货币政策和股票收益：对金融约束缓解效果的研究

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摘要：在我国金融市场的 30 多年来，许多学者对货币政策的传导机制进行了研究。他们普遍认为，货币政策会通过货币供应量、利率、汇率和信贷的变化影响风险资产的价格，最终传导到实体经济。然而，很少有学者研究货币政策在向实体经济传导的过程中对各个公司的影响，即不同的公司如何受到货币政策的影响。本文选取 2008-2015 年中国 A 股上市公司的面板数据，采用带有交叉项的固定效应模型，探讨利率政策对不同公司股价影响的差异，得出以下结论：第一，当利率政策发生变化时，现金流量较大的公司，其股价变动幅度较小；第二，当利率政策发生变化时，对外融资依存度高的公司股价变化较大；第三，股权期限越长，股价变动越大；第四，历史现金流波动较大的公司受货币政策影响较大；第五，公司盈利能力越高，股价受到利率政策的影响相对较小。

关键词：货币政策；利率政策的效果；固定效应模型

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Ⅰ Introduction

In 1990, Shanghai Stock Exchange was listed, and the next year, Shenzhen Stock Exchange was also listed, which marks the opening of China's financial market. The stock market is a barometer of a county's macroeconomic operation, and monetary policy is an important means of macroeconomic regulation. It plays an important role in economic development that the central bank effectively uses monetary policy to stabilize the stock market. There are two main directions for monetary policy to control macro-economy–quantity and price: When the central bank uses quantitative monetary policy tools, they usually adjust the deposit reserve ratio, open market operation, refinancing, rediscount and other means to control the amount of money (such as money supply), then the amount of funds in the real economy changes, the prices of assets were also influenced; When the central bank uses price oriented monetary policy tools, it is to regulate asset price and the financial cost and income expectation of micro subjects through interest rate and exchange rate.

During the unstable years of China's stock market, the People's Bank of China used price monetary policy many times in a period of time to control and stabilize the stock market by directly adjusting interest rate. On February 21, 2002, the People's Bank of China lowered the benchmark one-year lending rate from 5.85 to 5.31, and then raised it to 5.58 on October 29, 2004. From 2005 to 2007, China's stock market explored a non-tradable share reform, which resulted in a bull market of A-shares. At that time, the shares of the same listed company were divided into tradable shares and non-tradable shares, which was unique in the mainland securities market. The reform of non-tradable share structure means that the government takes the state-owned shares which could not be listed and circulated before to the stock market for circulation, so as to realize the same rights of the same shares. For China's stock market at that time, non-tradable share structure was the most uncertain factor in the stock market. Therefore, for the sake of the stability and long-term development of the China's stock market, the People's Bank of China decided to reform it from 2005 and finally completed the reform at the end of 2007. During this period, the central bank carried out a tightening monetary policy to ease the stock price rise caused by the reform, raised the one-year benchmark lending rate 8 times. After the reform, the People's Bank of

China has adjusted the benchmark one-year lending rate totally 18 times from 2008 to 2015, including 13 interest rate reductions and 5 interest rate increases. Among this period, from 2012 to 2015, the People's Bank of China continuously lowered the benchmark one-year lending rate, and at the same time, the stock market also ushered in a bull market. Then after 2016, the central bank gradually opened up the interest rate marketization and did not directly adjust the interest rate any more, instead, it often adopted open market operation to stabilize the economy.

For the micro-economy, the stock market is composed of listed companies, and the final effect of monetary policy is actually the sum of the effects of monetary policy on each company. For companies, the relationship between stock price and interest rate is inseparable, and different companies have different responses on interest rate. This paper combs the macro transmission channels of monetary policy on stock price, finds out the micro transmission channels from them, and finds the appropriate variables to express these channels, so as to judge the different degree of response of different companies to monetary policy.

1. Foreign Literature Review

From the macro point of view, monetary policy is the main means of economic control of the government, and the development of macro-economy will have an impact on the stock market, so there should be a connection between monetary policy and the stock market. Firstly, in terms of money supply, many scholars use the complex econometric models such as linear regression model (Homa and Jaffee, 1971) and VAR model (Schwartz, Sarkar and Wolf, 2005) to study the relationship between the change of money supply and stock price, and find that the two are significantly related. Secondly, in terms of exchange rate, Aggarwal (1981) points out that exchange rate fluctuation will cause stock market price fluctuation, and the exchange rate of US dollar has a positive impact on stock market return, that is, the depreciation of US dollar will cause stock market price to fall, and the short-term impact of US dollar exchange rate on stock market price is greater than its long-term impact. Thirdly, in the aspect of credit, scholars study credit and stock price theoretically and empirically, and several scholars believe that there is a correlation between credit and stock price, and credit funds will have an impact on stock price. In theoretical research, Allen and Gale (2000b) put forward the AG model, which incorporates credit expansion into the causes of asset price bubbles and financial crisis, and opens up a new channel to study stock price volatility from the perspective of credit. They believe that investors use credit funds to purchase risky assets and further transfer risks, when the market overinvestment in risky assets, asset prices will continue to be pulled up and lead to asset price bubbles. In empirical research, scholars have further verified the relationship between the two: Gyanerdrup (2003) studies the three financial crises in Norway in 1899-1905, 1920-1928 and 1988-1922, and finds that credit expansion would lead to the rise of stock prices. Finally, in terms of interest rate, most foreign scholars generally believe that interest rate is negatively correlated with stock price. Kim (2003) finds that the S&P 500 index has a negative correlation with the real exchange rate and interest rate, and the variance decomposition contribution rate of interest rate is a bit high. Bernanke and Kuttner (2005) show us that unexpected 25-basis-point cut in the Fed funds rate target is associated with about 1% increase in broad stock indexes. Similarly, Humpe and Macmillan (2009) study the linear relationship between stock price and interest rate, and find that there is a significant negative correlation between interest rate and stock price, and so is the growth rate of both.

