195	-0.175	0.624**	0.179
	(0.218)	(0.198)	(0.314)	(0.313)
TBQ	0.014	0.0002	-.014	-0.0001
	(0.01)	(0.012)	(0.024)	(0.026)
GP	1.581***	1.478***	1.618***	1.083**
	(0.249)	(0.225)	(0.445)	(0.431)
Lev	-0.759***	-0.291*	-1.26***	-0.614***
	(0.166)	(0.15)	(0.247)	(0.17)
ROA	-1.153***	-.957***	-2.546***	-1.282***
	(0.285)	(0.258)	(0.452)	(0.403)
IGrate	-0.083***	-0.072***	0.006	0.022*
	(0.02)	(0.021)	(0.016)	(0.011)
Cash	-0.028**	-0.024**	-0.013	-0.009
	(0.011)	(0.011)	(0.018)	(0.017)
EPA	-0.162	-0.022	-0.106	0.15
	(0.2)	(0.181)	(0.146)	(0.117)
Time fixed	No	Yes	No	Yes
Constant	-6.395***	8.793***	-10.108***	51.193***
	(1.008)	(1.536)	(1.443)	(5.678)
No.Obs	3497	3497	3639	3639
R-squared	0.155	0.303	0.202	0.335

Standard errors are in parentheses

*** p<.01, ** p<.05, * p<.1

However, from columns (2) and (4), after adding the time-fixed effect, the coefficients of monetary policy uncertainty are -2.407 and -11.755, respectively, and are significant at the 1% level. The absolute value of the monetary policy uncertainty index is significantly larger than that of smaller companies, which means that when the uncertainty of monetary policy increases, the larger the company, the greater the negative impact of monetary policy uncertainty on corporate R&D investment, confirmed the conjecture of this thesis.

Tobin's Q ratio is the ratio of a company's market value to its replacement cost of assets. It reflects the ratio of two different estimates of the value of a company. The value in the numerator is how much the company is worth in the financial market, and the value in the denominator is the “basic value” of the company—replacement cost. The financial market value of a company includes the market value of the company's stock and the market value of its debt capital. Replacement cost refers to how much it would cost to buy all the assets of a public company today, or how much it would have cost to create the company if we had to start all over again from scratch.Tobin's Q ratio is the ratio of a company's market value to its replacement cost of assets. It reflects the ratio of two different estimates of the value of an company. The value in the numerator is how much the company is worth in the financial market, and the value in the denominator is the “basic value” of the company—replacement cost. The financial market value of a company includes the market value of the company's stock and the market value of its debt capital. Replacement cost refers to how much it would cost to buy all the assets of a public company today, or how much it would have cost to create the company if we had to start all over again from scratch.

Tobin believes that stock prices will affect corporate investment, and the ratio of a company's market value to its replacement cost can be used as a criterion to measure whether new investment should be made. This ratio is represented by Q. The market value of a business is the total market value of the business' stock, so Q equals the market value of the business' stock divided by the cost of building a new business. If Q is less than 1, it means that buying an old business is cheaper than building a new one, so there will be no investment. Companies with large tobinQs are companies that investors consider them "promising". They usually have great growth potential and face more investment opportunities. At the same time, their demand for funds is gradually increasing, and the funds are mainly used to expand the production scale of the company and further develop the market. Therefore, this thesis makes the following conjectures:

Table 10 The impact of Tobin's Q ratio on R&D investment

	(1)	(2)	(3)	(4)
	FE	FE	FE	FE
	lrd	lrd	lrd	lrd
CNM1	-0.334***	-12.257***	0.008	-9.657***
	(0.084)	(1.404)	(0.07)	(1.222)
TBQ S	-0.005	-0.004		
	(0.039)	(0.042)		
TBQ L			-0.004	-0.003
			(0.012)	(0.015)
age	0.244***	-0.517***	0.307***	-0.394***
	(0.09)	(0.091)	(0.069)	(0.09)
size	0.182***	-0.061	.207***	-0.018
	(0.055)	(0.055)	(0.059)	(0.064)
SHratio	0.302	-0.053	1.017***	0.661**
	(0.248)	(0.24)	(0.338)	(0.286)
GP	1.408***	1.245***	1.936***	1.718***
	(0.335)	(0.314)	(0.388)	(0.361)
Lev	-1.379***	-0.672***	-0.431***	-0.134
	(0.222)	(0.197)	(0.146)	(0.122)
ROA	-2.099***	-1.445***	-1.709***	-1.002***
	(0.316)	(0.296)	(0.375)	(0.306)
lgrowth	-0.011	0.006	-0.092***	-0.071**
	(0.018)	(0.016)	(0.035)	(0.032)
Cash	-0.026*	-0.017	-0.028	-0.032
	(0.014)	(0.013)	(0.021)	(0.02)
EPA	-0.055	0.135	-0.261	-0.066
	(0.139)	(0.12)	(0.205)	(0.177)
Time fixed	No	Yes	No	Yes
Constant	-6.58***	53.858***	-9.516***	40.343***
	(1.297)	(6.761)	(1.444)	(6.248)
No.Obs	4694	4694	2442	2442
R-squared	0.163	0.314	0.191	0.31