From the micro perspective, Ozdagli and Velikov (2019) point out that monetary policy mainly affects the stock price of companies through credit channel, liquidity effect, discount rate effect, cash flow volatility and nominal rigidities. The first is credit channel, the impact of financial constraints on monetary

policy transmission has always been the core of policy and academic discussions (Gertler and Gilchrist, 1994; Fisher, 1933). Although a large number of literatures focus on the impact of this credit channel on real variables, there are relatively few researches on its impact on stock prices. Perez Quiros and Timmermann (2000) use the size of small enterprises as a measure of financial constraints, and find that the stock price of small enterprises is more sensitive to changes in monetary policy. Lamont et al. (2001) realize that monetary policy is implemented by choosing policy interest rate rather than money supply, but when they use the change of policy interest rate, they do not find any significant relationship between financial constraints and policy sensitivity of stock price. Whited and Wu (2006) provide a good model, which combines enterprise financial indicators with external finance constraints, and finds that constrained firms earn higher returns. As Allan et al. (2007) show, the unexpected change in Fed funds target rate has more impact on prices in the stock market than expected change does, stocks should not react to expected changes in monetary policy. Then Ozdagli (2018) uses the unexpected component of the policy rate change, using the WW index and natural experiments, he finds that the more constrained the enterprises are, the less their response to monetary policy, because the lower their dependence on external finance, the less they are affected by the change of external financing cost. The second is liquidity effect. The most liquid assets in an enterprise are also greatly affected by interest rates. According to the liquidity effect theory mentioned above, when the interest rate falls, that is, the value of money falls, the demand for non-monetary financial assets will increase. Similarly, according to the theory of money demand inventory proposed by Baumol (1952), interest rate is the opportunity cost of holding cash, and the demand for money transaction will decrease with the increase of interest rate. When the interest rate rises, the company will deposit the cash into the bank or interest account to obtain additional liquid funds, which will weaken the effect of monetary policy. The third is cash flow duration. Macaulay duration is proposed by Macaulay, which is the earliest concept of duration. It measures the interest rate risk of bonds, the longer the debt repayment time, the greater the interest rate risk. However, the earliest literature on how to calculate the duration of the equity market comes from Gordon's dividend discount model, which estimates stocks based on their estimated dividend, stock discount rate (k) and dividend growth rate (g). Later, Leibowitz (1986) firstly proposed an empirical approach to value equity duration. More recently, Dechow et al. (2004) and Weber (2018) study the concept of duration in the context of equity market. Dechow et al. (2004) first divided the infinite cash flow duration into two parts: finite and infinite, and then integrated them to get a model for calculating equity duration. In addition, the relationship between equity duration and interest rate sensitivity of stock has gradually been recognized by investors. Ozdagli (2018) finds that stocks of firms who have greater equity duration are more affected by monetary policy. The fourth channel is cash flow volatility, Ozdagli(2018) shows us that the cash flow volatility may reflect the monetary policy sensitivity of stock price in many ways. He points that higher cash flow volatility may mean that enterprises need to rely more on external financing, which increases the importance of external financing costs, which are directly affected by monetary policy. The last is nominal rigidities. As mentioned above, nominal rigidity theory is an important part of New Keynesian economics. For a company, if input prices such as waves are sticky, then expansionary monetary policy can have a huge impact on the income of enterprises without changing the total cost of investment, thus pushing up the stock price. For example, Gomes et al. (2016) proposed that expansionary monetary policy reduces the real debt burden of enterprises because they have nominal obligations to lenders. Similarly, in a few cases, if the output price is stickier than input price, the expansionary monetary policy will increase the input cost relatively more, thus reducing the stock price.

2. Domestic Literature Review

In the macro aspect, there are also many literatures in China that demonstrate and confirm the impact of monetary policy on the stock market. Wang et al. (2012) believe that the policy factor is the main reason for the fluctuation of China's stock market, and use the multiple regression model to get the empirical results: in the bull market, the policy factor is more likely to affect the fluctuation of the stock market, and more likely to cause the downward fluctuation of the stock market. And as Yang and Long (2006) using China's data show, monetary policy affects the stock market either by changing money supply or by changing interest rate. In terms of money supply, Wang and Han (2009) use GARCH model to study the relationship between the change of money supply and stock price, and find that they were significantly correlated. In addition, Li and Chen (2009) find that the changes of money supply, deposit interest rate and reserve ratio can have short-term or long-term impact on the stock market volatility to varying degrees, except that the amount of credit cannot have an impact on the stock market volatility. At the same time, Qian (1998) believes that the key to asset price changes affected by money supply is investors' expectations. Unexpected money supply will cause stock price changes, while predictable money supply will not affect stock price. In terms of exchange rate, Jiang (2014) uses VAR-EGARCH model to test the spillover effect of exchange rate on stock price; through VAR-EGARCH- BEKK model, Shi and Ren (2016) fInd that there are mean spillover and volatility spillover effects of exchange rate on stock price return. In terms of credit, Min et al. (2006) construct a theoretical model to study how bank credit funds play a role in the process of crisis bubble formation and analyze its mechanism. In empirical research, based on VEC model, Lu (2013) studies the relationship between bank credit and Shanghai Composite Index and Shenzhen Composite Index in the short term and the medium and long term, and find that there is a significant correlation between bank credit and stock price, and the impact of bank credit on stock price is stronger in the short term than in the medium and long term. While other scholars believe that there is a correlation between credit scale and stock price, but there is only one-way relationship between stock price and credit scale. They believe that credit will not affect stock price. For example, Gui et al. (2008) study the dynamic relationship between bank credit and stock in China, and find that the rise of stock price will lead to the expansion of bank credit, but the impact of bank credit on the rise of stock price is not significant. In terms of interest rate, China mainly studies the existing interest rate and stock market data from the empirical perspective. Wang and Lin (2015) obtain the result of negative correlation between interest rate and stock price through FAVAL-BL model analysis, and with the increase of interest rate by 100 basis points, the stock index decreased by about 8%. Wang (2016) uses the SVAR model, selected the monthly data from 2006 to 2015 to study the effect of open market business on the price of China's stock market. The results show that the impact of open market business on the stock price is significant in the short term and ineffective in the long term. In addition, the impact of interest rate on the stock market is deepening, even more than that of money supply on the stock market.