Standard errors are in parentheses

*** p<.01, ** p<.05, * p<.1

B. Companies with larger market value compared to the book value as measured by TobinQ, the weaker the inhibitory effect of monetary policy uncertainty on R&D investment.

As shown in Table 11, in the short term, the coefficient of the monetary policy uncertainty index of column (1) is larger than that of column (3), but the coefficient of the monetary policy uncertainty index of column (3) is not significant and meaningless. After adding the time-fixed model, the regression coefficients of the monetary policy uncertainty index are -12.257 and -9.657, respectively, and are significant at the 1% level. The absolute value of the monetary policy uncertainty index of companies with higher market value is significantly smaller than the market value. Smaller companies, which means companies with smaller market values are more vulnerable to the dampening effect of monetary policy uncertainty on R&D investment, concompanies the conjecture of this thesis.

6.3.4 Analysis of Hypothesis 4

Companies are classified into state-owned companies and non-state-owned companies based on the nature of ownership, where non-state-owned companies include private companies, foreign-funded companies, and non-state companies include private companies, foreign companies and other types of companies. In Table 12, columns (1)(3) show the results of the test of monetary policy uncertainty affecting innovation of non-state manufacturing firms; columns (2)(4) show the results of the test of monetary policy uncertainty affecting innovation of state-owned manufacturing firms. A significant dampening effect of rising monetary policy uncertainty on innovation in both SOCs and non-SOCs is in line with Hypothesis 1. This suggests that both SOCs and non-SOCs have a strong incentive to hedge against frequent monetary policy adjustments, and will adopt a more prudent investment strategy, choosing low-risk investment opportunities. Comparing the coefficients of monetary policy uncertainty further reveals that, over time, the inhibiting effect of monetary policy uncertainty on innovation is more severe among non-SOCs, because SOCs are financed by the State Council and local people's governments, and their behavior is more determined by the will and interests of the government, which is less sensitive to changes in the economic environment and thus less affected by changes in monetary policy. At the same time, the cost of loans to SOCs is lower than that of non-SOCs, and in the face of shocks from monetary policy uncertainty, SOCs have more funds to protect themselves against risk

Table 11 Comparison of SOC and non-SOC

	(1)	(2)	(3)	(4)
	FE	FE	FE	FE
	lrd	lrd	lrd	lrd
CNM1	-0.149***	-0.18**	-11.545***	-10.759***
	(0.056)	(0.085)	(1.387)	(1.277)
age	0.227***	0.586***	-0.403***	-0.574***
	(0.062)	(0.138)	(0.074)	(0.153)
size	0.115**	0.312***	-0.081	0.038
	(0.047)	(0.077)	(0.052)	(0.078)
SHratio	0.451**	0.373	0.254	0.257
	(0.201)	(0.389)	(0.178)	(0.38)
TBQ	0.002	0.0001	0.001	-0.011
	(0.008)	(0.024)	(0.011)	(0.026)
GP	1.474***	2.434***	1.147***	2.02***
	(0.313)	(0.466)	(0.306)	(0.452)
Lev	-0.718***	-0.869***	-0.388***	-0.316
	(0.185)	(0.255)	(0.121)	(0.256)
ROA	-1.794***	-2.702***	-1.21***	-1.349**
	(0.336)	(0.581)	(0.268)	(0.545)
IGrate	-0.01	-0.059**	0.0002	-0.021
	(0.025)	(0.025)	(0.024)	(0.02)
Cash	-0.02*	-0.028	-0.031***	-0.013
	(0.012)	(0.019)	(0.012)	(0.018)
Time fixed	No	No	Yes	Yes
Constant	-6.063***	-11.905***	50.603***	44.738***
	(0.995)	(1.72)	(6.713)	(6.822)
No.Obs	4453	2683	4453	2683
R-squared	0.146	0.237	0.266	0.356

Standard errors are in parentheses

*** p<.01, ** p<.05, * p<.1

and are less affected by innovation activities. Thus, Hypothesis 4 is tested.

6.4 Robustness Test

In order to examine the explanatory power of the evaluation methods and indicators, this thesis intends to carry out a robustness test, that is, to change some parameter information or tool methods of the empirical process to examine whether the evaluation conclusion is reliable.

6.4.1 Remeasurement of Monetary Policy Uncertainty Index

There are many methods to measure the uncertainty of monetary policy, but the measurement method based on information such as government change and official change is not sustainable and is not convenient for quantitative analysis. This thesis still adopts the most suitable CNM index for measurement. In the previous study, the monthly CNM index is taken as the arithmetic mean value of the annualized data, and then the logarithm is taken. Here, the standard deviation and logarithm of the monthly data are proposed to measure the uncertainty. The regression conclusion is still consistent with the original conclusion. The specific results are as follows.

From Table 13, the regression result columns (1) and (2), it can be seen that the regression coefficient of the currency uncertainty index is significantly negative, that is, the higher the value of uncertainty, the innovation investment tends to decrease, which is consistent with the regression result obtained by the original CNM measurement method. From the regression results of company size and age, it can be seen that in a short time, both size and age are positively correlated with company R& D investment, but there is a negative correlation after adding the fixed effect of time. The coefficient of investors' shareholding ratio in a short time is significantly positive, indicating that the higher the equity concentration, the weaker the inhibitory effect of monetary policy uncertainty on R&D investment. It is basically consistent with the previous conclusion.

6.4.2. Re-measurement of dependenct variables

In the above, the proportion of R&D expenditure of listed companies is used to measure innovation investment. In order to avoid the possible sample selection error caused by abandoning the samples with missing R&D expenses and verify the robustness of the above results, this thesis uses the patent acquisition of listed companies in China from 2007 to 2020 in the CIRD China innovation patent research database as the explanatory variable to measure the output of different types of innovation activities of companies, and repeat all the empirical analysis above. It can

be seen from columns (3) and (4) in the table that the regression coefficients of monetary policy uncertainty variables are negative and significant at the level of 1%,

Table 12 Robustness Test

	(1) FE lrd	(2) FE lrd	(3) FE Innovation	(4) FE Innovation	(5) FE lrd	(6) FE lrd
CNM3	-0.275***	-9.817***				
	(0.047)	(0.806)				
CNM1			-15.082*	-543.977***	-7.475***	-11.821***
			(9.058)	(208.782)	(0.57)	(0.836)
age	0.264***	-0.479***	3.967	-13.776	0.275***	-0.529***
	(.056)	(0.069)	(13.024)	(17.054)	(0.055)	(0.064)
size	0.218***	-0.091*	68.747***	55.649***	0.193***	-0.061
	(0.04)	(0.05)	(11.024)	(12.256)	(0.041)	(0.043)
SHratio	0.592***	0.276	63.767	76.912	0.589***	0.161
	(0.225)	(0.223)	(50.943)	(52.501)	(0.217)	(0.204)
TBQ	-0.007	-0.009	5.071**	7.527**	-0.002	-0.007
	(0.01)	(0.014)	(2.163)	(3.259)	(0.009)	(0.012)
GP	1.766***	1.564***	-110.636***	-106.487***	1.692***	1.376***
	(0.323)	(0.316)	(39.171)	(40.822)	(0.272)	(0.257)
Lev	-1.11***	-0.339**	-24.538	0.17	-0.907***	-0.37***
	(0.175)	(0.169)	(33.505)	(40.93)	(0.172)	(0.115)
ROA	-1.452***	-0.909***	-35.731	-65.288	-2.081***	-1.278***
	(0.372)	(.351)	(50.087)	(54.941)	(0.318)	(0.255)
lgrowth	-.054***	-.032***	-5.571***	-4.693***	-0.023	-0.004
	(0.01)	(0.009)	(1.598)	(1.517)	(0.025)	(0.022)
lCash	-0.023*	-0.025**	2.131	1.583	-0.028***	-0.026***
	(0.012)	(0.012)	(2.509)	(2.456)	(0.01)	(0.01)
EPA	-0.117	0.038	-5.172	-2.117	-0.093	0.098
	(0.129)	(0.109)	(15.087)	(15.61)	(0.127)	(0.106)
Time fixed	No	Yes	No	Yes	No	Yes
Constant	-0.851***	-6.587***	-1399.978***	1296.565	-7.82***	51.687***
	(0.143)	(0.792)	(230.83)	(1060.865)	(0.946)	(4.225)
No.Obs	8897	8897	5361	5361	7136	7136
R-squared	0.067	0.114	0.122	0.137	0.169	0.312