In the micro aspect, the domestic research literature is less. In terms of credit channel, Li (2018) believes that the impact of interest rate on stock price synchronization is mainly through three channels: investor sentiment, investor portfolio and corporate micro behavior. As for the micro behavior of enterprises, he points out that the rise of interest rate will increase the debt paying burden of enterprises, reduce the present value of the mortgaged resources of enterprises, lead to the decline of net value, increase the marginal cost of external financing, and thus increase the level of financing constraints of enterprises. In terms of cash flow, Pei et al. (2021) find that there is a significant positive relationship between cash flow risk and stock price crash risk, that is, the higher the company's cash flow risk, the greater the stock price crash risk. Zhang (2020) also says that cash flow plays an important role in the regulation of goodwill to stock price crash risk. Generally speaking, enterprises with more cash flow tend

to have lower stock price crash risk, that is, cash flow plays a positive role in the regulation of goodwill risk. In terms of cash flow duration, In the long run, Chen and Ye (2005) introduce the concept of equity duration to China, comprehensively measure the interest rate risk faced by commercial banks, and make an in-depth study on the application environment of equity duration. Kong (2018) uses the data from 1991 to 2015 to find that the correlation between the implied equity duration and the book to market ratio and the income price ratio is more significant, and it can predict the stock return more significantly than the value evaluation index. In terms of nominal rigidities, Ding et al. (2017) find that the rigidity of wage adjustment in the labor market may be one of the important short-term factors for the decline of the proportion of labor income in China. And Zhang and Zhang (2018) point out that price rigidity leads to economic depression, which shows that price rigidity exists objectively and has an impact on the economy.

From the above literature, we can see that the money supply, credit, interest rate and exchange rate all have great influence on the stock market. For the company, the change of money supply directly affects the cash flow of the company which is highly related to the M0, M1 and M2. At the same time, the change of credit scale will also affect the company more which is more highly dependent on borrowing, and the interest rate is also highly related to the discount value of future cash flow. The change of stock price should reflect the change of the company's profitability, but the nominal rigidity will also affect the output and input price of the company. Therefore, in the micro aspect, combined with the five transmission channels of monetary policy affecting stock price proposed by Ozdagli and Velikov (2019), we can conclude that these five channels play a regulatory role in the process of monetary policy affecting stock price.

But at present, there are few domestic literatures to add these regulatory factors to study the impact of changes in monetary policy on the company's stock price, so this paper adds the index which can represent these five channels to study the impact of changes in interest rate policy in monetary policy on the company's stock price.

Ⅱ Theoretical Transmission Mechanism

As mentioned above, monetary policy, such as credit and interest rate, will affect the stock market price through the operating performance and capital cost of listed companies. Then I mainly analyze how interest rate affects the company level and thus affects the stock price, that is, how interest rate affects different companies differently. Here I conclude the five channels mentioned by Ozdagli and Velikov (2019), and find the appropriate corporate financial indicators to represent these five channels, so as to provide a more detailed theoretical basis for the empirical research in Chapter 4.

1. Credit Channel

This paper discusses the credit channel of monetary policy affecting stock price in the previous part. The change of interest rate will affect the cost of enterprise credit, generally speaking, if the bank increases the loan amount or reduces the loan rate, the stock price will rise. This is because the enterprise's loan cost is reduced and the profit is increased, which makes the stock price rise. Therefore, at the extreme, companies without loans or liabilities have no loan cost, and in this dimension, stock price will not be affected by the change of lending rate. Ozdagli (2018) finds that firms that are more dependent on external financing are more responsive to monetary policy. This means that the degree of dependence on external financing is also the reason why interest rate has different influence on companies.

2. Liquidity Effect

Cash and short-term investment in financial data are the most liquid assets of enterprises, and these assets are directly related to monetary base. On the one hand, because interest rate is the opportunity cost of holding cash, companies with higher amount of cash should be more negative to the increase of policy interest rate. On the other hand, enterprises' cash reserve can reduce the sensitivity of investment to policy, so as to inhibit the effect of monetary policy. For example, if enterprises deposit cash into interest bearing account, the increase of interest rate can make enterprises obtain additional interest, so as to buffer the increase of enterprise cost caused by interest rate policy.

3. Cash Flow Duration

In terms of time dimension, theoretically, the cash flow paid later is more affected by the interest rate, for example, the present value of $100 after one day is different from that of $100 after one year. We can observe that the price of a bond is related to its maturity. The price of a long-term bond is higher than that of a short-term bond because the interest rate risk of a long-term bond is higher than that of a short-term bond. Therefore, in order to measure the actual maturity of bonds considering cash flow constraints, Macaulay proposed the concept of duration. In bond investment, duration is more used to measure the interest rate risk of bond or bond portfolio. In addition, duration can also be used to construct the immune policy of the bond portfolio, that is, the cash flow generated by the asset portfolio can meet the payment of future liabilities, and there is no need to add additional capital after investment, so the interest paying debt is equivalent to zero interest bond. In fact, this is a negative investment strategy, which only achieves the set rate of return target through the construction of portfolio under the condition of avoiding the risk of interest rate fluctuations. Then, due to the more and more important role of stock in the capital market, in order to consider the immunity of stock to interest rate changes, scholars put forward the concept of equity duration, similar to the bond duration, the equity duration is the actual maturity date of the stock. Scholars have put forward several models to measure the duration of equity since 1986. Dechow (2004) combines the duration with the popular valuation ratios such as ROE and book to market ratio to measure the equity duration more accurately and deeply. Ozdagli (2018) finds that the longer the equity duration, the greater the response of stock to monetary policy. This phenomenon can be explained as the future cash flow is more affected by the change of interest rate.

4. Cash Flow Volatility

Ozdagli (2018) finds that cash flow volatility may reflect the monetary policy sensitivity of corporate stock prices in a variety of ways. On the one hand, companies with low volatility are less likely to default, so they have longer life and longer cash flow duration. On the other hand, lower volatility may also mean lower option value of delayed investment, so companies with lower volatility may increase cash flow duration by increasing today's investment in exchange for future cash flow, in other words, when interest rates fall, companies with lower volatility of cash flow can increase their investments today in exchange for future cash. Another example of volatility importance, higher cash flow volatility may mean that enterprises need to rely more on external financing, which increases the importance of external financing costs, which are directly affected by monetary policy.

5. Nominal Rigidities

The nominal rigidity theory mentioned in the second chapter shows that nominal price and nominal wage cannot be completely adjusted with the change of nominal demand. Although nominal rigidity data at company level is not applicable to all stocks, operating profit margin can still provide a window to understand the impact of nominal rigidity. In particular, if the price of inputs (such as wages) is sticky,

expansionary monetary policy will have a huge impact on the income of enterprises, and will not cause too much change to the total cost of inputs, thus promoting the rise of stock prices. Due to the operating leverage effect of relatively fixed input cost, the percentage growth of stock price will be stronger for companies whose income is closer to input cost (i.e. companies with lower profitability). Recently, Gomes et al. (2016) argue that expansionary monetary policy reduces the real debt burden of enterprises because they have nominal obligations to lenders. This kind of "sticky leverage" mechanism works in a way similar to the sticky wage channel mentioned above, that is, sticky wage reduces the actual burden of nominal debt of employees after the expansionary policy.

Ⅲ Empirical Research

1. Measuring Monetary Policy Surprise

As the stock market generally does not respond to the expected policy behavior, this paper needs to select the unexpected part as far as possible to represent the part of policy changes. However, unlike the United States, China has no federal funds futures contracts that can extract the unexpected changes. I inquire about the announcement on the official website of the People's Bank of China and summarize the one-year benchmark lending rate adjustment by the central bank from 2005 to 2015 as shown in the Table 1 below. As shown in the Table 1, the People's Bank of China generally publishes the document of one-year benchmark interest rate adjustment after the closing, and there is no public meeting before the interest rate adjustment in China. Therefore, this paper just uses the change amount of interest rate by the central bank as the amount of policy change.

In the Table 1, the column Announcement represents the announcement date, the column Week represents the day of the week, the column Close indicates whether the announcement time is after the closing, and the column Vacation indicates whether it is a legal holiday before and after the announcement date. Therefore, we can judge whether the announcement time is during the opening or after the closing or on the stock market rest day. We can see from the Table 1 that the announcement time of the central bank is basically not during the opening period. The column Rate% indicates the adjusted one-year benchmark loan interest rate, and the unit is a percentage. The column Δ represents the adjustment range, that is, the amount of decrease or increase.

The change of interest rate policy (MPS) used in this paper is the opposite value of Δ, that is, MPS=-Δ. Therefore, positive MPS represents expansionary monetary policy and negative MPS represents tightening monetary policy.

At the same time, this paper collects the daily closing price of HS300 in the same period on the financial website of Tonghuashun, and compares it with the one-year benchmark lending rate of the central bank in recent years, as shown in the Figure 1. In the Figure 1, we can clearly see that the bull market before 2008 was accompanied by the rise of interest rate, and the reason is explained earlier, which is because of the reform of non-tradable shares. The change direction of stock market after 2008 is basically opposite to that of interest rate. Therefore, this paper only selects the data from 2008 to 2015 to avoid the error caused by the reform of non-tradable shares.

Table 1: Announcement Date and Interest Rate Change

No.	Announcement	Rate (%)	Δ	Week	Close	Vacation
1	2005-03-17	5.58	0.00	Thur.	—	—
2	2006-04-27	5.85	0.27	Thur.	After	—

3	2006-08-18	6.12	0.27	Fri.	after	—
4	2007-3-17	6.39	0.27	Sat.	—	—
5	2007-05-18	6.57	0.18	Fri.	after	—
6	2007-7-20	6.84	0.27	Fri.	after	—
7	2007-8-21	7.02	0.18	Tues.	after	—
8	2007-9-14	7.29	0.27	Fri.	after	—
9	2007-12-20	7.47	0.18	Fri.	after	—
10	2008-9-15	7.20	-0.27	Mon.	after	9.13-9.15
11	2008-10-8	6.93	-0.27	Wed.	after	—
12	2008-10-27	6.93	0.00	Mon.	after	—
13	2008-10-29	6.66	-0.27	Wed.	after	—
14	2008-11-26	5.58	-1.08	Mon.	after	—
15	2008-12-22	5.31	-0.27	Mon.	after	—
16	2010-10-19	5.56	0.25	Tues.	after	—
17	2010-12-25	5.81	0.25	Sat.	—	—
18	2011-02-08	6.06	0.25	Tues.	after	—
19	2011-04-05	6.31	0.25	Tues.	after	4.2-4.5
20	2011-07-06	6.56	0.25	Wed.	after	—
21	2012-06-07	6.31	-0.25	Thur.	after	—
22	2012-07-05	6.00	-0.31	Thur.	after	—
23	2014-11-21	5.60	-0.40	Fri.	after	—
24	2015-02-28	5.35	-0.25	Sun.	—	—
25	2015-05-10	5.10	-0.25	Sun.	—	—
26	2015-06-27	4.85	-0.25	Sat.	—	—
27	2015-08-25	4.60	-0.25	Tues.	after	—
28	2015-10-23	4.35	-0.25	Fri.	inter	—