Standard errors are in parentheses
*** p<.01, ** p<.05, * p<.1

indicating that the increase of monetary policy uncertainty will lead to a significant decline in company R&D investment, which is consistent with the above regression results. This verifies the robustness of the results of this study.

$$Innovation_{it} = \beta_0 + \beta_1 CNM + \beta_2 X_{it} + \alpha\_i + \varphi\_t + \varepsilon_{it} \quad (V)$$

6.4.3. Company data reselection

This thesis selects 783 listed manufacturing companies, covering 28 industries in the manufacturing industry. In the process of daily operation, companies also make ever-changing decisions, and there will be a variety of business States, so the data has many outliers. In order to verify the stability and eliminate the influence of outliers, this thesis winsorizes the data at the company level, that is, breaks the tail of continuous variables at the 10% quantile. As shown in columns (5) and (6), the coefficient of the normal uncertainty index of currency is still negative and significant, which is consistent with the above regression results.

7. Conclusions

This thesis adopts the monetary policy uncertainty index constructed by Huang and Luk (2020) based on the text analysis method, and combines the financial data of China's Shanghai and Shenzhen A-share listed companies to study the impact of monetary policy uncertainty on corporate R&D investment. Using the China Stock Market & Accounting Research Database (CSMAR)and the China Innovation Patent Research Database (CIRD), the correlation mechanism between macro-monetary policy uncertainty and micro-company innovation is verified in detail. This thesis draws the following research conclusions:

(1) Monetary policy uncertainty has a significant inhibitory effect on the innovation of listed manufacturing companies. The benchmark test results of this thesis show that the increase in monetary policy uncertainty will inhibit the innovation of manufacturing companies. The proportion of corporate R&D expenditure has a significant negative impact, and it also has a significant negative impact on the number of invention patents obtained. The empirical results show that monetary policy uncertainty has a significant inhibitory effect on corporate innovation.

(2) Monetary policy uncertainty inhibits company innovation by worsening the degree of external financing constraints on companies. The mechanism test in the empirical part of this thesis finds that monetary policy uncertainty has a negative impact on corporate innovation through financing constraints.

(3) The more abundant the cash flow of the company, the smaller the negative impact of the increase of monetary policy uncertainty on the R&D investment of the company.

(4) In terms of the nature of firm ownership, monetary policy uncertainty has a negative impact on the innovation activities of both SOCs and non-SOCs, but the negative impact on innovation in non-SOCs is more severe.

The research of this thesis has lessons for the optimal implementation of the central bank's monetary policy. First of all, for the implementation of the central bank's monetary policy, when the central bank formulates and implements monetary policy, in addition to paying attention to the horizontal impact effect of the policy on microeconomic entities, it cannot ignore the impact of the uncertainty brought about by frequent monetary policy adjustments on companies. In addition, while maintaining

a stable monetary policy, the central bank should improve the foresight and transparency of monetary policy, strengthen the management of monetary policy expectations, and provide a stable operating environment for companies. At the same time, focus on the precise implementation and targeted regulation of monetary policy tools, and give full play to the positive role of monetary policy in easing corporate financing constraints and improving corporate risk-taking capabilities, thereby promoting corporate innovation. For company operation and management, companies should avoid blind expansion and maintain a reasonable cash flow in the process of operation, so as to avoid the negative impact of external policy adjustments on the R&D investment of companies, thereby affecting the core competitiveness of companies and long-term development.

Bibliography

Abel A B. (1983): “Optimal Investment Under Uncertainty.” The American Economic Review 73(1): pp. 228-233.

Aghion, Philippe & Cai J, et al. (2015): “Industrial Policy and Competition.” American Economic Journal: Macroeconomics 7 (04): pp. 1-32.

Atanassov J, Julio B& Leng T. (2015): “The bright side of political uncertainty: the case of R&D. ” Working Paper.

Baker S R, Bloom N & Davis S J. (2003): “Measuring Economic Policy Uncertainty.” Chicago Booth Research Working Paper.

Baker S. R., Bloom N.& Davis S. J. (2016): “ Measuring Economic Policy Uncertainty.” The Quarterly Journal of Economics 131(04):pp.1593-1636.

Baltagi, Badi, Pirotte, Alain&Yang, Zhenlin. (2018): “Diagnostic Tests for Homoskedasticity in Spatial Cross-Sectional or Panel Models.” Economics and Statistics Working Papers.