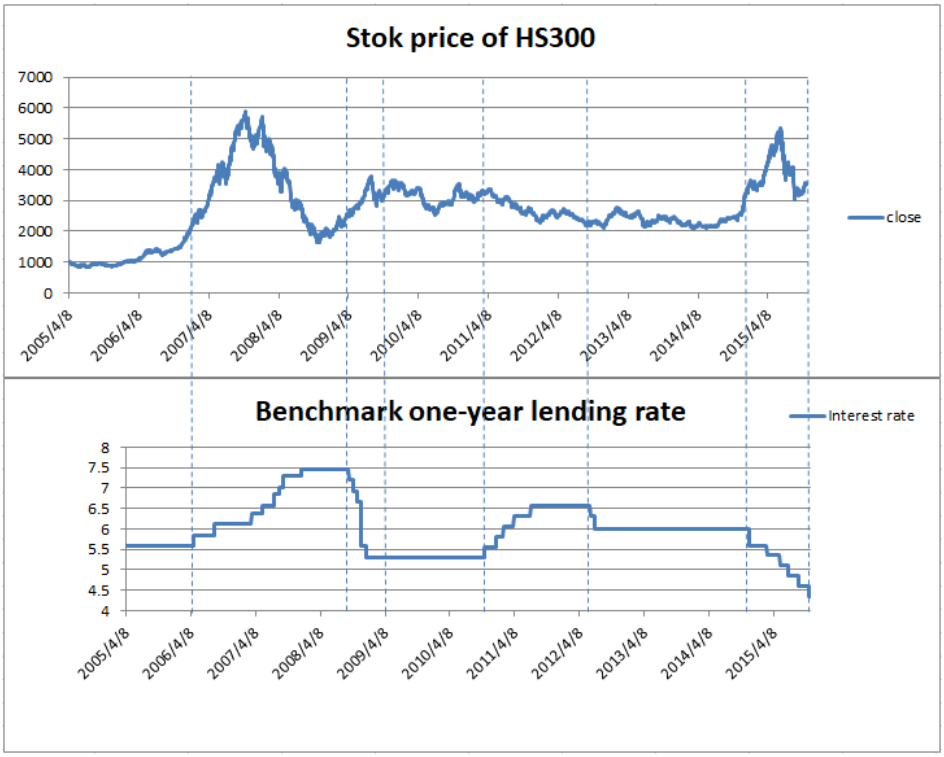

Figure 1: HS300 Stock Price and Lending Rate

2. Selecting Variables

(1) Credit channel index

In history, many literatures put forward many indicators as representative variables of financing constraints, such as KZ index, WW index, interest expense, cash holding, leverage level, company size, etc. This paper uses WW index which is proposed by Whited and Wu (2006) and can comprehensively represent the financing constraints of enterprises. The reasons are as follows: Firstly, the four variables of leverage level, interest expense, cash holding, and company size only describe financing constraints from one side, which is not comprehensive; in particular, these variables themselves can have multiple meanings, not just represent the financing constraints of enterprises. Secondly, KZ index is not a relatively stable index to measure financing constraints. As the origin of KZ index, the main purpose of Kaplan and Zingales (1997) is not to construct a new index representing financing constraints, but to criticize the problem of "investment-cash flow" as a measure of financing constraints. Hadlock and Pierce (2010) test on KZ index shows that the construction of KZ index contains both dependent variables and independent variables, which is not suitable as a proxy variable of financing constraints. Finally, there is no obvious evidence that WW index is invalid as a proxy variable of corporate financing constraints. Based on the WW index of Zeng and Lin (2015), who use the data form the listed company in China during 2004-2011 to construct the WW index, the structure of WW index is as follows:

$$\mathrm{WW}_{it} = 0.104 * \mathrm{TLTD}_{it} - 0.992 * \mathrm{DIVPOS}_{it} - 0.088 * \mathrm{CF}_{it} - 0.122 * \mathrm{LNTA}_{it} - 0.19 * \mathrm{ISG}_{it} + 1.182 * \mathrm{IndDebt}_{it} - 0.06 * State_{it} + 0.23 * Private_{it} \quad (1)$$

Where TLTD_{it} equals to long-term liabilities divided by total assets; DIVPOS_{it} is the dummy variable of whether the company pays cash dividends in period i and t. If there is, the value is 1; otherwise, it is 0; CF_{it} represents the cash flow from operating activities divided by total assets; LNTA_{it}

is the natural logarithm of total assets; ISG_{it} is the sales growth rate of the industry; $\mathrm{IndDebt}_{it}$ is the weighted industry average long term debt ratio of listed companies; $State_{it}$ is the dummy variable of whether the company is SOE, if it is, the value is 1, otherwise, it is 0; $Private_{it}$ if the dummy variable of whether the company is private, if it is, the value is 1, otherwise, the value is 0.

The following Table 2 shows the descriptive statistics:

Table 2: Descriptive Statistics of WW index

Variable	Observation	Mean	Std. Dev.	Min	Max
WW Index	13806	22.44	14.08	-9.72	67.43
TLTD	13806	16.99	18.92	0	90.41
CF	13806	16.07	11.65	0.03	89.26
LNTA	13806	22.37	1.28	15.77	28.02
IndDebt	13806	21.6	10.8	0.61	53.62
State	13806	0.72	0.45	0	1
Private	13806	0.23	0.42	0	1

(2) Cash flow duration

Due to the fact that the measurement model proposed by Dechow (2004) has been used by Kong (2018) in China among many models for studying equity duration, the indicators used to represent equity duration in this paper will also be obtained according to the model proposed by Dechow (2004). This paper briefly describes and introduces this model as follows.

This model is derived from Macaulay's bond duration formula:

$$\mathrm{D} = \frac{\sum_{t=1}^{T} t*(CF_t/(1+r)^t)}{P} \qquad (2)$$

Where CF_t represents the cash flow at t, r represents the yield to maturity, and P represents the price of the bond. However, it should be noted that the biggest difference between equity duration and bond duration is whether time T is limited. For bonds, T is finite time, but for stocks, T is infinite and cash flow is uncertain. Another difference is that the CF of bonds is known, but the dividend payment of equity bonds cannot be predicted and determined. Therefore, Dechow (2004) divided the above formula into two parts, the limited term part and the unlimited term part, as follows:

$$\mathrm{D} = \frac{\sum_{t=1}^{T} t*\frac{CF_t}{(1+r)^t}}{\sum_{t=1}^{T}\frac{CF_t}{(1+r)^t}} * \frac{\sum_{t=1}^{T}\frac{CF_t}{(1+r)^t}}{P} + \frac{\sum_{t=T+1}^{\infty} t*\frac{CF_t}{(1+r)^t}}{\sum_{t=T+1}^{\infty}\frac{CF_t}{(1+r)^t}} * \frac{\sum_{t=T+1}^{\infty}\frac{CF_t}{(1+r)^t}}{P} \qquad (3)$$

Where P represents the total market value of the stock, CF represents the net cash distribution of the stock holder, and r represents the expected rate of return of the stock. Next, assuming that the distribution of indefinite cash flow is equivalent to a perpetual annuity, then its value is the difference between the observed market value implied in the stock price and the present value of cash flow in the limited forecast period, as follows:

$$\sum_{t=T+1}^{\infty}\frac{CF_t}{(1+r)^t} = \left(\mathrm{P} - \sum_{t=1}^{T}\frac{CF_t}{(1+r)^t}\right) \qquad (4)$$

Because we assume that the indefinite cash flow is equivalent to a perpetual annuity, then the corresponding period can be expressed as $\mathrm{T} + (1+r)/r$, if bring it in the above two formulas, then it can get:

$$\mathrm{D} = \frac{\sum_{t=1}^{T} t*\frac{CF_t}{(1+r)^t}}{P} + \left(T + \frac{1+r}{r}\right) * \frac{(P - \sum_{t=1}^{T}\frac{CF_t}{(1+r)^t})}{P} \qquad (5)$$

There are two problems in this assumption. One is that it means that the cash flow in an indefinite part increases at a fixed interest rate; the other is that the measurement is based on the stock price rather than the objective and necessary forecast. To solve the second problem, Dechow (2004) uses the research method of Nissim and Penman (2001), that is, using the net profit and book value of stocks to predict CF, as follows:

$$CF_t = E_t - (BV_t - BV_{t-1}) \quad (6)$$

Then,

$$CF_t = BV_{t-1} * \left[\frac{E_t}{BV_{t-1}} - \frac{(BV_t - BV_{t-1})}{BV_{t-1}}\right] \quad (7)$$

Where E_t/BV_{t-1} is ROE, that is, return on equity; $(BV_t - BV_{t-1})/BV_{t-1}$ can be expressed as SG, that is, the growth rate of book value. In Nissim and Penman (2001), the mean value of ROE recovery is roughly equal to the cost of equity. Therefore, this paper models ROE as a first-order autoregressive process, in which we can get the long-term regression mean value, that is, the cost of equity. At the same time, Nissim and Penman (2001) believe that the growth of sales in the past can represent a better indicator of future equity growth than the growth of stocks, Therefore, this paper also models the sales growth rate as a first-order autoregressive equation, and its autoregressive coefficient is obtained by making the long-term average growth rate in the mean recovery process equal to the long-term GDP growth rate.

Thus, to calculate the duration of equity, I need to use four financial variables and four forecast parameters. The four financial variables are book value (current period and lag period), sales (current period and lag period), net profit (current period and lag period) and market value (current period). The four prediction parameters are ROE autocorrelation coefficient, sales growth autocorrelation coefficient, expected return on equity and long-term GDP growth rate.

Table 3: Summary of financial variables and forecasting parameters used in the estimation of implied equity duration.

Panel A: Financial Variables	Description
Book value of equity(BV)	Net asset value per share
Earnings(E)	Earnings per share
Sales(S)	Operating income per share
Market capitalization(P)	Price per share
Panel B: Forecasting Parameters	**Value**
Autocorrelation coefficient for ROE	0.0035
Cost of equity capital	3%
Autocorrelation coefficient for SG	-0.007
Long-run SG	2%

The GDP growth rate in this paper is the average value calculated according to the GDP growth rate from 2008 to 2015, which is about 8%, converted into quarterly data of 2%. The data is from the official website of the National Bureau of statistics. The growth rate of equity is equivalent to the average return rate of the market portfolio. According to the research of Cai (2011), the value is the expected return rate

of the market portfolio. From CSMAR, the expected return rate of A-share comprehensive market securities is about 12%, which is converted into the quarterly data of 3%. We boldly assume that the expected return on equity is a constant in the analysis, so that the expected return may systematically change with the duration. In this paper, the first-order autocorrelation coefficients of ROE and SG are obtained by using the A-share data without missing data and the first-order autocorrelation model, which is shown in the Table 3 above.

On this basis, this paper calculates the current book value by using the growth rate and the book value of one lag period, and then calculates the current income by using the estimated roe and the book value of one lag period, and finally brings in the formula to obtain the equity duration of each stock i at time t, where the time t is the quarter of announcement day from 2008 to 2015. Take the implied equity duration of Angang (000898) in the second quarter of 2012 as an example, as shown in the Table 4.

Table 4: The computation of implied equity duration for Angang Steel for second quarter of 2012

Input Data		Forecasting Parameters	
Price(P_0)	4.2669	Autocorr. Coeff. for ROE	0.0035
Lagged Book Value(B_{-1})	6.75	Cost of equity capital(r)	3%
Book Value(B_0)	6.74	Autocorr. Coeff. for Growth	-0.007
Growth Rate$(S_0 - S_{-1})/S_{-1}$	1.0846	Growth Rate(GDP)	2%
Earnings(E_0)	-0.277		

Forecast Model											
Time Period	0	1	2	3	4	5	6	7	8	9	10
Growth rate (%)	108.46	1.25	2.01	2	2	2	2	2	2	2	2
ROE_t (E_t/B_{t-1})(%)	-4.1	2.98	3	3	3	3	3	3	3	3	3
BV_t	6.74	6.82	6.96	7.1	7.24	7.39	7.54	7.69	7.84	8	8.16
$E_t = B_{t-1} * ROE_t$		0.20	0.02	0.21	0.21	0.22	0.22	0.23	0.23	0.24	0.24
$CF_t = B_{t-1} + ROE_t - BV_t$		0.12	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08
$PV(CF_t)$		0.11	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
$t * PV(CF_t)$		0.11	0.13	0.19	0.25	0.31	0.37	0.43	0.49	0.54	0.6
$\sum(PV(CF_t))$		0.6692			Terminal PV			3.5977			
$\sum(t * PV(CF_t))$					3.4177						
10 season duration		5.1068			Terminal duration			44.3333			
10 season weight		0.1568			Terminal weight			0.8432			
Implied equity duration					38.1809						

(3) Other variables

The dependent variable return at time t is represented as followings:

$$r_t = \frac{opening\ price_{t+1} - closing\ price_t}{closing\ price_t} \quad (4.8)$$

Where t is the date of announcement.

Cash flow volatility is the standard deviation of cash flow in the past 12 quarters, where cash flow is equal to operating cash flow divided by total assets. Operating cash flow and total assets are obtained from CSMAR database. I use operating cash flow scaled by market value of asset as the index to represent enterprise operating profitability, and market value of asset equals total asset minus shareholder equity plus market capitalization. The parameter to represent the liquidity effect of a company is the ratio of corporate cash to market capitalization, because corporate cash is the most liquid asset of an enterprise. The data are from Tonghuashun website.

(4) Control variables

In addition, this paper controls the industry effect, firm effect, time effect, size effect, and controls debt level and industry sale growth as well. And the MPS variable is omitted due to time effect.