Baron R M& Kenny D A. (1986):“The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations.” Journal of personality and social psychology51(6):pp.1173.

Benfratello L, Schiantarelli F, Sembenelli A. (2008):“ Banks and innovation: Microeconometric evidence on Italian firms.” Journal of Financial Economics,90(2):pp.197-217.

Benito, Andrew &Young, (2002): “Hard Times or Great Expectations?”: Dividend omissions and dividend cuts by UK firms.” Bank of England Quarterly Bulletin.

Bernanke & Ben, S. (1995): “A conference panel discussion: What do we know about how monetary policy affects the economy?”

Bjorvatn, K. & C. Eckel (2006): “Policy Competition for Foreign Direct Investment Between Asymmetric Countries.” European Economic Review 50(7): pp. 1891–1907.

Bloom N, Bond S& Van Reenen J. (2007): “Uncertainty and Investment Dynamics.” Review of Economic Studies74(2): pp.391-415.

Bloom N, Bond S& Van Reenen J. (2007):“Uncertainty and Investment Dynamics. ” Review of Economic Studies 74(2):pp.391-415.

Bloom N, Floetotto M & Jaimovich N, et al. (2018): “Really Uncertain Business Cycles. Econometrica.” 86(3):pp.1031-1065.

Bordo M D, Duca J V& Koch C. (2016): “Economic Policy Uncertainty and the Credit Channel: Aggregate and Bank Level U.S. Evidence over Several Decades. ” Journal of Financial Stability 26：pp.90-106.

Born B & Pfeifer J. (2014): “Policy Risk and the Business Cycle.” Journal of Monetary Economics 68(1):pp.68-85.

Cai. (2018): “The Impact of corporate taxes on firms Innovation.” NBER Working Paper.

Caldara， D.， Fuentesalbero C.Gilchrist S. & Zakrajsek E. (2016): “ The Macroeconomic Impact of Financial and Uncertainty Shocks.” European Economic Review88:pp.185-207.

Campello M, Graham J R & Harvey C R.“The Real Effects of Financial Constraints: Evidence from a Financial Crisis. Social Science Electronic Publishing.”

Chen K; Ren J& Zha T. (2018):“The nexus of monetary policy and shadow banking in China.”American Economic Review 108(12): pp.3891-3936.

Chuang Deng & Ziwen Cao. (2020): “Measurement of China's Monetary Policy Uncertainty and Analysis of its macroeconomic effects.” Journal of Social Sciences of Jilin University 60(01): pp.50-59+220

Cohen J& Alexopoulos M. (2009): “Uncertain Times, Uncertain Measures. Working Paper. ” University of Toronto, Department of Economics.

Delis M D , Hasan I & Mylonidis N . (2011): “The risk-taking channel of monetary policy in the USA: Evidence from micro-level data. ”MPRA Paper.

Dixit A K &Pindyck R S. (1994): “Investment under Uncertainty. ” Economics Books 39(5):pp.659-681.

Dixit A K& Pindyck R S. (1994): “Investment under Uncertainty.” Econometrica. 39(5): pp.659-681.

Doms M E& Morin N J. (2004): “Consumer Sentiment, the Economy, and the News Media.” SSRN Electronic Journal 1(96):pp.945–975.

Durnev A. (2013): “The Real Effects of Political Uncertainty: Elections and Investment Sensitivity to Stock Prices. ” Working Paper.

Ellsberg D. (1961): “Risk, Ambiguity, and the Savage Axioms.” Quarterly Journal of Economics 75(4):pp.643-669.

Fasolo A M. (2019): “Monetary policy volatility shocks in Brazil. ”Economic Modelling 81:pp.348-360.

Fernandez-Villaverde J, Guerron-Quintana P& Rubio-Ramirez J F, et al. (2011): “Risk Matters: The Real Effects of Volatility Shocks.” The American economic review 101(6):pp.2530-2561.

Gilboa I,& Schmeidler D. (1989): “ Maxmin expected utility with non-unique prior.” Journal of Mathematical Economics 18(2):pp.141-153.

Giordani P& Soderlind P. (2003): “Inflation forecast uncertainty.” European Economic Review 47(6):pp.1037-1059.

Goel R K& Ram R. (2001): “Irreversibility of R&D investment and the adverse effect of uncertainty: Evidence from the OECD countries. ”Economics Letters 71(2): pp.287-291.