3. Estimation procedure

(1) Estimation

This paper uses the return mentioned in the previous section as the dependent variable and other variables as the independent variable. In addition, this paper uses the interaction of these firm characteristics with MPS as the explanatory variables.

My main specification is:

$$\mathrm{r_{it}} = \alpha + \sum_{k=1}^{n} \beta_k \mathrm{x_{itk}} + \sum_{k=1}^{n} \gamma_k \mathrm{MPS_t} \times \mathrm{x_{itk}} + \mathrm{Controls_{it}} + \varepsilon_{it} \quad (9)$$

Where i identifies the firm, t is the date when the people's Bank of China announced the change in benchmark one-year lending rate, $\mathrm{r_{it}}$ is the stock return on date t for firm i. $\mathrm{MPS_t}$ is the surprise of monetary policy on date t, $\mathrm{MPS_t} = -\Delta_t$ so that a positive MPS is expansionary. The variable $\mathrm{x_{itk}}$ is the characteristic of the kth firm，which concludes WW index, Cash, CF Duration, CF Volatility and Operating Profitability. $\mathrm{Controls_{it}}$ include industry, size, firm, time, debt, industry sale growth.

(2) Descriptive Statistics

Here this paper gives the overall description of the variables as followings.

The data is a balanced panel data, and there are 18 periods and 569 individuals.

Following Table 5 are descriptive statistics:

Table 5: Summary Statistics

Variable	Observation	Mean	Std. Dev.	Min	Max
Return (%)	10242	0.8547	2.5091	-45.38	11.17
WW Index	10242	22.4	13.9392	-4.3717	67.4312
CF duration	10242	42.8783	0.9627	15.1119	49.244
Cash	10242	0.614	0.7832	0.0131	35.8988
Operating Profitability	10242	0.0164	0.0494	-0.2835	0.5379
CF Volatility	10242	0.0483	0.0284	0.0036	0.3098

(3) Hausman Test

If considering from a purely practical point of view, the fixed effect model often costs a lot of freedom, especially for the panel data with a large number of sections, the random effect model seems to be more suitable. But on the other hand, the fixed effect model has a unique advantage. We don't need to make

the hypothesis that individual effect is not related to other explanatory variables. In the random effect model, this hypothesis is necessary. If important variables are omitted in the model setting, the parameter estimation will be inconsistent.

Therefore, we can test whether the fixed effect is related to other explanatory variables as the basis for screening fixed effect and random effect models. Hausman test is such a test statistic. The basic idea is that under the original assumption that AI is not related to other explanatory variables, the parameter estimates obtained by OLS fixed effect model and GLS random effect model are unbiased and consistent, but the former is not effective. If the original hypothesis is not true, the parameter estimation of the fixed effect model is still consistent, but the random effect model is not. Therefore, under the original hypothesis, there should be no significant difference between the two parameter estimates. We can construct a statistical test based on the difference between the two parameter estimates.

The result of Hausman test shows that we should refuse the hypothesis and choose the fixed effect model.

(4) Cross Sectional Heteroscedasticity Test

For cross-sectional data using fixed effect model, it is often necessary to test whether there is cross-sectional heteroscedasticity, the test result shows that the data in this paper have cross-sectional heteroscedasticity because of rejecting the original homo-variance hypothesis. Therefore, robust should be used to adjust the regression.

(5) F-test

F-test, the most commonly used alias is joint hypothesis test. It is a test under null hypothesis (H_0) that statistical values obey F-distribution. It is usually used to analyze the statistical model with more than one parameter to determine whether all or a part of the parameters in the model are suitable for estimating the population. F-test shows that the model as a whole is significant.

In addition, at the confidence level of 5%, we reject the original hypothesis H0: individual fixed effect is the same. So between the mixed least squares model and fixed effect model, fixed effect model should be chosen.

(6) Cross Sectional Correlation

Panel data is composed of cross-sectional data of multiple individuals and time series data observed by each individual over time. In order to reflect the influence of time on the data, the time effect factor is considered in the model, and a two factor error component model is established.

The common panel data model assumes that the pure error terms are independent and identically distributed or uncorrelated. However, the observation value of each individual at different time points is a time series data, and the time series data often have sequence correlation. Therefore, in practical application, the hypothesis of uncorrelation or independent identity distribution of error terms is questionable, and it is necessary to test whether there is sequence correlation.

The results show that there is a significant serial autocorrelation in the panel data.

(7) Determination of Estimation Method

From the test above, it can get that there is cross sectional heteroscedasticity and autocorrelation in the panel data. Therefore, combined with the characteristics of "long N, short T" of the panel data in this paper and the results of Hausman test requiring fixed effect model, this paper uses the method of Driscoll and Kraay standard error (1998) to overcome the heteroscedasticity problem of panel data. In this method, the error structure is set as heteroscedasticity and autoregression of specific order. When the time dimension increases gradually, the standard error is robust to general cross-sectional correlation and time correlation. Because this method uses nonparametric technique to estimate the standard error,

there is no restriction on the number of sections, so even if the number of sections n is much larger than the period T, the estimation will not be greatly affected.

4. Results

The following Table 6 shows the results of the estimations.

I use negative change of interest rate as the variables, which means that the positive MPS in the Table 6 means expansionary monetary policy.

The first column indicates that an expansionary policy is related to a higher return. There is a negative relationship between interest rate and return. It can be seen from the Table 6 that a 20 basis point drop in interest rate can cause the share price to increase by 1%.

The second column shows the impact of financial constraints. The higher the degree of constraints, that is, the higher the WW index, the worse the stock price's response to the unexpected monetary policy. That is to say, in the process of the interest rate policy affecting the stock price, the effect of monetary policy is affected by the company's financing constraints. Because coefficient of the interaction of the WW index and MPS is greater than 0, the effect of the interest rate policy on the stock price decreases with the increase of the WW index.

The third column indicates that the marginal impact of MPS on firm’s return decreases with the rise of firm’s cash, which means the firm with higher cash response less to monetary policy. Because when interest rates rise, companies with more cash can deposit their cash to earn interest to offset the risk of a fall in return.

The forth column shows that, consistent with the discount rate effect, companies with longer cash flow duration respond more positively to unexpected changes in the interest rate.