Gu Qun, Wang Wenwen & Li Min. (2020): “Economic policy uncertainty, institutional investor holdings and corporate R&D investment: based on the perspective of R&D heterogeneity.” Soft Science (2):pp. 21-26.

Gulen H& Ion M. (2016): “Policy uncertainty and corporate investment. ”Review of Financial Studies. 29(3): pp.523-564.

Guo Hua, Wang Cheng& Li Houjian. (2016): “ Policy uncertainty, bank credit and corporate R&D investment. ”Macroeconomic Research. (02): pp.89-105.

Guo Yue. (2018): “The signal transmission mechanism of government innovation subsidies and enterprise innovation.” China Industrial Economics (09):pp.98-116.

Hadlock C J & Pierce J R. (2010):“New Evidence on Measuring Financial Constraints: Moving Beyond the KZ Index.” Review of Financial Studies 23(5):pp.1909-1940.

Hall B H, Lerner J. (2010):“The Financing of R&D and Innovation.”Handbook of the Economics of Innovation, 1:pp.609-639.

He Dexu, Zhang Xuelan & Wang Chaoyang, et al. (2020): “ Monetary policy uncertainty, bank credit and dynamic adjustment of corporate capital structure.” Economic Management (7): pp.5-22.

He Dexu, Zhang Xuelan, Wang Chaoyang &Bao Huina. (2020): “The uncertainty of monetary policy, bank credit and the dynamic adjustment of corporate capital structure.” Economic Management 42(07):pp.5-22.

Herro N& Murray J. (2013): “Dynamics of Monetary Policy Uncertainty and the Impact on the Macroeconomy. ”Economics Bulletin 33(1):pp.257-270.

Horie, Norio& Kumo, et al. “Socialist Legacies of Personnel and Human Resource.”

Huang T, Wu F& Yu J, et al. (2015): “ Political Uncertainty and Dividend Policy: Evidence from International Political Crises. ”Journal of International Business Studies. 46(5): pp.574-595.

Huang Y& Luk P. (2020): “ Measuring Economic Policy Uncertainty in China.” China Economic Review.59:pp1-18.

Huseyin G& Mihai I. (2015): “ Policy Uncertainty and Corporate Investment. ”Review of Financial Studies 29 (3):pp. 523-564.

Jiang Jun, Shen Danlin, Jiang Xuanyu& Yi Zhihong. (2017): “ Creditor Protection and Enterprise Innovation.” Financial Research (11):pp.128-142.

Jianping Ding& Lu Liu. (2020): “The RMB exchange rate effect of China's monetary policy uncertainty and macroeconomic news.” Finance and Trade Economics 41(05):pp.19-34.

Jorda O & Salyer K . The response of term rates to monetary policy uncertainty.”

JORDÀ O &SALYER K D. (2003): “The Response of Term Rates to Monetary Policy Uncertainty Review of Economic Dynamics. ” Review of Economic Dynamics 6（4）：pp.941-962.

Jorgenson D W. (1963): “Capital Theory and Investment Behavior.”The American Economic Review 53(2):pp.247-259.

Julio, B.，& Y. Yook. (2016): “ Policy Uncertainty，Irreversibility,and Cross-border Flows of Capital .” Journal of International Economics (10)3:pp.13-26.

JulioB, Yook Y. (2012): “Political Uncertainty and Corporate Investment Cycles. ”The Journal of Finance. 67(1):pp. 45-83.

Jurado K , Ludvigson S C & Ng S. (2015):“Measuring Uncertainty. ”American Economic Review. 105(3):pp.2-7.

Kaminska I& Roberts-Sklar M. (2017): “Volatility in equity markets and monetary policy rate uncertainty.” Journal of Empirical Finance :pp.68-83.

Kelly B, ĽUBOŠ-PÁSTOR &Veronesi P. (2016): “ The Price of Political Uncertainty: Theory and Evidence from the Option Market. ”The Journal of Finance 71(5):pp.2417-2480.

Keynes J.M. (1936):“The General Theory of Employment, Interest and Money.” London: Macmillan.

Klein A, Marquardt C A. (2006): “Fundamentals of Accounting Losses.” The Accounting Review. (81): pp.179-206.

Knight F. (1921): “Risk, Uncertainty and Profit. ”1st ed. Wilmington: VERNON PRESS.

Korajczyk R& Levy A. (2006): “Capital Structure Choice: Macroeconomic Conditions and Financial Constraints.” Journal of Financial Economics. (68): pp.75-109.

Li Changqing, Li Yukun& Li Maoliang. (2018):“Controlling shareholders' equity pledges and firms' innovation investment.” Financial Research (7):pp.143-157.

Li Fengyu & Yang Mozhu. (2015): “Will economic policy uncertainty inhibit corporate investment? ——An Empirical Study Based on China’s Economic Policy Uncertainty Index.” Financial Research (4):pp.115-129.

Li Linmu,Wang Chong. (2017): “Tax and Fee Burden, Innovation Ability and Enterprise Upgrade——Empirical Evidence from Companies Listed on the "New Third Board".” Economic Research 52(11):pp.119-134.

Li Wenjing, Zheng Manni. (2016): “Substantial innovation or strategic innovation? ——The impact of macro-industrial policies on micro-enterprise innovation.” Economic Research (4):pp.60-73.

Liu Jinquan& Pan Fanghui. (2012): “Research on the relationship between uncertainty, inflation and actual output: an empirical test based on the VAR-GARCH model.” Journal of Social Sciences of Jilin University 52(03):pp.85-91+ 160.

Lucas, Jr. R E. (1967): “Adjustment Costs and the Theory of Supply.” Journal of Political Economy 75(4):pp.321-334.

Lv Xiaojun. (2015): “Research on the impact of government R&D subsidies on enterprise technological innovation.” Wuhan University.

Management in European Transition Economies : An Analytical Review. Economic

Manso G. (2011):“ Motivating innovation.” Journal of Finance 66(5):pp.1823-1860.

Marwan, Alssadek & James, Benhin. (2021):“Oil boom, exchange rate and sectoral output: An empirical analysis of Dutch disease in oil-rich countries. ” Resources Policy .

Masuda K. (2015): “ Fixed investment, liquidity constraint, and monetary policy: Evidence from Japanese manufacturing firm panel data.”Japan & the World Economy, 33(feb.):pp.11-19.

Meng Qingbin & Shi Qian. (2017): “ The Impact of Macroeconomic Policy Uncertainty on Enterprise R&D: A Theoretical and Empirical Research. ”World Economy 40(09): pp.75-98.

Modigliani F& Miller M H. (1958): “The Cost of Capital, Corporation Finance and the Theory of Investment.” The American Economic Review 48(3):pp.261-297.

Mueller P, Tahbaz-Salehi A& Vedolin A. (2017): “Exchange Rates and Monetary Policy Uncertainty. ”Journal of Finance 72(3):pp.1213-1252.

Mumtaz H& Surico P. (2018): “Policy uncertainty and aggregate fluctuations.” Journal of Applied Econometrics 33(3):pp.319-331.

Oriani R& Sobrero M. (2010): “Uncertainty and the market valuation of R&D within a real options logic. ”Strategic Management Journal. 29(4): pp.343-361.

Pastor L& Veronesi P. (2013): “Political uncertainty and risk premia. Journal of Financial Economics. 2013, 110(3): 520-545.

Peng Yuchao & Fang Yi. (2016):“Structural monetary policy, industrial structure upgrading and economic stability.” Economic Research 51(07):pp.29-42.

Ramey V A. (2011): “ Identifying Government Spending Shocks: It's All in the Timing. ”The Quarterly Journal of Economics 126(1):pp.1-50.

Ramsey F P. (1926): “Truth and probability. Studies in subjective probability.” pp. 23-52.

Rao Pingui, Yue Heng& Guohua. (2017):“ Research on economic policy uncertainty and firms' investment behavior.” World Economy 40(02):pp.27-51.

Renyong Chi. (2003): “Research on Enterprise Technology Innovation Efficiency and Its Influencing Factors.” Quantitative Economics and Technical Economics 06:pp.107-110.

Rich R & Tracy J. (2010): “The Relationships among Expected Inflation, Disagreement, and Uncertainty: Evidence from Matched Point and Density Forecasts.” Review of Economics and Statistics 92(1):pp.200-207.

Rogers J H, Bo S&Husted L F. (2016): “Measuring Monetary Policy Uncertainty: The Federal Reserve, January 1985-January 2016. ”IFDP Notes.

Romer C D& Romer D H. (1989): “Does Monetary Policy Matter? A New Test in the Spirit of Friedman and Schwartz.” Social Science Electronic Publishing 4:pp.121-170.

Romer C D& Romer D H. (2004): “A New Measure of Monetary Shocks: Derivation and Implications.” American Economic Review 94(4): pp.1055-1084.

Savage L J. (1954): “ The foundations of statistics.” JOHN WILEY.

Shenglan Chen, Xiaoling Liu. (2018): “The uncertainty of economic policy and the supply of corporate commercial credit. ”Financial Research 05:pp.172-190.