The fifth column shows that companies with higher cash flow volatility are more sensitive to monetary policy surprises, which is consistent with the view that companies with higher cash flow volatility may more often rely on external financing.

The sixth column shows that companies with higher profitability are less responsive to monetary policy. Because of wage and price stickiness, those companies with income closer to cost, have a larger amount change of stock price when the interest rate policy changes. As a result of the operating leverage effect of relatively fixed input costs, the resulting share price growth percentage will be higher for companies with revenues close to input costs (i.e. companies with lower profitability). The working mode of the sticky leverage mechanism is similar to the above- mentioned sticky wage channels, that is, the sticky wage reduces the actual burden of employees’ nominal debt after the expansionary policy. Therefore, we expect that sticky leverage will increase the policy sensitivity of the stock price of the company with lower profitability.

The last column of the Table 6 puts the variables together, and it can be found that the five coefficients of the interaction terms are significant. Therefore, the impact of interest rate change on stock price is affected by these factors, and the response of company stock price to monetary policy is also different because of these factors. In other words, the effect of MPS on stock price changes with these factors.

Table 6: Estimation Result

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable	Return	Return	Return	Return	Return	Return	Return
WW index		0.02 [1.49]					−0.002 [-0.45]
Cash			1.65*** [4.63]				0.103 [1.58]
CF duration				-0.03 [-0.97]			-0.024 [-0.89]
CF volatility					−17.53** [-2.46]		−2.07* [-1.95]
Operating profitability						-1.47 [-0.53]	0.893 [1.3]
MPS	5.001*** [24.55]						
MPS×WW index		−0.13* [-3.47]					−0.018*** [-3.67]
MPS×Cash			−2.15*** [-7.34]				−0.711*** [-4.3]
MPS×CF duration				0.32*** [7.29]			0.15*** [3.65]
MPS×CF volatility					29.8* [1.76]		5.9** [2.86]
MPS×Operating profitability						−8.45** [-2.27]	−3.08*** [-4.6]
Firm FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Size FE	No	Yes	Yes	Yes	Yes	Yes	Yes
LnDebt	No	Yes	Yes	Yes	Yes	Yes	Yes
ISG	No	Yes	Yes	Yes	Yes	Yes	Yes
n	27918	13806	13662	10368	13798	13788	10242
group	—	767	759	576	767	766	569
$within-R^2$ (%)	2.11	25.07	26.3	55.16	26.78	23.07	55.51

Ⅳ Conclusion

The previous paper mainly analyzes the impact of monetary policy on the stock market through theoretical derivation and empirical proof. In the aspect of theoretical derivation, firstly, this paper introduces the relevant concepts of monetary policy, and describes the relationship between interest rate and stock price with a graph. Then this paper explains the influence path of monetary policy tools on stock price in the macro aspect, and analyzes how the interest rate in monetary policy tools affects the stock price in the micro aspect from the perspective of the company as the receiver of monetary policy. In

the aspect of empirical proof, this paper uses multiple linear regression model with cross items to empirically analyze the impact of interest rate changes on stock price from 2008 to 2015, further verifies the negative correlation between interest rate and stock price, and verifies the difference of the impact of interest rate changes on stock price. The conclusions are as follows:

(1) At the macro level, monetary policy has a significant impact on the stock price. From the transmission channel, the four tools of monetary policy: credit, interest rate, exchange rate and money supply have their own channels to affect the stock price. The increase of money supply, the decrease of interest rate and the increase of credit scale will increase the expectation of investors and increase the flow of funds in the market, which will lead to the rise of stock price; the decrease of money supply, the increase of interest rate and the decrease of credit scale will give investors negative information and reduce the flow of funds in the market, which will lead to the fall of stock price.

(2) At the micro level, as the receiver of monetary policy, the company's stock price is affected by monetary policy from the aspects of credit, cash flow and profitability. In terms of credit, for companies that rely more on external financing, monetary policy will have a greater impact on credit channels; in terms of cash flow, for companies with sufficient cash flow, due to the strong liquidity of cash and the existence of asset substitution, monetary policy will have a smaller impact on them; in terms of profitability, due to the existence of nominal rigidity, monetary policy will have a greater impact on revenue The impact of income is greater than cost. Therefore, for the company whose income is close to the cost, that is, the company with low profitability, monetary policy has a greater impact on it.

(3) In the empirical aspect of the model, we can get the following basic conclusions. First, the effect of interest rate policy decreases with the increase of cash owned by the company, that is to say, the more cash the company has, the more capable it is to weaken the negative impact of monetary policy. Second, companies that are more dependent on external financing are more vulnerable to the impact of interest rate policy, because the monetary policy tool itself includes credit, so it will have a greater impact on companies that are more dependent on credit; third, the effect of interest rate policy increases with the increase of the duration of the company's implied equity, which measures the interest rate risk of the stock, so the longer the time is, the more the stock price is affected by the interest rate Fourth, for companies with low volatility of cash flow, the effect of interest rate policy is smaller; fifth, for companies with weak profitability, the effect of interest rate policy is greater. Therefore, the actual impact of monetary policy on stock price is different for different companies.

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Monetary Policy and Equity Returns: An examination of the mitigating effects of financial constraints

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Abstract: In China's financial market for more than 30 years, many scholars have studied the transmission mechanism of monetary policy. They generally believe that monetary policy will affect the price of risky assets through the changes of money supply, interest rate, exchange rate and credit, and finally transmit to the real economy. However, few scholars have studied the effect of monetary policy on each company in the process of its transmission to the real economy, that is, how different companies are affected by monetary policy. This paper selects panel data of China A-share listed companies from 2008 to 2015, and uses the fixed effect model with cross items to explore the difference of the impact of interest rate policy on the stock prices of different companies, and obtains the following conclusions: first, when the interest rate policy changes, the company with more cash flow will change its stock price less; second, when the interest rate policy changes, the stock price of the company with high dependence on external financing will change more; third, the longer the equity duration, the greater the change of stock price; fourth, companies with high historical cash flow volatility are more affected by monetary policy; fifth, the higher the profitability of the company, its stock price is relatively less affected by monetary policy.

Key words: Monetary policy; Effect of interest rate policy; Fixed effect model;