SINHA A. (2016): “Monetary Policy Uncertainty and Investor Expectations.” Journal of Macroeconomics 47（Part B）： pp.188-199.

Stein L C & Stone E. (2013): “The effect of uncertainty on investment, hiring, and R&D: causal evidence from equity options. ”Working Paper.

Sun Ying. (2013): “ Research on the Impact of Tax Incentive Policies on Enterprise Innovation Performance. ”Donghua University.

TALK M. (2016): “ Negative Interest Rates：Have They Backfired Already?” The Wall Street Journal.

Tegarden L F, Hatfield D E& Echols A E. (1999): “Doomed from the start: what is the value of selecting a future dominant design?. Strategic Management Journal. 20(6):pp.495-518.

Tobin J. (1969): “A General Equilibrium Approach to Monetary Theory. ”Journal of Money, Credit and Banking 1(1):pp.15-29.

Wang Bo, Li Li& Hao Dapeng. (2019): “ Monetary policy uncertainty, default risk and macroeconomic fluctuations. ”Economic Research 054(003):pp.119-134.

Wang Liyong & Wang Shenling. (2020): “Progress in Research on the Uncertainty of Monetary Policy.” News in Economics(06):pp.109-122.

Wang Shaoguo. (2005): “A Review of Modern Western Investment Theories.” Journal of Capital University of Economics and Business (06):pp.7-12.

Wang Yizhong & Song Min. (2014): “Macroeconomic uncertainty, capital demand and corporate investment. ”Economic Research 49(02):pp. 4-17.

Wu chaopeng & Tang di. (2016): “Enforcement of intellectual property protection, technological innovation and corporate performance: Evidence from Chinese listed companies.” Economic Research 51(11):pp.125-139.

Wu Shue. (2016): “Financing sources, cash holdings and R&D smoothing: empirical evidence from my country’s biomedical manufacturing industry.”Economics 15(02): pp.745-766.

Xu Zhong. (2017):“ Practical experience of China's prudent monetary policy and the international frontier of monetary policy theory.” Financial Studies (01):pp.1-21.

Xuan Zhang, Bebe Liu Ting Wang& Chuntao Li. (2017):“ Credit rent-seeking, financing constraints and firm innovation.” Economic Research 52(05):pp.161-174.

Yang Mingjing, Cheng Xiaoke& Zhong Kai. (2019): “Research on the Impact of Equity Pledge on Enterprise Innovation——Based on the Analysis of the Moderating Effect of the Uncertainty of Monetary Policy.” Finance and Economics Research 45(02):pp.139-152.

Yang XQ, Li WC&Yin XQ. (2019):“A study on the "double" impact of diversification on corporate innovation. ”Financial Research 45(08):pp.58-71.

Ye Kangtao, Zhu Jigao. Monetary tightening and credit resource allocation. Management World,2009(01):22-28+188.

Yu Minggui, Fan Rui &Zhong Huijie. (2016): “China's. Industrial Policy and Enterprise Technological Innovation.” China Industrial Economics (12):pp.5-22.

Zhang Chengsi & Liu Guanchun. (2018): “A study on the investment and financing decision mechanism of China's industrial sector - based on the perspective of economic policy uncertainty and financing constraint heterogeneity.”Economic Research 53(12):pp.51-67.

Zhang J& Zheng WP. (2018): “Has the innovation catch-up strategy inhibited patent quality in China?” Economic Research53(05):pp.28-41.

Zhang J. Leading high-quality development of manufacturing industry with key core technology innovation. Social Science Daily,2019-03-07(002).

Zhou Hongshan & Wu Yimin.Inflation .(2008): “Inflation Volatility and Output Growth in China: An Analysis Based on the MGARCH Model.” Statistics and Information Forum 23(12):pp.53-58.

Zhou, Kaiguo, Lu, Yunzhi & Yang Haisheng. (2017):“ Financing constraints, innovation capacity and corporate co-innovation.” Economic Research 52(07):pp.94-108.

Zhu Jun&Cai Tiantian. (2018): “The Uncertainty of China's Fiscal and Monetary Policy and Inflation Expectation——Based on the Empirical Analysis of China's Fiscal-Monetary Policy Uncertainty Index.” Financial Research (01):pp.53-64.

Zou Yang, Nie Mingming, Guo Ling& Yan Hao. (2016): “Analysis of the impact of fiscal and taxation policies on enterprise R&D investment.” Tax Research (08):pp.42-46.